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GIBBS & HILL, INC.

QUALIFICATION PLAN

NO. QP-12442

DATE June 30, 1978

QUALIFICATION OF CLASS 1E BATTERY CHARGERS FOR

TEXAS UTILITIES SERVICE INC.

COMANCHE PEAK STATION

APPROVED
FOR ARRANGEMENT ONLY
PROCEED WITH FABRICATION
SUBJECT TO COMPLIANCE WITH
ALL CONTRACT REQUIREMENTS,
DRAWINGS, AND SPECIFICATIONS.

SEP 13 1979

GIBBS & HILL, INC.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

PURCHASE ORDER CP-0440B

SPECIFICATION 2323-ES-3B

CLASS 1E EQUIPMENT
NUCLEAR SAFETY
RELATED

Prepared by Lawrence G. Lutz
Lawrence G. Lutz
Product Engineer

Rev. 1 by [signature] Date 26 Nov 78

Approved by [signature] Date 26 Nov 78

Rev. 2 by [signature] Date 16 Feb 79

Approved by [signature] Date FEB 16, 1979

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William F. Neilson Jr.
Manager, Quality Assurance

Approved by Chris F. Seyer
Chris F. Seyer
Executive Vice-President

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REVISION RECORD

REVISION 3 - By Lawrence G. Lutz Date 9 May 79

Approved by Jefferson V. Mitchell Date 5/10/79

REVISION 4 - By Lawrence G. Lutz Date 2 Aug 79

Approved by Jefferson V. Mitchell Date 8/2/79

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NOTICE

THIS PLAN SUPERCEDES ALL DRAFTS PRIOR TO JUNE 16, 1978. THE METHODS AND PROCEDURES INCLUDED IN THIS PLAN INCORPORATE ALL COMMENTS RECEIVED FROM PARTICIPANTS PRIOR TO JUNE 16, 1978.

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(CONT.)

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1.0 SCOPE

This plan will outline the Qualification Program for the Class 1E Battery Chargers for the Comanche Peak Station.

It will demonstrate the capability of the Class 1E Battery Chargers to perform their required function over the qualified life period. The Qualification Program is based upon a combination of analysis and testing. Included in the program is a generic type test of a sample Class 1E Battery Charger. The specific 1E charger or chargers to be qualified in this program are subsequently qualified by analysis and/or testing based upon the generic type test data. At the conclusion of the program, a qualified life for these chargers will be determined. The goal of this program is a qualified life of 40 years. The qualification methods are in accordance with IEEE 323-1974. In addition, the methods utilize guidance from the proposed Standard IEEE P-650 "Qualification of Class 1E Battery Chargers and Static Inverters for Nuclear Power Generating Stations" (Draft #7, May 16, 1978) and IEEE 381-1977. In all cases the Qualification Program will be performed in accordance with the latest available technical data and state of art procedures. The entire Qualification Program will be subject to the requirements of the PCP Quality Assurance Program. The battery chargers discussed in this plan are safety related, however, this document addresses only this equipment as a <u>component</u> in the safety related electrical system. The application of this equipment in the plant's electrical system is not within the scope of this document as industry standards exist for this purpose such as IEEE 308-1974, IEEE 279-1971, and IEEE 603-1977.

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2.0 REFERENCE DOCUMENTS

2.1 The following documents are referenced in the generic Qualification Plan for the sample equipment:

IEEE Standards

A.	100-1977	IEEE Dictionary of Electrical and Electronics Terms
B.	101-1972	IEEE Guide for the Statistical Analysis of Thermal Life Test Data
C.	259-1974	Standard Test Procedure for Evaluation of Systems of Insulation for Specialty Transformers
D.	323-1974	Qualifying Class 1E Electric Equipment for Nuclear Power Generating Stations
E.	344-1975	Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations (ANSI N. 41.7)
F.	352-1975	Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Protection Systems
G.	380-1972	Definitions of Terms Used in IEEE Standards on Nuclear Power Generating Stations
H.	381-1977	Criteria for Type Tests of CLass 1E Modules Used in Nuclear Power Generating Stations
I.	383-1974	Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations
J.	P650 DRAFT 10	(Proposed Standard) Qualification of Class 1E Battery Chargers and Static Inverters for Nu lear Power Generating Stations.

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Military Handbooks

J.	Mil-Hdbk-217-B, Notice 1, 7Sep76	Reliability Prediction of Electronic Equipment

National Electrical Manufacturers Association (NEMA) Standards

K.	PV-5-1976	Constant-Potential Type Electric Utility (Semiconductor Power Converter) Battery Chargers

Other Documents

L.	Wyle Laboratories	Test Plan 545/7611, Revision A dated May 22, 1978
M.		PCP Workmanship Manual
N.		PCP Quality Assurance Manual

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2.2 The following documents will be referenced in qualifying the specific Class 1E Charger or Chargers:

A. Purchaser's Specification 2323-ES-83 Rev. 1 (12-17-76) 2

B. PCP Drawing D-55-15395

Schematic Diagram

C. PCP Drawing D-55-1539

Outline and Parts Layout

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3.0 DEFINITIONS

These definitions establish the meaning of words in the context of their use in this document.

3.1 Age-Related Failure Mechanism - A mechanism of degradation in components or equipment which may result in the failure of the equipment under specified service conditions during the qualified life.

3.2 Aging (Accelerated) - The process of subjecting components or equipment to stress conditions in accordance with known measurable physical or chemical laws of degradation in order to render its physical and electrical properties similar to those it would have at an advanced age operating under expected service conditions.

3.3 Aging (Natural) - The change with passage of time of physical, chemical, or electrical properties of components or equipment under design range operating conditions which may result in degradation of significant performance characteristics. (IEEE Std 381-1977)

3.4 Analysis - A process of mathematical or other logical reasoning that leads from stated premises to the conclusion concerning specific capabilities of equipment and its adequacy for a particular application. (IEEE Std 323-1974)

3.5 Break-In Period - That early period, beginning at some stated time during which the failure rate of some items is decreasing rapidly. Also called early failure period. (IEEE Std 352-1975)

3.6 Burn-In - The operation of components or equipment, prior to type test or ultimate application, intended to stabilize their characteristics and to identify early failures. (IEEE Std 100-1977)

3.7 Common-Mode Failure - Multiple failure attributable to a common cause. (IEEE Std 352-1975) In the context of a single type test, any failure must be examined to determine its potential for occurrence in the same time frame in identical equipment due to the same excitation stress.

3.8 Components - Items from which the system is assembled (for example, resistors, capacitors, wires, connectors, transistors, tubes, switches, springs, etc.). (IEEE Std 380-1972)

3.9 Containment - That portion of the engineered safety features designed to act as the principal barrier, after the reactor system pressure boundary, to prevent the release, even under conditions of a reactor accident, of unacceptable quantities of radioactive material beyond a controlled zone. (IEEE Std 323-1974)

3.10 Demonstration - A course of reasoning showing that a certain result is a consequence of assumed premises; an explanation or illustration, as in teaching by use of examples. (IEEE Std 323-1974)

3.11 Design Basis Events - Postulated events, specified by the safety analysis of the station, used in the design to establish the acceptable performance requirements of the structures and systems. (IEEE Std 323-1974)

3.17 Maintenance Interval - The period, defined in terms of real time, operating time, number of operating cycles, or a combination of these, during which satisfactory performance is required without maintenance or adjustments.

3.18 Malfunction - The loss of capability of Class 1E equipment to initiate or sustain a required function, or the initiation of undesired spurious action which might result in consequences adverse to safety. (IEEE Std 344-1975)

3.19 Operating Basis Earthquake (OBE) - That earthquake which could reasonably be expected to affect the plant site during the operating life of the plant; it is that earthquake which produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional. (IEEE Std 344-1975)

3.20 Operating Experience - Accumulation of verifiable service data for conditions equivalent to those for which particular equipment is to be qualified. (IEEE Std 323-1974)

3.21 Qualified Life - The period of time for which satisfactory performance can be demonstrated for a specific set of service conditions. Note: The qualified life of a particular equipment item may be changed during its installed life where justified. (IEEE Std 323-1974)

3.22 Random Failure - Any failure whose cause and/or mechanism make its time of occurrence unpredictable. (IEEE Std 100-1977)

3.23 Sample Equipment - Production equipment tested to obtain data that are valid over a range of ratings and for specific services. (IEEE Std 323-1974)

3.24 Service Conditions - Environmental, power, and signal conditions expected as a result of normal operating requirements, expected extremes in operating requirements, and postulated conditions appropriate for the design basis events of the station. (IEEE Std 323-1974)

3.25 Stress Analysis - An electrical and thermal design analysis of component applications in specific circuits under the specified range of service conditions.

3.26 Stress Test - A type test performed on a sample equipment which "stresses" the equipment to the specified range of service conditions.

3.27 Type Tests - Tests made on one or more sample equipments to verify adequacy of design and the manufacturing processes. (IEEE Std 323-1974)

3.28 Wear-Out Period - The time interval following the period of constant failure rate, during which failures occur at a greater rate. (IEEE Std 352-1975)

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4.0 IDENTIFICATION OF THE EQUIPMENT TO BE QUALIFIED

The Class 1E Battery Chargers for the Comanche Peak Station will be qualified using analysis and/or testing based upon actual type testing of a sample Class 1E Battery Charger (sample equipment) hereafter called "the sample charger". The specifications for the sample charger are included in Appendix A and condensed below:

Model No. 3SD-130-300 Serial No. 12442-1

AC Input 460 Volts 60 Hz 3 Phase

DC Output 135 Volts 300 Amps

Output Ripple .030 Volts rms

Cabinet Size 75" H 46" W 36" D

By comparison, the Class 1E Chargers for the Comanche Peak Steam Electric Station (CPSES), hereafter called "Station", are detailed in Appendix B and condensed below:

P.O. Item No. CP-0440-B-1

Model No. 3SD-130-300

AC Input 460 Volts 60 Hz 3 Phase

DC Output 135 Volts 300 Amps

Output Ripple .030 Volts rms

Cabinet Size 75" H 46" W 36" D

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P.O. Item No. CP-0440-B-2

Model No. 3SD-130-300

AC Input 460 Volts 60 Hz 3 Phase

DC Output 135 Volts 300 Amps

Output Ripple .030 Volts rms

Cabinet Size 75" H 46" W 36" D

P.O. Item No. ____________

Model No. ____________

AC Input ____________ Volts ________ Hz ________ Phase

DC Output ____________ Volts ________ Amps

Output Ripple ____________ Volts rms

Cabinet Size ________ H ________ W ________ D

P.O. Item No. ____________

Model No. ____________

AC Input ____________ Volts ________ Hz ________ Phase

DC Output ____________ Volts ________ Amps

Output Ripple ____________ Volts rms

Cabinet Size ________ H ________ W ________ D

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5.0 QUALIFICATION OF THE SAMPLE CHARGER

Refer to Figure 1 for a flowchart representation of the qualification process. The flowchart will greatly assist in understanding the qualification steps. Steps 5.1 through 5.5 consist of qualification of the components within the sample charger. In step 5.6, all components are assembled into the complete charger and the charger subjected to a series of type tests to demonstrate the ability of the charger to perform its required function during normal, abnormal, DBE and post DBE service conditions.

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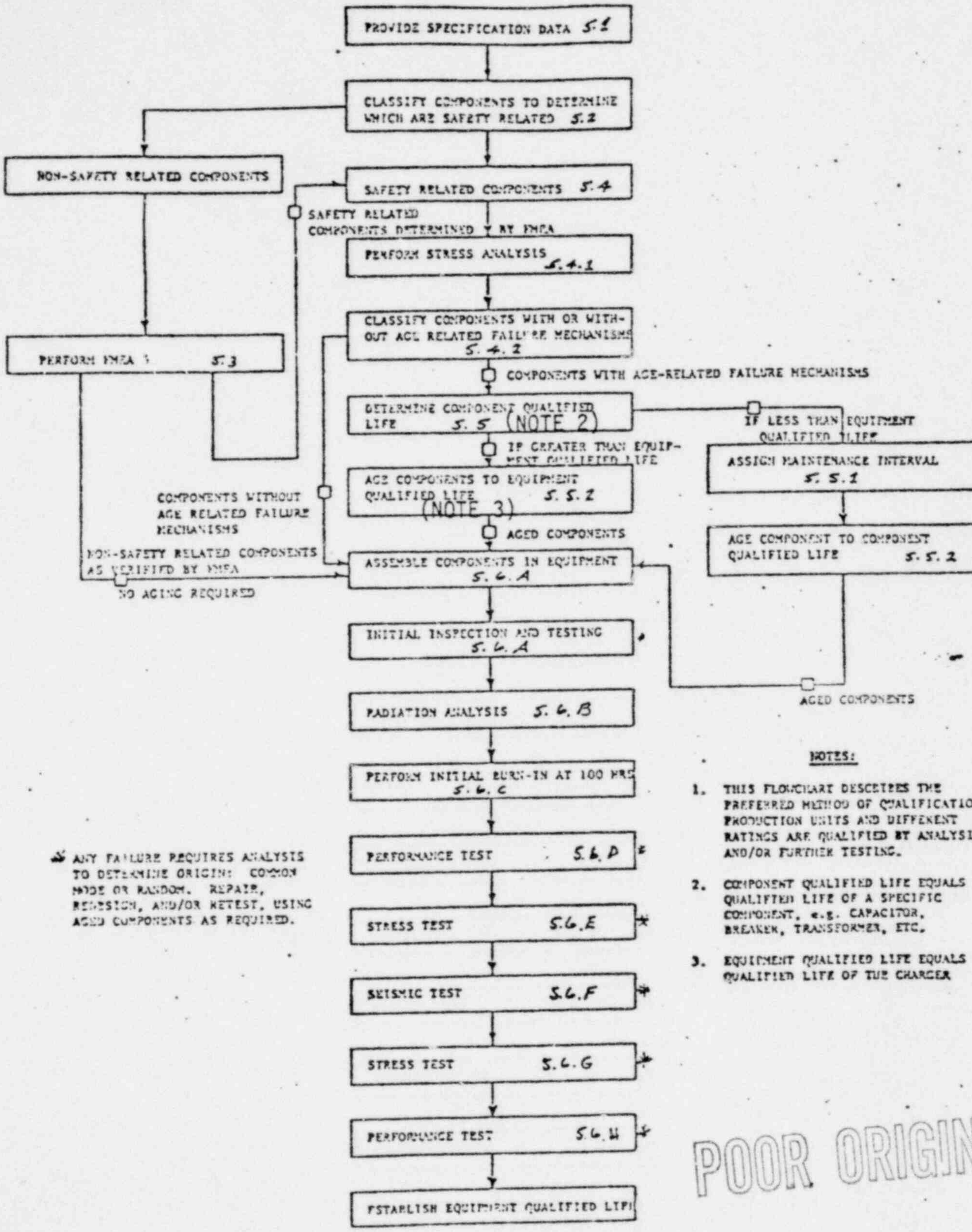
FIGURE 1

FLOWCHART FOR QUALIFICATION OF CLASS 1E BATTERY CHARGERS



NOTES:

1. THIS FLOWCHART DESCRIBES THE PREFERRED METHOD OF QUALIFICATION. PRODUCTION UNITS AND DIFFERENT RATINGS ARE QUALIFIED BY ANALYSIS AND/OR FURTHER TESTING.
2. COMPONENT QUALIFIED LIFE EQUALS QUALIFIED LIFE OF A SPECIFIC COMPONENT, e.g. CAPACITOR, BREAKER, TRANSFORMER, ETC.
3. EQUIPMENT QUALIFIED LIFE EQUALS QUALIFIED LIFE OF THE CHARGER

POOR ORIGINAL

2331 019

5.1 Provide Specification Data

The first step in qualification is to provide specification data for the following:

A. Class 1E performance characteristics

B. All significant environmental parameters

C. All significant service conditions

D. Any other conditions.

The above specifications are provided by those responsible for design application of the equipment. The specifications for the sample charger are contained in Appendix A and are actually a composite of the specifications for many Class 1E Chargers for several nuclear plants.

5.2 Classify Components

Next all components within the sample charger are classified into two categories:

A. Non-safety related components (refer to Appendix C)

B. Safety related components (refer to Appendix D)

Components designated as safety related are those whose failure affects the ability of the charger to perform its required function.

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5.3 Non-Safety Related Components

A Failure Modes and Effects Analysis (FMEA) in accordance with IEEE 352-1975 will be performed on all components designated as non-safety related to demonstrate that the failure of these components as used in the circuit does not affect the ability of the charger to perform its required function. Any component determined to be safety related by the FMEA will be addressed in 5.4. All components classified as non-safety related after the FMEA will be assembled into the sample charger in a new condition without any additional analysis or testing.

5.4 Safety Related Components

All components classified as safety related will be analyzed in accordance with the requirements in this section.

5.4.1 A stress analysis will be performed on all safety related components to demonstrate that no component is stressed to a point where its aging is accelerated beyond that expected in normal operation.

5.4.2 All safety related components will be classified into one of the two categories below:

A. Components with age-related failure mechanisms.

B. Components without age-related failure mechanisms.

The safety related components are classified into the two categories above in Appendix D.

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Components in category 5.4.2.B need not be aged. They will be assembled into the sample charger in a new condition.

5.5 Component Qualification

To qualify components with age-related failure mechanisms the component shal' be aged to the equipment qualified life objective or if the qualified life of the component is less than that of the equipment, then the component shall be aged to its qualified life and assigned a maintenance replacement interval equal to or less than its qualified life.

5.5.1 Determination of Maintenance Replacement Interval

The replacement interval for age sensitive components which cannot meet the desired equipment qualified life will be determined based upon either operating experience or component life test data.

5.5.2 Aging Techniques

Components with age-related failure mechanisms will be aged in accordance with accelerated aging techniques which are technically justifiable and the latest state of art. Actual procedures are specified in Appendices F through K.

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5.6 Equipment Qualification

IEEE Std 323-1974, paragraph 6.3.2, outlines a specific order in which type testing is to be performed. This sequence is not followed in this plan due to the variations in aging rate of the various components. Since the equipment is to be assembled of aged components, testing of the sample equipment must come after the components have been aged and the assembly is complete. The type test sequence in this section includes margin in that the components are subjected to additional stresses after aging.

A. Non-safety related and safety related components will be assembled into a complete piece of equipment (the sample charger) in accordance with the PCP Workmanship Manual and Quality Assurance Manual. Mechanical inspection, dielectric testing and functional testing for normal conditions will be performed in accordance with the procedures in Appendix M. Tests will be conducted to demonstrate the following specification conditions in Appendix A, Section 1.0: A, B, C, D, E, F.

B. Since the battery charger is located outside containment, only low levels (typically 1.0×10^4 rads or less, total integrated dose) of radiation are encountered. Documentation (refer to Appendix N) will be provided to demonstrate that the ability of the equipment to perform its required function is unaffected by the radiation dose specified.

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C. The equipment will be subjected to a minimum burn-in of 100 hours (50 hours at full load, 50 hours at no load) at room ambient temperature. The burn-in places the equipment into its normal installed condition and is intended to eliminate infant mortality failures.

D. In order to establish a reference for the measurement of operating parameters and a valid basis for comparison of test results, the sample charger will be subjected to the conditioning process as follows:
Place the charger into an environmental test chamber which has the capability of being varied both in temperature and humidity over the required service conditions. With the chamber set at an ambient temperature of 25 degrees ± 5 degrees C and prevailing relative humidity, operate the equipment at full load for a period of two hours and document functional performance date for normal conditions in Appendix A,1.0.A, B, C, D, and F. This data will be utilized as reference data for the continued tests to follow. Calibration adjustments may be made to the equipment at this time.

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E. In order to demonstrate that the equipment will meet its specified performance characteristics under the specified abnormal conditions as required by IEEE Std 323-1974 refer to Figure 2 and perform the following stress test to the fully loaded equipment in the test chamber: Allow the chamber to increase to the maximum temperature and maximum relative humidity specified in Appendix A. The equipment will be operated at this level for a period of eight hours at the end of which functional performance data (Appendix A,1.0.A, B, C, D, and F) at maximum, nominal, and minimum input voltages will be documented. Allow the chamber to decrease to the minimum temperature specified in Appendix A and maximum relative humidity attainable. The equipment will be operated at this level for a period of eight hours at the end of which functional performance data (Appendix A,1.0.A, B, C, D, and F) at maximum, nominal and minimum input voltages will be documented. A complete cycle including the transition period will last a maximum of 24 hours. At the end of the test cycle, the equipment will be allowed to stabilize at room ambient temperature and humidity and a final set of functional performance data (Appendix A,1.0.A, B, C, D, and F) at maximum, nominal, and minimum input voltages will be documented. The above stress test is described in Figure 2. This test subjects the complete equipment to the worst case and nominal conditions of temperature, humidity, input voltages and output loads (for battery chargers, input frequency variations have no impact on aging). The stress test also adds additional aging (margin) to the previously aged components. In addition, non-aged components are "soaked" at these conditions after the 100 hour burn-in, thus giving additional age-type stress prior to the seismic test.

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F. The ability of the equipment to withstand the operational vibration requirements specified will be demonstrated by analysis. The equipment will be subjected to a simulated seismic environment as specified in the equipment specification. The testing will be performed per IEEE 344-1975 and the equipment will be operated during and after the seismic test at rated output and within the specified input voltage range. The equipment must meet its required Class 1E function (Appendix A,1.0.G) during and after the seismic test.

G. In order to demonstrate the ability of the equipment to meet its specified performance characteristics during post DBE conditions, an additional stress test using the procedures of 5.6.1.E in accordance with the post DBE conditions will be performed.

H. Upon successful completion of these tests, a functional test shall be performed to meet the performance characteristics for normal conditions specified in Appendix A,1.0.A, B, C, D, and F, and the sample charger will be considered qualified.

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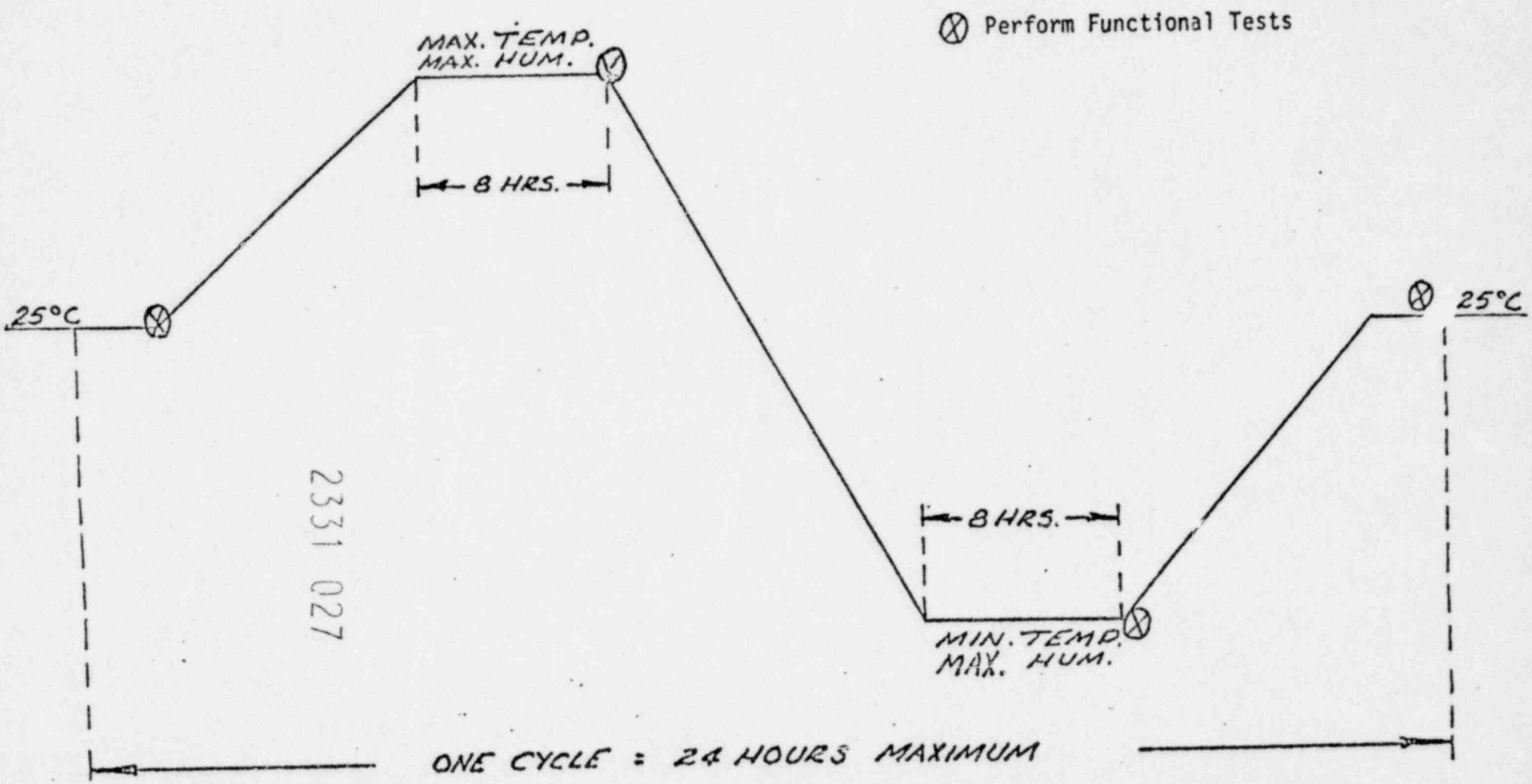
STRESS TEST



Perform Functional Tests
MAX. TEMP.
MAX. HUM.
8 HRS.
25°C
8 HRS.
MIN. TEMP.
MAX. HUM.
25°C
ONE CYCLE = 24 HOURS MAXIMUM

6.0 ACCEPTANCE CRITERIA

In the evaluation of the type test results, any sample equipment is considered to have passed when the equipment meets or exceeds the function required by the equipment specification as determined by the data taken during the type test. If any failure occurs during test steps 5.5.2 and 5.6.C the defective component will be replaced with a component that has been subjected to the same aging as the component which it replaces. Should any failure occur during test steps 5.6.A, 5.6.D, and all subsequent testing, it will be analyzed to determine if it is of random or common-mode origin. The failure will be determined not to be common mode if one of the following criteria is met:

A. Physical examination of the failed component(s) and its interface(s) determines that a workmanship problem was the cause of failure; e.g. improperly tightened connector, cold solder joint, use of an incorrect component, etc.

B. Reexamination of the stress analysis determines that the part is properly applied and any components similarly applied in the test sample have had no like failures and the failure is not repeated during subsequent retesting with replacement components. Note: Consequential component failures caused by the failure of a single component are not considered to be of common mode origin.

If the above or other methods have not identified the cause of failure, further analysis will be conducted.

7.0 COMPARISON OF STATION CLASS 1E CHARGERS TO THE SAMPLE CHARGER

Details will be provided on the differences between the Class 1E Charger to be qualified and the sample charger. A complete analysis of components of the other model ratings to demonstrate that no component of the type aged and qualified in the type tests is stressed at a rate higher than that in the qualified model to the extent that a different aging acceleration would have to be employed. Should the analysis determine that either a different aging acceleration test is necessary or an entirely new generic type of part be employed, the part will be aged and seismic tested as a component or assembly to a level equivalent to the previous qualification level. Note: Different ratings of the same component family are considered type-qualified if the applied stress does not exceed that in the qualification model. A demonstration will be made to verify that the service conditions to which the qualified unit was tested are as severe as those specified for the units being qualified. Each model rating will be seismically qualified by testing and/or analysis in accordance with IEEE 344-1975 and a determination made that the acceleration of components or assemblies which have age-related failure mechanisms does not exceed that of the sample charger.

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8.0 DOCUMENTATION

8.1 The following documents will be provided to verify that the Class 1E Charger or Chargers are qualified:

A. Qualification Plan - The Qualification Plan will contain a description of the methods and procedures used to qualify a Class 1E Charger or Chargers for a specific application.

B. Qualification Report - The Qualification Report will contain the following:

1. Equipment performance specifications
2. Identification of specific features to be demonstrated by the analysis and testing
3. Qualification procedures
4. Qualification results which shall include:
   - A. Failure Modes and Effects Analysis (FMEA) for non-safety related components (5.3)
   - B. Stress analysis (5.4.1)
   - C. Documentation for classification for component qualification (5.4.2)
   - D. Test data, component aging data, accuracy and instrument calibration for each test described in Section 5.5
   - E. Documentation for radiation analysis (Section 5.6.B)
   - F. Specific failure analysis for any failure occuring during the qualification type tests in Sections 5.6.A, 5.6.D, and all subsequent tests.

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   - G. Identification of equipment qualified life with a summary of justification for the qualified life. This shall include any maintenance replacement components or assemblies.

APPENDIX A

Specifications for the Sample Charger

The specifications below represent a composite of specifications for many Class 1E Chargers for nuclear generating stations and will be used in qualifying the sample charger.

1.0 Class 1E Performance Characteristics

A. Input conditions are: 460 VAC ± 10%, 60 Hz ± 5%, 3 Phase

B. Output conditions are: 135 VDC, 300 ADC

C. Output voltage regulation is: ± 0.5% from 0-100% load

D. Output ripple voltage is: 30 mv. rms. without battery connected

E. Surge withstand capability is:

4000 V applied to DC output terminals (10 microseconds)

3000 V applied to AC input terminals (20 microseconds)

F. Output current limit is: 120% of rated output current

G. Required (Class 1E) function is:

1. Rated output is 135 Volts DC, 300 Amps DC with input variations of 414 VAC to 506 VAC.
2. While delivering rated output current and rated output voltage within the input variations specified above, the voltage regulation shall not exceed ± 2%, output ripple shall not exceed 1% rms without a battery connected, and all external alarms contacts will remain operational (will not give false alarms). Maximum relay contact chatter allowed = 30 milliseconds.

APPENDIX A

Specifications for the Sample Charger

(cont.)

2.0 Environment

A. Ambient Temperature

Minimum 32°F (0°C) Maximum 122°F (50°C)

Annual Average 86°F (30°C)

B. Storage Temperature

Minimum 32°F (0°C) Maximum 122°F (50°C)

C. Maximum Relative Humidity

Operating 0 to 95 % Storage 0 to 95 %

D. Minimum Pressure Atmospheric

Altitude 3300 Ft. 1000 meters

E. Operational vibration - not specified

F. Seismic Requirements - See Appendix Q

G. Radiation Type - Gamma

H. Dose Rate 0.25 mr/hr

Total Dose 1×10^4 Rads

I. Radio Frequency Interference (RFI) or Electromagnetic Interference (EMI)

not specified

APPENDIX A

Specifications for the Sample Charger

(cont.)

3.0 Other Considerations

A. Significant sequence, rate of change, or combinations of performance characteristics and environmental limits have not been specified.

B. Duty cycle is continuous.

C. No unusual atmospheric contamination has been specified.

D. All input and output connections will enter the equipment enclosure from the top. The equipment will be welded to the floor.

E. Dielectric test requirements are specified below (refer to NEMA-PV-5-1976):

AC to Ground - 2000 Volts

DC to Ground - 1500 Volts

AC to DC - 1500 Volts

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APPENDIX B

Specifications for the Station Class 1E Battery Chargers

The specifications below include the detailed requirements for the Station Class 1E Battery Chargers. If there are differences between the specifications for the station chargers and those for the sample charger, the differences must be analyzed and justification provided in sections 7.0 and 8.0. Additional analysis and/or testing may be required to verify that the qualification of the Station Class 1E Battery Chargers is valid.

1.0 Class 1E Performance Characteristics

The required Class 1E performance characteristics are specified by those responsible for design application of the charger and include numberical values for normal, abnormal, DBE and post DBE conditions as follows:

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APPENDIX B

Specifications for the Station Class 1E Battery Chargers

(cont.)

A. Input conditions are:

460 ± 10% Volts, 60 ± 5% Hz, 3 Phase 2

B. Output conditions are:

135* Volts 300 Amps * Max. Float Vo` age 2

C. Output voltage regulation is:

0.5% from 0 % load to full load 2

D. Output ripple voltage is:

.030 Volts rms with battery

E. Surge withstand capability is:

4000 volts applied to DC output terminals (10 microseconds)

3000 volts applied to AC input terminals (20 microseconds)

F. Output current limit is:

120 % of rated output current.

2331 035

G. Required (Class 1E) function is:

While delivering rated output current and rated output voltage within the input variations specified above, the voltage regulation shall not exceed ± 1%, output ripple shall not exceed .030V RMS with a battery connected, and all external alarms will remain operational (will not give false alarms). Maximum relay contact chatter allowed = 30 milliseconds 2

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APPENDIX B

Specifications for the Station Class 1E Battery Chargers

(cont.)

2.0 Environment

All significant environmental parameters are specified by those responsible for design application of the equipment. The range of environmental conditions specified below includes normal, abnormal, DBE and post DBE conditions.

A. Ambient Temperature

Minimum 20 °F -6 °C Maximum 122 °F 50 °C

Annual Average 75 °F 24 °C | 2

B. Storage Temperature

Minimum 32 °F ____ °C Maximum 122 °F ____ °C | 2

C. Relative Humidity

Operating 30 to 90 % Storage ____ to ____ %

D. Minimum Pressure atmospheric

Altitude 792 Ft. 241 Meters

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E. Operational Vibration not specified

F. Seismic Requirements See Appendix Q

APPENDIX B

Specifications for the Station Class 1E Battery Chargers

(cont.)

G. Radiation Type gamma

H. Irradiation

Dose Rate 0.25 mR/hr 2

Total Dose 10^3

I. RFI/EMI Requirements not specified

2331 037

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APPENDIX B

Specifications for the Station Class IE Battery Chargers

(cont.)

3.0 Other Considerations

A. Significant sequence, rate of change, or combinations of specified performance and environmental limits listed in 1.0 and 2.0 are identified below:

not specified

B. The duty cycle is ___continuous___.

C. Unusual atmospheric contaminations are specified below:

N/S

D. All input and output connections will enter the equipment from the _X_ top ____ bottom as specified in the outline drawing referenced in section 2.2. The equipment will be _X_ welded _____ bolted to the floor as shown in the outline drawing referenced in section 2.2.

E. Dielectric test requirements are specified below:

AC to Ground ___2000___ Volts

DC to Ground ___1500___ Volts

AC to DC ___1500___ Volts

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APPENDIX C

Evaluation of Non-Safety Related Components

The following items are included in the sample charger. It is believed that the failure of these components will not affect the ability of the charger to perform its safety related function. The justification for this determination will be included in the Qualification Report.

1.0 Quantity 3 Stock No. 0214266050

Manufacturer * 2 Manufacturer's Part No. 26F1059 2

Value and Rating 5mfd/660V. AC Description Paper oil capacitor

2.0 Quantity 3 Stock No. 1102260110

Manufacturer 7 Manufacturer's Part No. FRS 10

Value and Rating 600 Volts AC, 10 Amps Description Fuse

Schematic Symbol F14-16 Function Protect filter capacitors

3.0 Quantity 1 Stock No. 1262603100

Manufacturer 8 Manufacturer's Part No. 6F30A3S

Value and Rating 600V. AC/24 Amps Description Fuse holder

Schematic Symbol F14-16 Function Hold fuses F14-16

* See Appendix E

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power conversion products inc.

APPENDIX C

Evaluation of Non-Safety Related Components

(cont.)

4.0 Quantity 1 Stock No. 0821500320

Manufacturer 36 Manufacturer's Part No. T3S-DMV-050-UW/Scale

Value and Rating 0-500 A. DC Description 2% Accuracy DC ammeter

Schematic Symbol AM Function DC current moni.or

5.0 Quantity 1 Stock No. 0801150320

Manufacturer 36 Manufacturer's Part No. T3S-DVV-150-U

Value and Rating 0-150V. DC Description 2% Accuracy DC voltmeter

Schematic Symbol VM Function DC voltage monitor

6.0 Quantity 1 Stock No. 98-3019 modified

Manufacturer 28 Manufacturer's Part No. 1416

Description 0-120 hour timer

Function Changes charger output from float to equalize manually and from equalize to float automatically.

7.0 Quantity 1 Stock No. DS1

Description Q-55-13034 Rev.) Pilot light assembly

Consists of:

Qty	Manufacturer	Mfg. Part No.	Description
1	29	30099-0	Receptacle
1	29	P5B120	Bulb
1	30	135-3271	Lens

Function AC (on) pilot light

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APPENDIX C

Evaluation of Non-Safety Related Components

(cont.)

8.0 Quantity 1 Stock No. 96-1136

Manufacturer 26 Manufacturer's Part No. B258B

Value and Rating 115 VAC Description AC undervoltage relay

Schematic Symbol K3 Function AC undervoltage monitor

9.0 Quantity 1 Stock No. 96-2771

Manufacturer 27 Manufacturer's Part No. KUP11A15

Value and Rating 115 VAC Description Relay

Schematic Symbol K2 Function Fan-out relay

10.0 Quantity 1 Stock No. 96-1131

Manufacturer 27 Manufacturer's Part No. KUP11D15

Value and Rating 115 VDC Description Relay

Schematic Symbol K1 Function Fan-out relay

11.0 Quantity 1 Stock No. 91-3202

Manufacturer 1 Manufacturer's Part No. DSLV120T2-01

Value and Rating 120 VDC Description Low DC Voltage Relay

Schematic Symbol DSL Function Low DC Voltage Relay

2331 041

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APPENDIX D

Evaluation of Safety Related Components

Items listed on the following pages are safety related components. The column headings are explained below:

DESCRIPTION - the industry standard nomenclature for the component

QTY. - quantity (number of components of this type in the equipment)

STOCK NO. - the internal PCP stock number shown on the bill of material

MFG. APP.E - the manufacturer of this component is listed in Appendix E

MFG. P/N - the manufacturer's part number for this component

RATING - significant parameters (input or output) for this component

REF. DES. - the reference designation on the schematic diagram

FUNCTION - the function of the component in the equipment

AGE-RELATED FAIL. MECH. - age-related failure mechanism; if the component has age-related failure mechanisms, the letter "Y" is shown in this column. If not, the letter "N" is listed.

AGING PRO. (APP.) - the appropriate aging procedure can be found in the appendix listed in this column

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SAFETY RELATED COMPONENT LIST

DESCRIPTION	QTY.	STOCK NO.	MFG. APP. E	MFG. P/N	RATING	REF. DES	FUNCTION	AGE RELATED FAIL. MECH. YES(Y)NO(N)	AGING PROC. (APP.)
Circuit Breaker	1	1314217312	3	THED 136125WL	125A	CB1	AC Protection	Y	F
Circuit Breaker	1	1314240207	3	THJK 426400WL	400A	CB2	DC Protection	Y	F
Wire & Cable	1 Lot		33	EXAR 400			Interconnection	Y	I
Thyristor	6	0657529005	8	CS-400-08-G02	750A/900V	CR1-6	Rectifier/Control	N	
Diode	1	0554731206	5	471PDA120	470A/1200V	CR8	Blocking Diode	N	
Diode	1	0551023003	5	1N3290	100A/300V	CR7	Circulating Diode	N	
Amplifier Board	1	91-2801-1	11	VVCR1001-115/230-1		A2	Control	Y	K
Firing Board	1	91-3113	11	VPH-1019-115-3		A1	Firing Circuit	Y	K
Sensing Board	1	F-55-2819	1	35-130-C8		A3	Control	N	
Transformer	3	04747	1			T1A-C	Power Transformer	Y	H
Choke	1	04606	1			L1	Filter	Y	H
Fuse	6	1106213240	7	KAA400	400A/130V	F1-3,9-11	SCR Protection	N	
Capacitor	10	0221215373	2	86F198	7300MFD150VDC	C1	Filter	Y	J
Fuse	7	1113225010	7	AGC-1	1A,250V	F4-8,12,13	Control Protection	N	
Resistor	6	0132152215	13	0006	150Ω,225W	R1	Bleeder	N	
Switch	1	97-8520	12	8282K14	5A/120VAC	SW2	F/E selection	Y	F
Surge Suppressor	7		20	V250PA40C		D1-D7	Transient Protection	N	
Potentiometer	2	2130525000	16		500Ω,2W	R3,R6	Range Adjustment	N	
Resistor	1	0111032182	16	GD 1	82Ω,1W	R4	Range Adjustment	N	
Cabinet	1	D-55-1538-03	10				Structure	N	

2331 043

D-2

2

4

POOR ORIGINAL

SAFETY RELATED COMPONENT LIST

DESCRIPTION	QTY.	STOCK NO.	MFG. APP. E	MFG. P/N	RATING	REF. DES.	FUNCTION	AGE RELATED FAIL. MECH. YES(Y) NO(N)
Ammeter Shunt	1	90-0525	18	MSB50H7	400A	RS1	Ammeter Shunt	N
Thermal Compound			9	120			Cooling for semi-conductors	N
Terminal Block	1	91-2523	8	1433563		TB1	AC Terminal Block	N
Terminal Block	2	Q-55-13223	1			TB2	DC Terminal Block	N
Terminal Block	1	91-2810	20	EB5		TB3	Alarm Terminal Block	N
Terminal Block	1	91-2813	20	EB5		TB4	Alarm Terminal Block	N
Terminal Block	3	91-2330	19	CJ-2-140		TB5-7	Terminal Block	N
Connector for A3,DSL	2		32	09-01-1121				N
Heat Sink	8	0912275113	9	133-7.5B		CR1-6, 8		N
Heat Sink	2	0913325112	9	133-24.5B		CR1-6		N
Heat Sink	1	0940042211	35	1480610		CR7		N
Glastic Channel	6 Ft.	94-0916	21	1940-1B		Used for Mounting Heat Sinks		N
Glastic Insulator	8	93-6108	21	2015-2A		Used for Mounting Heat Sinks		N
Terminal Block	2	91-2769	17			Used to Mount F1-6,9		N
Fuseholder	8	1261151200	34	342014		Used to Mount F4-8,12,13		N
Relay Socket	1	97-3502	27	27E122		K3	Relay	N
Relay Socket	2	97-3501	27	27E121		K1,2	Mounting*	N
Fuse	1	1126225625	7	ABC¼	¼A	F17	Protection	N
Glastic Insulator	6	94-0921	21	2165-1A		Used for mounting capacitors		N

2331 044

POOR ORIGINAL

power conversion products inc.

APPENDIX E

List of Manufacturers

No.	Manufacturer	Location
1	Power Conversion Products Inc.	Crystal Lake, Illinois
2	General Electric - Capacitors	Columbia, South Carolina
3	General Electric - Breakers	Plainview, Connecticut
4	National	Geneva, Illinois
5	International Rectifier	El Segundo, California
6	Syntron Div., FMC Corporation	Broomfield, Colorado
7	Bussman	St. Louis, Missouri
8	Marathon	Waco, Texas
9	Wakefield	Wakefield, Massachusetts
10	Alloy Welding	Melrose Park, Illinois
11	Vectrol	Lincolnwood, Illinois
12	Cutler-Hammer	Broadview, Illinois
13	Ohmite	Skokie, Illinois
14	Centralab	Milwaukee, Wisconsin
15	Stackpole	Kane, Pennsylvania
16	Allen-Bradley	Milwaukee, Wisconsin
17	Western Cullen	Chicago, Illinois
18	Crompton	Elk Grove Village, Illinois
19	Cinch-Jones	Elk Grove Village, Illinois
20	General Electric-Terminal Blocks	Philadelphia, Pennsylvania
21	Glastic Corporation	Cleveland, Ohio
22	Yokagawa Corporation of America	Elmsford, New York

APPENDIX E

List of Manufacturers

(cont.)

No.	Manufacturer	Location
23	Samuel Harris	Waukegan, Illinois
24	Westinghouse Electric Corporation	Beaver, Pennsylvania
25	Fenwal	Ashland, Massachusetts
26	Time Mark Corporation	Tulsa, Oklahoma
27	Potter & Brumfield	Princeton, Indiana
28	Zenith Timer & Controls	Chicago, Illinois
29	Sylvania	Salem, Massachusetts
30	Dialco	Brooklyn, New York
31	C.T.S. Corporation	Elkhart, Indiana
32	Molex	Lisle, Illinois
33	Haveg, Inc.	Winooski, Vermont
34	Littlefuse	Des Plaines, Illinois
35	Trantec	Columubs, Nebraska
36	Modutec	Norwalk, Connecticut

2331 046

APPENDIX F

Aging Procedures - Circuit Breakers and Switches

(cont.)

1.0 Circuit Breakers

The number of cycles required for all necessary testing prior to plant operation is a maximum of 20 cycles (10 times per year x 2 years). The number of plant maintenance cycles is 4 times per year or 160 times for 40 years maximum. The number of customer planned cycles for equipment or plant maintenance is 2 times per year or 80 times for 40 years maximum. The circuit breakers will be cycled a total of 260 times to simulate 40 years of service. The cycling will occur with a representative charger operating at full rated load.

2.0 Switches (Float-Equalize)

The number of cycles required for all necessary testing prior to plant operation is a maximum of 20 cycles (10 times per year x 2 years). The number of plant maintenance cycles is 4 times per year or 160 times for 40 years maximum. The number of customer planned cycles for equipment or plant maintenance is 12 times per year or 480 times for 40 years maximum. The switch will be cycled during the stress test and seismic test a total of 660 times to simulate 40 years of service.

2331 047

APPENDIX F

Aging Procedures - Circuit Breakers and Switches

General

The predominant age-related failure mode of circuit breakers and switches in typical Class 1E Battery Charger applications is of a mechanical fatigue nature as induced by switching cycles. Due to the continuous operating mode of this equipment, circuit breakers, control and power switches (and their associated annunciating relays) are only cycled during testing, preventive and corrective maintenance and during plant shutdown periods. A determination of anticipated number of cycles during the qualified life will be made based on the sum of the following:

- Number of cycles required for all necessary testing prior to plant operation.
- Estimated number of equipment maintenance cycles.
- Number of customer-planned cycles for any purpose (equipment or plant maintenance, etc.)

The breakers and switches will then be cycled under simulated service conditions. Coil insulation systems associated with the breakers and switches if normally de-energized (e.g. shunt trip coil) need not be aged. If normally energized, they will be aged.

2331 048

power conversion products inc.

APPENDIX H

Aging Procedures - Magnetic Components

General

The life of any magnetic component is determined by the insulation system (IEEE 259-1974). An insulation system will be employed on which thermal evaluation has been performed and correlated temperature versus age data has been done in accordance with IEEE 259-1974. Magnetic components will be subjected to accelerated aging to the desired qualified life at the selected temperature and time in accordance with documented thermal evaluation data. Accelerated aging will be performed in accordance with one of the procedures of section 3.2 of IEEE 259-1974.

Procedures

The following magnetic components are used in the sample charger:

Quantity 3 Part No. 04747

Manufacturer 1 Description Transformer

Schematic Symbol T1A,B,C Function Isolate input and reduce primary AC

Rating 22.56 KVA voltage to usable level.

Class of Insulation 220°C

Max. Hot Spot Temp. 150°C at 35°C ambient 2

2331 049

APPENDIX H

Aging Procedures - Magnetic Components

(cont.)

Quantity 1 Part No. 04606 Rev. 1

Manufacturer 1 Description Choke

Schematic Symbol L1 Function Filter DC output

Rating 2.00 milli-henries at 300 amps DC

Class of Insulation 220°C

Max. Hot Spot Temp. at 150°C at 35°C ambient

In the analysis in this section, the ambient within the cabinet is 5°C above the specified annual average ambient temperature to account for temperature rise within the cabinet. The magnetics above consist of copper magnet wire, steel core material and insulation materials. Thermal degradation of the insulating materials determines the life of these components. The insulation materials consist of layer to layer and wire insulation. The copper magnetic wire used is classified as 220°C insulation. The layer to layer insulation used consists of a high temperature resistant polyamide polymer and is classified as Class H insulation.

2331 050

APPENDIX H

Aging Procedures - Magnetic Components

(cont.)

The insulation curves reveal that operation at 150°C yields an expected life of approximately 1×10^8 hours (using the lower 95% confidence limit). This is an expected life of 100,000,000 hours or 1141 years and far exceeds the qualified life objective. An accelerated aging test will be conducted as described below. Data from the insulation chart will be used to age the magnetics. Testing at 230°C for $7.5 \times 10^2 = 750$ hours is equivalent to 400,000 hours at 150°C (35°C ambient) which exceeds our life objective. The values of maximum hot spot temperatures stated above are based upon PCP engineering design data. Actual hot spot tests have been conducted demonstrating that these values are accurate.

Procedures

1. Equipment required
   - A. Nine (9) transformers - PCP #04747
   - B. Three (3) chokes - PCP #04606
   - C. Hipot tester
   - D. Temperature chamber capable of temperatures = 230°C

2331 051

APPENDIX H

Aging Procedures - Magnetic Components

(cont.)

2. Procedures

   A. Dielectric test magnetics and record.

   B. Energize oven to obtain 230°C ± 3°C

   C. Remove one set of transformers and chokes after 562½ hours to simulate 30 years of life.

   D. Remove the last set after 750 hours to simulate 40 years of life.

   E. Perform an insulation resistance test to check the integrity of the insulation system.

   F. Failure is defined as a dielectric breakdown in any of the components.

2331 052

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APPENDIX I

Aging Procedures - Wire and Cable

General

Wire and cable used will be qualified for temperature, humidity, and time required for normal service of this equipment by the methods described in IEEE Standard 383-1974. The basis for qualification will include pre-aging data to simulate qualified life (such as Arrhenius plots with 95% confidence limits). Wire and cable used in the sample charger will be thermally aged in accordance with this data. Where practical, wire will be aged in harnesses with connectors and terminal blocks attached in order to test the integrity of the connection methods employed in the aged condition. Mechanical cycling of connectors as employed in this equipment is not an aging factor. Interconnections shall be aged by the thermal and mechanical stresses induced by the burn-in test (5.6.C), the stress test (5.6.D), and the seismic test (5.6.E).

Procedures

In accordance with IEEE 383-1974, proceed as follows:

1. Equipment needed
   - A. Two complete wire and cable harnesses acquired from model 3SD-130-300 battery charger, S/N 12442-01.
   - B. One temperature chamber capable of temperatures = 150°C.

2331 053

APPENDIX I

Aging Procedures - Wire and Cable

(cont.)

2. Procedure

   A. Measure and record length of representative sample wire.

   B. Install harness in oven. The harness will be suspended in the oven with continuous air circulation simulating service conditions.

   C. Energize oven to obtain 136°C ± 2°C.

   D. Remove one harness after 126 hours to simulate 30 years life at 35°C annual average ambient within the cabinet. Measure and record length of sample. Failure is defined as more than 50% elongation.

      A representative sample of the aged wire shall be bent around a mandril 40 times to verify lack of brittleness of the wire insulation. Evidence of brittleness to the extent that the wire insulation fractures or cracks shall be cause for rejection.

   E. Remove the last harness after 168 hours to simulate 40 years life at 35°C annual average ambient within the cabinet. Measure and record length of sample. Failure is defined as more than 50% elongation.

      A representative sample of the aged wire shall be bent around a mandril 40 times to verify lack of brittleness of the wire insulation. Evidence of brittleness to the extent that the wire insulation fractures or cracks shall be cause for rejection.

power conversion products inc.

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

General

The life of a DC electrolytic capacitor in filter applications is proportionately related to the core temperature, working voltage and ripple current. Accelerated aging of DC electrolytic capacitors will be achieved by subjecting the capacitors to rated core temperature and rated working voltage for the rated life or less. The rated life is the life published by the capacitor manufacturer when the capacitor is operated within rated conditions. Acceleration factors are developed from the ratio of operation at rated conditions to operation under actual conditions.

Procedures

Quantity 20 Stock No. 0221215373

Manufacturer 2 Manufacturer Part No. 86F 198L

Value/Rating 7300 mfd./150V. DC Description Dry aluminum electrolytic

Schematic Symbol C1 Function Filter capacitor

The rated values for this capacitor are shown below:

Rated life = 500 hours

Rated core temperature = 95^{o}C

Rated working voltage = 150V. DC

Rated ripple current = 9.69 amps

2331 055

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

(cont)

Refer to the specified annual average ambient temperature (Appendix A). The annual average ambient is specified as 30°C. To allow for temperature rise of 5°C inside the cabinet, the ambient air around the capacitor is specified as 35°C. Thus the actual operational values for this capacitor are shown below:

Average ambient temperature = 35°C

Case temperature = 35°C

Core temperature = 35.03°C

Working voltage = 135V. DC 2

Ripple current = 4.07 amps

Core temperature and ripple current calculations are attached at the conclusion of this appendix. Using the life multiplier curves supplied by the capacitor manufacturer (shown at the conclusion of this appendix), the expected life for this capacitor is 500 hours X 202.1 = 101,050 hours. 101,050 hours = 11.5 years, however the manufacturer has stated that this is an expected life in that the capacitor will continue to function after 10 years. It is not an end of life value. 2

2331 056

power conversion products inc.

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

(cont.)

Based upon the above data, the conservative approach dictates that an appropriate replacement interval for these capacitors is 10 years. To age the capacitors to 10 years (87,600 hours), simply operate the capacitors under the following conditions:

Test Hours	Core Temperature	Working Voltage
500	95°C	150V. DC

Since the actual operational ripple current has little affect on raising the core temperature above the ambient temperature, the test temperature (95°C) will be the ambient temperature of the chamber. In the actual test, several samples will be aged to different periods giving a large group of aged capacitors for the equipment test. Test levels are shown here:

Core Temperature	Working Voltage	Test Hours	Life Years
95°C	150V. DC	500	10.0
95°C	150V. DC	400	8.0
95°C	150V. DC	250	5.0

At the end of each test period, the following values will be checked:

(1) Capacitance

(2) ESR (Equivalent Series Resistance)

2331 057

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

(cont.)

Aging Procedure - Capacitors

1. Equipment needed

   A. 80 pieces, capacitor, 7300 mfd. 150 VDC, G.E. #86F198L

   B. Temperature chamber, A+L #BK-110B

   C. 1 voltage source, 150V, 10 A

   D. AC ammeter, 0-5A AC, 0.5% accuracy

   E. Capacitance bridge

   F. Monitoring Equipment

2. Procedure

   A. Measure and record ESR, capacitance of all capacitors.

   B. Connect capacitors in parallel with hook-up wire.

   C. Place capacitors in ovens.

   D. Energize voltage source.

   E. Energize oven to 95^{o}C.

   F. Remove 26 capacitors after 250 hours to simulate 5 years life.

   G. Remove 26 capacitors after 400 hours to simualte 8 years life.

   H. Remove the remaining capacitors after 500 hours to simulate 10 years life.

2331 058

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

(cont.)

2. Procedure (cont.)

I. After each of the above times check parameters in (A) above and record.

J. Failure is defined below:

(1) Capacitance shall not be less than 90% of the published value.

(2) The equivalent series resistance shall not be greater than 175% of the initial measured value.

2331 059

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

(cont.)

Calculations of Ripple Current, Core Temperature and Expected Life

For G.E. 86F198L Capacitors

$$\text{Ripple Current} = \frac{\text{Ripple Voltage}}{\text{Impedance } (X_C)}$$

Ripple voltage is measured at .030 volts at full rated output.

$$X_C = \frac{1}{2\pi fc}$$

$$= \frac{1}{2 \times 3.142 \times 360 \times .0073}$$

$$= \frac{1}{16.512} = 6.05 \times 10^{-2}$$

$$\text{Ripple Current} = \frac{.030}{.0605} = .495 \text{ Amps}$$

2331 060

APPENDIX J

Aging Procedures - DC Electrolytic Capacitors

(cont.)

Calculation of Core Temp

(1) $\text{Core Temp } (^{o}C) = (CRF)\,(103)\left(\frac{I^2 ESR}{AREA}\right)^{.833} + AMB.$

or

(2) $\text{Core Temp } (^{o}C) = (CRF)\,(\text{Case Temp.} - AMB.) + AMB.$

D = Dia. (in.)
L = Case Length (in.)
CRF = Core Rise Factor = 1.068 + .31154 x Can Dia.
AREA = Surface Area of Can = $\frac{\pi D^2}{4} + \pi DL$
I = Ripple Current (Amps)
AMB = Ambient Temperature (^{o}C)
ESR = Equivalent Series Reisstance (ohms)

Acceleration Factors

(3) $A_1 = 2^{(T\,Max-Core)/10}$ (Due to Chemical Kinetics)

(4) $A_2 = \frac{I_L \text{ at Rated Voltage and Temperature}}{I_L \text{ at Derated Voltage and Temperature}}$

(5) $A = A_1 \times A_2$

Table I - Base Life

Type	Life	Ambient Temperature	Design Core Temperature
84F	500 hrs	85°C	95°C
86F	500 hrs	85°C	95°C
88F	1500 hrs	85°C	105°C
92F	1000 hrs	85°C	115°C

2331 061

LIFE MULTIPLIER FOR

TYPE 86F/84F

% RATED VOLTAGE

CORE TEMPERATURE (°C)

	50.	55.	60.	65.	70.	75.	80.	85.	90.	95.	100.
95.	5.3	4.7	4.1	3.5	3.0	2.6	2.2	1.8	1.5	1.2	1.0
94.	5.7	5.1	4.4	3.8	3.3	2.8	2.3	1.9	1.6	1.3	1.1
93.	6.2	5.5	4.8	4.2	3.6	3.0	2.5	2.1	1.7	1.4	1.2
92.	6.8	6.0	5.2	4.5	3.8	3.2	2.7	2.3	1.9	1.5	1.2
91.	7.4	6.5	5.7	4.9	4.2	3.5	2.9	2.4	2.0	1.6	1.3
90.	8.1	7.1	6.2	5.3	4.5	3.8	3.2	2.6	2.2	1.8	1.4
89.	8.8	7.7	6.7	5.7	4.9	4.1	3.4	2.8	2.3	1.9	1.5
88.	9.6	8.4	7.3	6.2	5.3	4.4	3.7	3.0	2.5	2.0	1.7
87.	10.5	9.1	7.9	6.7	5.7	4.8	4.0	3.3	2.7	2.2	1.8
86.	11.4	9.9	8.6	7.3	6.2	5.1	4.3	3.5	2.9	2.4	1.9
85.	12.4	10.8	9.3	7.9	6.6	5.6	4.6	3.8	3.1	[illegible]	2.1
84.	13.5	11.7	10.1	8.5	7.2	6.0	5.0	4.1	3.3	[illegible]	2.2
83.	14.7	12.7	10.9	9.2	7.8	6.5	5.4	4.4	3.6	[illegible]	2.4
82.	16.0	13.8	11.8	10.0	8.4	7.0	5.8	4.7	3.9	[illegible]	2.6
81.	17.4	15.0	12.8	10.8	9.1	7.5	6.2	5.1	4.2	[illegible]	2.7
80.	19.0	16.3	13.9	11.7	9.8	8.1	[illegible]	5.5	4.5	3.6	2.9
79.	20.6	17.7	15.1	12.7	10.6	8.8	7.2	5.9	4.8	3.9	3.2
78.	22.5	19.2	16.3	13.7	11.4	9.5	7.8	6.4	5.2	4.2	3.4
77.	24.4	20.9	17.7	14.8	12.3	10.2	8.4	6.8	5.6	4.5	3.7
76.	26.6	22.7	19.2	16.0	13.3	11.0	9.0	7.4	6.0	4.9	3.9
75.	28.9	24.6	20.8	17.3	14.4	11.9	9.7	7.9	6.4	5.2	4.2
74.	31.4	26.7	22.5	18.8	15.5	12.8	10.5	8.5	6.9	5.6	4.5
73.	34.2	29.0	24.3	20.3	16.8	13.8	11.3	9.2	7.5	6.0	4.9
72.	37.2	31.4	26.4	21.9	18.1	14.9	12.1	9.9	8.0	6.5	5.2
71.	40.4	34.1	28.5	23.7	19.5	16.0	13.1	10.6	8.6	7.0	5.6
70.	43.9	37.0	30.9	25.6	21.1	17.3	14.1	11.4	9.3	7.5	6.0
69.	47.7	40.1	33.4	27.7	22.7	18.6	15.2	12.3	10.0	8.0	6.5
68.	51.9	43.5	36.2	29.9	24.5	20.0	16.3	13.2	10.7	8.6	6.9
67.	56.4	47.2	39.1	32.3	26.5	21.6	17.6	14.2	11.5	9.3	7.5
66.	61.2	51.1	42.3	34.9	28.5	23.3	18.9	15.3	12.4	10.0	8.0
65.	66.5	55.4	45.8	37.7	30.8	25.1	20.3	16.5	13.3	10.7	8.6
64.	72.3	60.0	49.5	40.7	33.2	27.0	21.9	17.7	14.3	11.5	9.2
63.	78.5	65.1	53.6	43.9	35.8	29.1	23.6	19.0	15.3	12.3	9.9
62.	85.2	70.5	57.9	47.4	38.6	31.3	25.3	20.5	16.5	13.3	10.6
61.	92.5	76.3	62.6	51.2	41.6	33.7	27.3	22.0	17.7	14.2	11.4
60.	100.4	82.7	67.7	55.2	44.9	36.3	29.3	23.6	19.0	15.3	12.3
59.	109.0	89.5	73.2	59.6	48.3	39.1	31.6	25.4	20.4	16.4	13.2
58.	118.3	97.0	79.1	64.3	52.1	42.1	33.9	27.3	22.0	17.6	14.1
57.	128.3	105.0	85.5	69.4	56.1	45.3	36.5	29.4	23.6	18.9	15.2
56.	139.2	113.6	92.4	74.9	60.5	48.8	39.3	31.6	25.3	20.3	16.3
55.	151.0	123.0	99.8	80.7	65.2	52.5	42.2	33.9	27.2	21.8	17.5
54.	163.8	133.1	107.8	87.1	70.2	56.5	45.4	36.4	29.2	23.4	18.8
53.	[illegible]	144.0	116.5	93.9	75.6	60.8	48.8	39.2	31.4	25.1	20.1
52.	[illegible]	155.9	125.8	101.3	81.5	65.4	52.5	42.1	33.7	27.0	21.6
51.	208.9	168.6	135.8	109.2	87.7	70.4	56.4	45.2	36.2	29.0	24.9
50.	226.4	[illegible]	146.6	117.8	94.5	75.7	60.7	48.6	38.9	31.1	24.9
49.	245.4	[illegible]	158.3	127.0	101.7	81.5	65.2	52.2	41.7	33.4	26.7
48.	266.0	213.3	170.9	136.8	109.5	87.6	70.1	56.1	44.8	35.8	28.6
47.	288.2	230.6	[illegible]	147.5	117.9	[illegible]	75.3	60.2	48.1	38.5	30.7
46.	312.3	249.3	[illegible]	159.0	127.0	101.4	81.0	64.7	51.7	41.3	33.0
45.	338.3	269.5	214.8	171.3	136.7	109.0	87.0	69.5	55.5	44.3	35.4
44.	366.4	291.3	231.8	[illegible]	147.1	117.3	93.5	74.6	59.6	47.5	38.0
43.	396.9	314.8	250.1	[illegible]	158.3	126.1	100.5	80.2	63.9	51.0	40.7
42.	429.8	340.1	269.7	214.2	170.4	135.6	108.0	86.1	68.7	54.8	43.7
41.	465.3	367.5	291.0	230.8	[illegible]	145.8	116.1	92.5	73.7	58.8	46.9
40.	503.7	397.0	313.8	248.6	[illegible]	156.8	124.7	99.3	79.1	63.1	50.3
39.	545.3	428.8	338.4	267.7	212.2	168.5	134.0	106.6	84.9	67.7	54.0
38.	590.1	463.1	364.9	288.3	228.3	[illegible]	143.9	114.5	91.2	72.6	57.9
37.	638.6	500.2	393.4	310.5	245.6	[illegible]	154.6	122.9	97.8	77.9	62.1
36.	691.0	540.0	424.1	334.3	264.2	209.3	[illegible]	132.0	105.0	83.6	66.6
35.	747.5	583.1	457.2	[illegible]	284.2	225.0	[illegible]	141.7	112.7	89.7	71.5
34.	808.6	629.4	492.7	[illegible]	305.7	241.8	191.7	152.2	121.0	96.3	76.7
33.	874.6	679.4	531.0	417.1	[illegible]	259.9	205.9	[illegible]	129.8	103.3	82.2
32.	945.8	733.2	572.3	448.9	353.5	279.2	221.1	[illegible]	139.3	110.8	88.2
31.	1022.7	791.3	616.6	483.1	380.1	300.1	237.5	188.3	149.5	118.9	94.6
30.	1105.7	853.8	664.4	519.9	408.7	322.4	225.0	202.1	[illegible]	127.6	101.5
29.	1195.3	921.2	715.7	559.5	439.5	346.4	273.9	217.0	[illegible]	136.8	108.9
28.	1291.9	993.7	771.0	602.0	472.5	372.2	294.1	232.9	184.8	146.8	116.8
27.	1396.3	1071.9	830.4	647.8	507.9	399.9	315.8	250.0	198.3	[illegible]	125.3
26.	1508.8	1156.1	894.4	696.9	546.0	429.6	339.1	268.3	212.8	[illegible]	134.3
25.	1630.2	1246.8	963.2	749.7	586.9	461.5	364.1	288.0	228.3	181.2	144.1

*Multipliers resulting in life predictions exceeding 10 years should not be used due to the existence of secondary failure modes not considered in the development of this table.

2331 062

APPENDIX K

Aging Procedures - Circuit and Alarm Boards

Circuit Boards

General

Circuit boards may consist of devices with age-related failure mechanisms and devices without age-related failure mechanisms. An analysis will be performed of all components on the board to determine if any have age-related failure mechanisms. If there are no components with age-related failure mechanisms on the circuit board, it does not have to aged prior to the type test. If there are components with age-related failure mechanisms on the board, the component which has the shortest qualified life determines the qualified life of the board. All components with age-related failure mechanisms will be aged to the qualified life of the "short life" component in accordance with the aging techniques in this section. These components may be aged on or off the circuit board. If aged off the board, care shall be taken to insure that the components are not damaged during assembly onto the board.

2331 063

APPENDIX K

Aging Procedures - Circuit and Alarm Boards

(cont.)

Procedure

A stress analysis of each circuit board will be performed in accordance with Mil-Hdbk-217B to verify that no component is stressed to a point where its aging is accelerated beyond that expected in normal operation. The only "age sensitive" devices which exist on circuit boards A1 and A2 are transformers which will be aged in accordance with Appendix H. The test procedure is described below. After the magnetics are aged to their 40 year life condition, they will be installed in the circuit boards for use in the equipment type test. No other "age sensitive" components are included on the other circuit boards.

The magnetics above consist of copper magnetic wire, steel core material and insulation materials. Thermal degradation of the insulating materials determines the life of these components. The insulation materials consist of layer to layer wire and insulation. The copper magnetic wire used is coated with an insulation consisting of polyurethane with a nylon jacket and is classified as Class A (105 degrees) insulation. The layer to layer insulation used is Kraft Class A paper. An accelerated aging test will be conducted as described below:

2331 064

APPENDIX K

Aging Procedures - Circuit and Alarm Boards

(cont.)

Aging Procedure

1. Equipment To Be Aged

   A. Nine (9) transformers - Vectrol #A31-9010-7

   B. Five (5) transformers - Vectrol #1-9010-119

   C. Fifteen (15) transformers - Vectrol #A-9010-4

   D. Five (5) Vectrol disk torrite transformers

2. Test Equipment

   A. Hi-pot tester

   B. Temperature chamber

3. Determination of Test Parameters

   In order to determine the temperature at which the transformers will be aged, it is necessary to determine the actual operating temperature of the device and utilize this data for calculating aging parameters.

2331 065

APPENDIX K

Aging Procedures - Circuit and Alarm Boards

(cont.)

Aging Procedure (cont.)

4. Procedure

   A. Dielectric test on the magnetics at 1500V.

   B. Install specimens.

   C. Energize oven to desired temperature.

   D. Remove all remaining specimens after specified time to simulate 40 years life. (See test report for details.)

   E. Dielectric test all specimens as in (A) above.

Failure is defined as a dielectric breakdown in any of the specimens.

Alarm Boards

A stress analysis of each alarm board will be performed in accordance Mil-Hdbk-217B to verify that no component is stressed to a point where its aging is accelerated beyond that expected in normal operation. The alarm boards are evaluated below.

Alarm Board Evaluation

A stress analysis will be performed for all alarm boards included within the equipment. The only components on the boards which are age sensitive are the Potter & Brumfield relays which will be analyzed and aged per Appendix G.

2331 066

power conversion products inc.

APPENDIX L

Fuses (Documentation of Non Age-Related Failure Mechanisms)

Fuses in Class 1E Battery Chargers are used to protect semiconductors, instrumentation and power and control circuits. A stress analysis will be furnished to demonstrate that the fuses are properly applied in circuits with respect to ampacity, voltage and temperature. Specifically, adequate temperature margin will be provided to preclude an increase in temperature rise at the fuse or fuse holder termination beyond the fuse rating. Documentation will be provided to verify that, subject to the design and inspection programs above, age does not represent a common mode failure for the fuses used.

2331 067

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APPENDIX M

Mechanical and Electrical Test Procedures

The following mechanical inspection and electrical test procedures will be followed as referenced in the Qualification Type Test (section 5.6):

A. Mechanical Inspection

The battery charger will be given a complete visual and mechanical inspection. The following inspection points will be verified:

1. All units to be checked to assure there are no loose nuts, bolts, screws, or parts loose in chassis.
2. No components missing.
3. All components tight.
4. Al nuts tight.
5. Lockwashers on all screws, except where a rivnut is used.
6. Screws in all holes.
7. Proper size hardware used: lugs, screws, nuts, etc.
8. Wires extending through lugs flush or not over 1/16 inch.
9. Lugs will be mounted as follows: 1 lug, open side down, 2 lugs, bottom one, open side down and top one, open side up.
10. Stress bend in all wires and leads.
11. Wires harnessed and run neatly.
12. Wires not against or close enough to any heat-producing component which could cause deterioration of wire insulation.

2331 068

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

A. Mechanical Inspection (cont.)

13. No burned insulation or components.
14. Wires not too tight or too much excess wire.
15. Components flush on board except where mounted with clamp or potted.
16. Tracks on P.C. boards not cut or broken.
17. Proper soldering of all solder connections.
18. Serial number tag installed.
19. P.C. boards and all components and parts clean of all solder and flux.
20. No scratches on chassis or units.
21. All units to be blown out.

B. Electrical Inspection

Note: Industry standard, NEMA PV-5-1976 shall be the basis of resolving any questions of interpretations and procedures unless specifically excluded.

1.0 Test configuration and test equipment shall be arranged as shown in Dwg. Q-55-13327-323.

1.1 Input waveform of the supply line shall not contain more than 3% waveform distortion from a normal sinewave.

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

1.2 If the supply voltage is polyphase, the line to line unbalance must be less than 5% at the start of test. Line balance shall be verified with the unit operating at full load.

1.3 Input metering requirements:

1.3.1 Input voltage to the unit under test (UUT) shall be measured with an AC voltmeter accurate to at least 2% and readable to 2%. Voltage measurements shall be made at the UUT input terminal connections.

1.3.2 Input current to the UUT shall be measured with a current transformer type AC ammeter accurate and readable to at least 2%. Care shall be taken that the meter shall read only the UUT current. Note: If the UUT input current imbalance exceeds 10%, discontinue testing.

2.0 Output connections

Unless otherwise specified, the UUT output shall be connected to the resistive load bank cables that are bundled together. The cables shall be sized such that under full load current (FLC) the total voltage drop between the UUT and the load shall be less than 0.1 VDC.

2331 070

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APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

2.1 UUT output voltage shall be measured at the UUT output terminals with a meter accurate to ¼%. Note: For routine testing of identical products, the voltage measurement may be made with a DC voltmeter accurate to 1% and repeatable to 1% provided that:

a. Periodically the product is verified to conform to specification requirements with a meter of ¼% accuracy, and

b. The UUT performance is such that the worst case of meter error and unit performance combined will be within specification limits.

2.2 UUT output current shall be measured with a calibrated shunt and millivoltmeter accurate to ½%. The shunt shall be connected between the UUT negative output terminal and the negative load cable. Note: For routine testing of identical products the output current readings may be made with a calibrated direct reading ammeter or shunt and millivolt meter accurate to 2% provided that the output current is set by the load conditions such that the load current shall be at least 2% above the required FLC.

2331 071

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

2.3 UUT ripple voltage measurement shall be read at the output terminals of the charger with a true RMS or Quasi-RMS reading AC voltmeter accurate to at least 2%. Note: For routine testing of identical products ripple measurements may be made with an RMS calibrated peak reading AC voltmeter provided that:

a. Evidence is established that the UUT ripple waveform does not contain abnormal noise components (by periodic oscilloscope observation) and

b. True RMS readings are taken periodically.

2.3.1 When specified by the specifications (Appendix A), output noise measurements may require one or more of the following special measurements:

a. Readings at the UUT output terminals

b. Oscilloscope records (photographs) of the noise

c. Peak to peak measurements (oscilloscope)

2331 072

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

3.0 Performance Testing

3.1 Testing will be conducted as specified in section 5.6 and will normally be in the sequence listed in Table 1. However, for reasons of efficiency, the test sequence may be altered, provided that:

a. In all cases the dielectric strength test must be performed before any other electrical testing is attempted, and

b. All of the tests required by Table 1 are completed.

Table 1

Test Name	Spec. Para.
Dielectric Strength	4.1
Circuit Operation	4.2
Range Adjustment	4.3
Overload Set	4.4
Voltage Regulation	4.5
Ripple Voltage	4.6
Surge Withstand	4.7

2331 073

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

4.0 Detailed test procedures

4.1 Dielectric strength testing shall be in accordance with NEMA PV-5-6.02 except that where experience has shown that the short circuiting of semi-conductors and capacitors is not required it may be omitted. Dielectric testing shall be performed before the burn-in only.

4.2 Circuit operation testing shall proceed only after successful completion of the dielectric strength test.

4.2.1 Apply AC voltage to the UUT, while monitoring the input current, input voltage, output voltage, and UUT meters. As soon as it is established that the UUT is performing properly, adjust the input AC to its nominal value, verify adjustment of controls, etc.

4.3 Range adjustment shall be performed with the UUT operating under nominal input conditions, and an output load of approximately 50%. Unless otherwise specified, the following ranges will apply. Note that the UUT must exceed the indicated ranges but not exceed the absolute limits.

2331 074

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

UUT Volts	Float Range	Equalize Range	Float "Setting"	Absolute Limits Float	Absolute Limits Equalize
130	124.8-135.2	134.2-145.2	130.2	100 min.	150 max

4.4 Overload setting (current limiting) shall be performed with the UUT adjusted for its nominal setting, as defined above, in the float mode, with the load connected and the input voltage at nominal line. Increase the load current to 125% FLC,* keeping the input voltage at nominal line, and adjust the overload setting to secure the following output voltage under the above conditions.

UUT Setting	Overload Output Volts
130.2	105.0 $\pm$ 5

* Other values than 125% FLC may be required by the detailed specifications (Appendix A). When provided, transfer to the equalize mode and verify that the UUT meets the above table also.

2331 075

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

4.5 Voltage regulation testing shall be performed to demonstrate that the combined effects of line and load variations will not result in a deviation in charger output greater than that allowed by the UUT specification. Since a UUT is being delivered with the float and equalize settings not factory set, it is not necessary to establish the exact set point for this test. At no time will a UUT be acceptable if it evidences a negative slope-to-load regulation curve, i.e. voltage must not increase with increasing load. Note: Normally as a convenience, the data required for ripple voltage should be taken simultaneously with the data for voltage regulation. Proper readings of meters should be noted during regulation testing.

Definition of Regulation (Ref. 2.8, PV-5-1.14):

$$\pm\% \text{ Regulation} = \frac{E(h) - E(1) \times 100}{E(h) + E(1)}$$

Where: E(h) is the highest UUT output voltage recorded

E(1) is the lowest UUT output voltage recorded

2331 076

APPENDIX M

Mechanical and Electrical Test Procedures

(cont.)

B. Electrical Inspection (cont.)

4.5.1 Voltage regulation records for performance testing will be taken with the UUT in the float mode, resistive load connected, and with input ovltages of rated low, nominal and high line. A minimum of five different levels of load current shall be taken as follows: 100% FLC, 75% FLC, 50% FLC, 25% FLC, 0* FLC.
* "0" indicates that the UUT will have no load resistance connected but may be supplying "trickle" charging to the test battery (if present). As a practical matter 1% or less FLC will be accepted as "0".

4.6 Output ripple measurements are taken across the output terminal of the battery charger. The RMS reading will be taken at full load only and no load. Full load is the worst case condition.

4.7 AC and DC transient surges shall be applied across the input and output terminals respectively as specified in NEMA-PV-5-6.14. The surges used shall be equivalent to or greater than those specified in Appendix A. The surge withstand test shall be performed before the burn-in (5.6.C).

2331 077

ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.

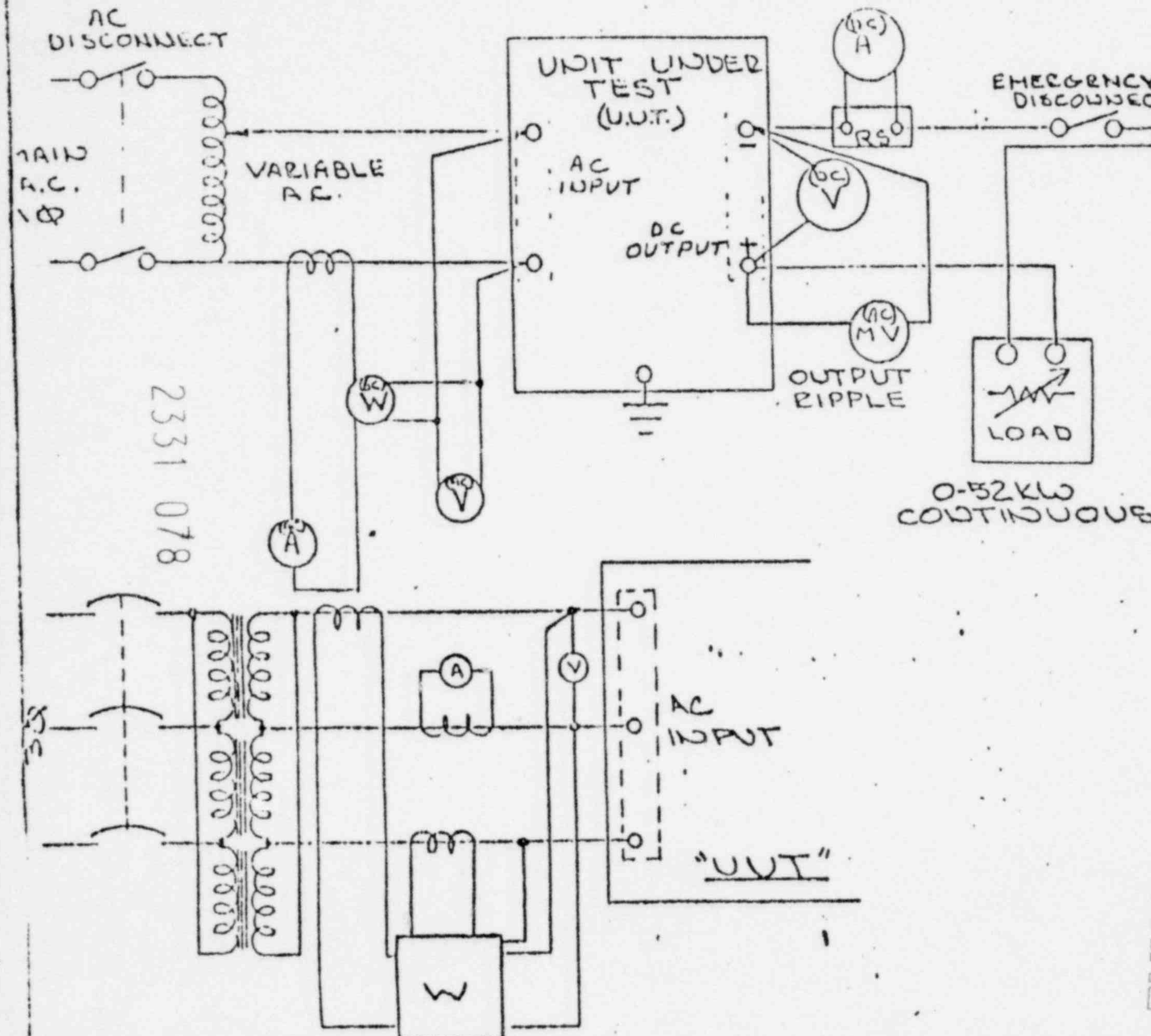
ALLOWABLE VARIATION ON ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ±

PART NO. Q-5 13227-32

power conversion products, crystal lake, Illinois 60014

TITLE UNIT TESTING CONFIGURATION

SCALE	DATE	DRAWN	CHECKED	APP
NONE	26 JUN 78	EA		4



MATERIAL

WEIGHT PER 1000 PIECES

GROSS NET

TREATMENT AND FINISH

CUSTOMER'S NAME

REVISIONS

NO.	DATE	DESCRIPTION

PART NO. Q-55-13227-32

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APPENDIX N

Radiation Data Search Report

IRT Corporation Report INTEL-RT-5199-001 Rev. 1-7/16/76 documents that the material and components included within the sample equipment are not affected by radiation levels of 1.4×10^3 rads gamma integrated dose. Additional data is furnished in the report to document no affects at 1.0×10^4 rads. In a telephone conversation with Mr. John Harrity of IRT Corporation on November 18, 1977, it was specified by Mr. Harrity that a maximum dose rate of 1.0×10^7 rads/sec. would not affect the performance of these components over the integrated doses specified in the report. This level exceeds the level specified in Appendix A and thus the equipment is qualified for the radiation level specified. A copy of the report will be included in the complete Qualification Report.

2331 079

power conversion products inc.

APPENDIX O

Burn-In Test Procedures

1.1 The battery charger will be subjected to 50 hours continuous operation with nominal 480 VAC, 3 phase power input and no load on the 135 VDC output. *

1.2 The battery charger will be subjected to 50 hours continuous operation with nominal 480 VAC, 3 phase power input and PCP furnished 300 amp load on the 135 VDC output. * The 480 VAC input power consumption will be approximately 100 amps.

* Note: Refer to Appendix A. This value may range from 125 volts to 135 volts DC depending upon the number and type of battery cells used in the application. The value of 135 volts DC will be used in the burn-in test as it is the "worst case" condition.

2331 080

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APPENDIX P

Stress Test Procedures

1.1 The battery charger will be subjected to 8 hours continuous operation in a environmental chamber with nominal 480 VAC, 3 phase power input at 50°C (122°F), 90 to 95% relative humidity. Operation will be at 300 amps load at 135 VDC. *

1.2 The environmental chamber will be cooled to 0°C (32°F), using CO_2, as rapidly as possible, while maintaining the humidity at the maximum attainable level.

1.3 The battery charger will be operated at the 300 amp output load for 8 hours at 0°C, 90-95% relative humidity.

1.4 The environmental chamber will be shut down and the temperature allowed to return to ambient. The AC input power to the battery charger will be disconnected during this period.

1.5 The above test will be conducted over a 24 hour maximum period.

* The value of 135 volts DC will be used in the stress test as it is the "worst case" condition.

2331 081

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APPENDIX Q

Seismic Test Procedures

1. Mounting

1.1 Specimen Orientation

A 130 volt battery charger, approximately 75" high x 26" wide x 36" deep, weighing approximately 3000 pounds, hereinafter called the specimen, will be placed on the Wyle multiaxis Seismic Simulator Table such that the base of the specimen will be flush with the top of the table. The specimen will be oriented such that its longitudinal axis will be colinear with the longitudinal axis of the table. For the second axis of test, the specimen will be rotated 90 degrees in the horizontal plane.

1.2 Specimen Tie-Down

The mounting base of the specimen will be welded to the Wyle Multiaxis Seismic Simulator Table. The mounting of the specimen will simulate as closely as practical the actual in-service configuration. Welding procedures will be in accordance with PCP process specification 77-15 and 77-16. 3

2331 082

APPENDIX Q

Seismic Test Procedures

(cont.)

2.0 Excitation

2.1 Simultaneous Biaxial Excitation

Each horizontal axis will be excited separately, but each one will be excited simultaneously with the vertical axis (longitudinal simultaneous with vertical, then lateral simultaneous with vertical). The horizontal and vertical input acceleration levels will be phase incoherent during the multifrequency tests.

2.2 Resonant Search Test

A low-level (approximately 0.2 g horizontally and vertically) biaxial sine sweep shall be performed to determine resonances in both the front-to-back/vertical and the side-to-side/vertical orientations. The sweep rate will be one octave per minute from 1 Hz to 50 Hz.

2331 083

APPENDIX O

Seismic Test Procedures

(cont.)

2.3 Multifrequency Tests

The specimen will be subjected to 30 second duration simultaneous horizontal and vertical phase-incoherent inputs of random motion consisting of frequency bandwidths spaced one-third octave apart over the frequency range of 1 Hz to 40 Hz. The amplitude of each one-third octave frequency bandwidth will be independently adjusted in each axis until the Test Response Spectra (TRS) envelope the Required Spectra. The resulting table motion will be analyzed by a spectrum analyzer at a damping of 1%, 2%, 5% OBE, and 2%, 3%, 5% SSE and plotted at one-third octave frequency intervals over the frequency range of interest. In addition to the required tests, calibration tests will be performed.

Five (5) Operating Basis' Earthquake (OBE) tests, followed by a full-level Design Basis Earthquake (DBE) test will be performed in both the front-to-back/vertical and the side-to-side/vertical orientations. This sequence of tests satisfies the aging requirements of the IEEE Standard 344-1975.

2331 084

APPENDIX Q

Seismic Test Procedures

(cont.)

2.3 Multifrequency Tests (cont.)

The OBE and DBE Required Response Spectra (RRS) will be generated by making composites (horizontal and vertical) of the Required Spectra for the applicable power plants. The appropriate RRS is attached. A 10% margin will be added to the RRS to satisfy the conservatism requirements of the IEEE Standard 323. It is assumed that the Required Response Spectra will be within the capabilities of the Wyle test machine.

2.4 Excitation Control

Control accelerometers will be mounted on the table at locations near the base of the specimens.

3.0 Specimen Response

Twenty two each specimen-mounted uniaxial piezo-electric accelerometers will be located on the test specimen during the test program. FM tape and oscillograph recorders will provide a record of each accelerometer response. Transmissibility plots of the specimen response accelerometers from the resonant search tests will be provided. Test Response Spectrum plots of the control and specimen-mounted accelerometers will be provided from one Design Basis Earthquake (DBE) test and one OBE test in each test orientation.

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APPENDIX Q

Seismic Test Procedures

(cont.)

3.0 Specimen Response (cont.)

Horizontally-oriented accelerometers and vertically-oriented accelerometers will be placed at the several location.

4.0 Electrical Powering

Electrical powering of 480 VAC, 3 phase, 60 Hz, at 100 amperes or less, for operation of the specimen will be provided.

5.0 Electrical Monitoring

Five (5) channels of electrical monitoring will be recorded on an oscillograph recorder during the test program. These channels may be used to ascertain electrical continuity, spurious or improper operation, contact chatter, etc., before, during and after the seismic excitation. The following will be monitored on the test specimen:

1) AC input voltage phase A to phase B
2) AC input voltage phase B to phase C
3) DC output voltage
4) DC output current
5) Normally closed (when charger is operating) contacts of all the alarms

2331 086

APPENDIX Q

Seismic Test Procedures

(cont.)

6.0 Electrical Load

A resistive load (300 amps DC) will be connected to the specimen 135 VDC output during the test program.

7.0 In-Process Inspection

The records will be checked for equality of performance after each test.

The specimen will be examined for possible damage following all violent tests such as at severe structural resonance.

All important vibration effects will be logged (including specimen response at all accelerometer locations).

Photographs will be taken of any noticeable physical damage that may occur.

8.0 Report

A certification-type report will be issued subsequent to completion of testing. This report will be signed by a Registered Professional Engineer and will summarize the maximum g levels, details and recommendations concerning deficiencies and repairs, photographs of test setups, accelerometers, failures, etc. The report will also contain a list of test equipment used, calibrations, and Instrumentation Log Sheets and transmissibility plots of all accelerometers.

2331 087

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FOR ANY ADDITIONAL INFORMATION

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EXECUTIVE VICE-PRESIDENT

2331 088

TEXAS UTILITIES SERVICES, INC.
AGENT FOR
TEXAS UTILITIES GENERATING COMPANY
ACTING FOR
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

COMANCHE PEAK STEAM ELECTRIC STATION
UNIT NOS. 1 & 2

IEEE 323-1974 ENVIRONMENTAL QUALIFICATION OF
BATTERY CHARGERS
IEEE 344-1975 SEISMIC QUALIFICATION OF
BATTERY CHARGERS

SPECIFICATION NO: 2323-ES-8B
PURCHASE ORDER: CP-0440B
VENDOR: POWER CONVERSION PRODUCTS, INC.

1. QUALIFICATION PLAN: #QP-12442, REV. 4

2. QUALIFICATION REPORT: #QR-12442, REV. 3

2331 089

GIBBS & HILL, INC.
ENGINEERS-DESIGNERS-CONSTRUCTORS
NEW YORK

TEXAS UTILITIES SERVICES, INC.
AGENT FOR
TEXAS UTILITIES GENERATING COMPANY
ACTING FOR
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

COMANCHE PEAK STEAM ELECTRIC STATION
UNIT NOS. 1 & 2

IEEE 323-1974 ENVIRONMENTAL QUALIFICATION OF
BATTERY CHARGERS
IEEE 344-1975 SEISMIC QUALIFICATION OF
BATTERY CHARGERS

SPECIFICATION NO: 2323-ES-8B
PURCHASE ORDER: CP-0440B
VENDOR: POWER CONVERSION PRODUCTS, INC.
QUALIFICATION PLAN: #QP-12442, REV. 4
UALIFICATION REPORT: #QR-12442, REV. 3

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& HILL, INC.
IGNERS-CONSTRUCTORS
EW YORK