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21 November 2006

# PERFORMANCE SPECIFICATION

## SWITCH, BUS TRANSFER, ELECTRIC POWER, AUTOMATIC

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A FSC 6110

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
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IN REPLY REFER TO
4121
Ser 05Z/584
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From: Commander, Naval Sea Systems Command (SEA 05, CHENG)

Subj: CHENG'S INTENT FOR IMPLEMENTATION OF ELECTRIC POWER AUTOMATIC BUS TRANSFER SWITCHES

Ref: (a) MIL-PRF-17773D(SH), Switch, Bus Transfer, Electric Power, Automatic
(b) NAVSEAINST 4120.8, NAVSEA Policy for Commonality of Systems, Subsystems, and Components

1. Purpose. The NAVSEA Chief Engineer's (CHENG's) intent for revising reference (a) is to include requirements for "fast acting" automatic bus transfer switches (ABTs) which can provide an alternative to static or solid state automatic bus transfer switches (SABTs).

2. Discussion. NAVSEA's commonality and variation reduction program, per reference (b), determined a revised ABT specification was needed. The recommendation from the commonality deep dive study was to provide an option to replace SABTs with ABTs for shipboard applications when suitable replacements were available. The specification includes technical requirements for the new model "fast acting" ABTs. The new "fast acting" ABTs can be used in shipboard applications which were only able to utilize SABTs in the past. The "fast acting" ABTs will be a more cost-effective alternative to SABTs, which have a higher initial cost and a total cost of ownership. This revision also incorporates changes to qualification retention testing set forth in the previous interim amendment.

3. Action. NAVSEA encourages the use of reference (a) in future acquisitions of ABTs to enhance commonality of requirements and parts and encourages the option to replace SABTs with ABTs for shipboard applications where suitable replacements are available.

4. Point of Contact. For information pertaining to SABTs or ABTs, please contact the Machinery - Electrical Systems - Surface Ships Technical Warrant Holder, Gene Blalock, SEA 05Z32, commercial: (202) 781-3192, email: gene.blalock@navy.mil.

L. B. FULLER
By direction

Affixed to: MIL-PRF-17773D(SH)

This specification is approved for use by the Naval Sea Systems Command and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the electric power Automatic Bus Transfer Switch (ABT) (see 6.4.1), herein referred to as ABT or switch(es), for use on surface and submarine naval vessels. Requirements for Static or Solid State ABTs (SABTs) are not defined in this specification. MIL-PRF-32150 specifies requirements for SABTs.

1.2 Classification. ABTs have the following characteristics: (Part or identifying number [PIN] codes are provided along with the classifications to avoid unnecessary duplication of information in 1.3.)

1.2.1 Voltage. The ABT voltages are as follows:

| Voltage (V) | PIN Code |
|---|---|
| 120 V | 1 |
| 208 V | 2 |
| 240 V | 3 |
| 450 V | 4 |
| Other | 6 |

1.2.2 Frequency. The ABT frequencies are as follows:

| Frequency | PIN Code |
|---|---|
| 60 Hz | A |
| Direct Current (DC) | D |
| 400 Hz | F |

1.2.3 Configuration type. The ABT configuration types are as follows:

| Configuration Type Description | PIN Code |
|---|---|
| ABT has:<br>(a) the option for control circuit time delay (see 6.4.6) (less than 500 milliseconds) when specified (see 6.2), **and**<br>(b) single-phase monitoring (see 3.4.1.13 and 6.4.23) on normal bus, **and**<br>(c) is normal-seeking (see 6.4.14), **and**<br>(d) unless otherwise specified (see 6.2), has a total transfer time ($T_{Total}$) (see 3.4.1.6) of less than 550 milliseconds. | 21 |
| ABT has:<br>(a) the option for control circuit time delay (less than 500 milliseconds) when specified (see 6.2), **and**<br>(b) three-phase monitoring (see 3.4.1.12 and 6.4.9) on normal bus, **and**<br>(c) is normal-seeking, **and**<br>(d) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 550 milliseconds. | 22 |
| ABT has:<br>(a) the option for control circuit time delay (less than 500 milliseconds) when specified (see 6.2), **and**<br>(b) line circuit time delay (see 6.2 and 6.4.13) **or** in-phase monitoring [1/] (see 6.2 and 6.4.10), **and**<br>(c) single-phase monitoring on normal bus, **and**<br>(d) is normal-seeking, **and**<br>(e) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 3.0 seconds. | 23 |
| ABT has:<br>(a) single-phase monitoring on normal bus, **and**<br>(b) is power-seeking (see 6.4.18), **and**<br>(c) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 500 milliseconds. | 24 |
| ABT has:<br>(a) control circuit time delay (300 to 500 milliseconds) on voltage sensing, **and**<br>(b) single-phase monitoring on normal bus, **and**<br>(c) random transfer (see 6.4.20) below 25 percent voltage, **and**<br>(d) contains in-phase monitoring [1/], **and**<br>(e) transfer on frequency sensing, **and**<br>(f) unless otherwise specified (see 6.2), a $T_{Total}$ of less than 550 milliseconds. | 25 |
| ABT is for DC only and has:<br>(a) no line circuit time delay, **and**<br>(b) single-phase monitoring on normal bus, **and**<br>(c) is power-seeking, **and**<br>(d) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 550 milliseconds. | 26 |
| ABT has:<br>(a) single-phase monitoring on normal bus, **and**<br>(b) senses voltage and frequency, **and**<br>(c) is power-seeking, **and**<br>(d) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 570 milliseconds. | 27 [2/] |

| Configuration Type Description | PIN Code |
|---|---|
| ABT is similar to configuration type (CT) 27 with additional current sensing on load terminals to inhibit transfer (see 6.4.24) during overload conditions. | 28 2/ |
| ABT is the same as CT23, but is:<br>(a) three-way, **and**<br>(b) normal seeking between normal and alternate, **and**<br>(c) power seeking to emergency, **and**<br>(d) automatically signals the start of the emergency power source, **and**<br>(e) automatic starting of emergency/auxiliary generator, **and**<br>(f) open mounting type 3/, **and**<br>(g) facilities for dead front mounting, **and**<br>(h) DC has no line circuit time delay, **and**<br>(i) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 3.0 seconds. | 29 |
| ABT has:<br>(a) control circuit time delay 2.5 to 3.5 seconds, **and**<br>(b) single-phase monitoring on normal bus, **and**<br>(c) in-phase monitoring 1/, **and**<br>(d) is normal-seeking, **and**<br>(e) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 4.0 seconds. | 30 |
| ABT is the same as CT23, but is power-seeking. | 31 |
| Fast Acting ABT has:<br>(a) three-phase monitoring, **and**<br>(b) is normal-seeking, **and**<br>(c) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 50 milliseconds. | 40 2/ |
| Fast Acting ABT has:<br>(a) three-phase monitoring, **and**<br>(b) is power-seeking, **and**<br>(c) unless otherwise specified (see 6.2), has a $T_{Total}$ of less than 50 milliseconds. | 41 2/ |
| FOOTNOTES:<br>1/ Random transfer applies if in-phase monitoring is specified (see 3.4.1.2.2 and 3.4.1.14).<br>2/ Has re-transfer stabilization time (see 3.4.1.10).<br>3/ Applies for switchboard ABTs; not bulkhead mounted ABTs.<br>NOTE:<br>1. In-phase monitoring is not used in 400-Hz ABTs on naval vessels. | |

1.2.4 Special features. The ABT special features are as follows:

| Special Feature | PIN Code |
|---|---|
| Special feature(s) | S |
| No special feature(s) | X |

1.2.5 Current rating. The ABT current ratings are as follows:

| Current Rating | PIN Code |
|---|---|
| 25 to 600 A | XXX |

1.2.6 Cabinet integrity. The ABT cabinet integrities are as follows:

| Cabinet Integrity | PIN Code |
|---|---|
| Drip-proof | D |
| Splash-proof | S |
| Watertight | W |
| Open mounted | O |

1.3 Part or identifying number (PIN). PINs to be used for ABTs acquired to this specification are created as follows: (see 1.2.1 through 1.2.6 for PIN code designations)

| M Prefix | Specification Number | Hyphen | Voltage | Frequency | CT | Special Feature | Current Rating (maximum) | Cabinet Integrity |
|---|---|---|---|---|---|---|---|---|
| M | 17773 | - | 4 | A | 21 | S | 600 | D |

The example above (M17773-4A21S600D) is for a 450-V, 60-Hz, normal-seeking, special feature, 600-amp maximum current rating, drip-proof ABT.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

FED-STD-595-26307 - Gray, Semigloss

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901 - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for

MIL-DTL-917 - Electric Power Equipment Basic Requirements

MIL-DTL-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard

MIL-DTL-2212 - Contactors and Controllers, Electric Motor AC or DC, and Associated Switching Devices

| | | |
|---|---|---|
| MIL-DTL-15024 | - | Plates, Tags, and Bands for Identification of Equipment, General Specification for |
| MIL-P-15024/5 | - | Plates, Identification |
| MIL-DTL-16036 | - | Switchgear, Power, Low Voltage, Naval Shipboard |
| MIL-DTL-17587 | - | Circuit Breakers, ACB, Low Voltage, Electric Power, Air, Removable Construction, General Specification for |
| MIL-PRF-19207 | - | Fuseholders, Extractor Post Type, Blown Fuse, Indicating and Nonindicating, General Specification for |
| MIL-R-19523 | - | Relays, Control |
| MIL-PRF-24712 | - | Coatings, Powder, Thermosetting |

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---|---|---|
| MIL-STD-108 | - | Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment |
| MIL-STD-130 | - | Identification Marking of U.S. Military Property |
| MIL-STD-167-1 | - | Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited) |
| MIL-STD-202 | - | Electronic and Electrical Component Parts |
| MIL-STD-461 | - | Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment |
| MIL-STD-681 | - | Identification Coding and Application of Hookup and Lead Wire |
| MIL-STD-740-2 | - | Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment |
| MIL-STD-810 | - | Environmental Engineering Considerations and Laboratory Tests |
| MIL-STD-1310 | - | Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility, Electromagnetic Pulse (EMP) Mitigation, and Safety |
| DOD-STD-1399-070-1 | - | Interface Standard for Shipboard Systems, Section 070 - Part 1, D.C. Magnetic Field Environment (Metric) |
| MIL-STD-1399-300 | - | Interface Standard for Shipboard Systems, Section 300, Electric Power, Alternating Current (Metric) |
| MIL-STD-1399-390 | - | Interface Standard for Shipboard Systems, Section 390, Electric Power, Direct Current, (Other Than Ship’s Battery) for Submarines (Metric) |
| MIL-STD-1472 | - | Human Engineering |
| MIL-STD-1474 | - | Noise Limits |
| MIL-STD-1686 | - | Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) |

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-470 - Designing and Developing Maintainable Products and Systems, Volume I

(Copies of these documents are available online at http://quicksearch.dla.mil.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST SP 500-234 - Reference Information for the Software Verification and Validation Process

(Copies of this document are available online at http://nvl.nist.gov.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9086-KC-STM-010/300 - Naval Ships' Technical Manual, Chapter 300, Electrical Plant, General

(Copies of this document are available online via Technical Data Management Information System (TDMIS) at https://mercury.tdmis.navy.mil/ by searching for the TMIN without the suffix. Refer questions, inquiries, or problems to: DSN 296-0669, Commercial (805) 228-0669. This document is available for ordering (hard copy) via the Naval Logistics Library https://nll.ahf.nmci.navy.mil. For questions regarding the NLL, contact the NLL Customer Service at nllhelpdesk@navy.mil, (866) 817-3130, or (215) 697-2626/DSN 442-2626.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE)

IEEE 1012 - Standard for Software Verification and Validation

IEEE 1709 - Recommended Practice for 1 kV to 35 kV Medium-Voltage DC Power Systems on Ships

(Copies of these documents are available online at www.ieee.org.)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 12207 - Systems and Software Engineering – Software Life Cycle Processes

(Copies of this document are available online at http://webstore.iec.ch.)

UNDERWRITERS LABORATORIES INC. (UL)

UL 1008 - Standard for Transfer Switch Equipment

UL 60950 - Safety of Information Technology Equipment

(Copies of these documents are available online at www.ul.com.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. REQUIREMENTS

3.1 Qualification. ABTs furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Mechanical and physical.

3.2.1 Materials. Materials capable of meeting all of the operational, safety, and environmental requirements specified herein in accordance with MIL-DTL-917 shall be selected.

3.2.1.1 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.2.1.2 Prohibited material. The prohibited materials as specified in MIL-DTL-917 shall not be used.

3.2.2 Electrical insulation. Electrical insulating materials shall be in accordance with the requirements of MIL-DTL-16036 and MIL-DTL-917.

3.2.3 Parts. Parts used in the manufacture of an ABT shall be in accordance with the requirements for parts as specified in MIL-DTL-917.

3.2.4 Relays. If electromechanical relays are used, they shall meet the requirements of MIL-R-19523 and shall have operating voltages as specified in 3.4.1.3.

3.2.5 Creepage and clearance distances. Electrical creepage and clearance distances shall be in accordance with MIL-DTL-917.

3.2.6 Nameplates. Manufacturer identification other than that allowed for the nameplates shall not appear on the equipment. Markings shall be in accordance with MIL-DTL-15024 and MIL-P-15024/5.

3.2.6.1 Embedded software. Embedded software (firmware) that is used in ABTs shall appear on the nameplate by name, part number, or both, the version number or designator. Equipment furnished with embedded software, calibration software, or both shall have software developed in accordance with IEC 12207 and certified by independent Verification and Validation (V&V) testing in accordance with NIST SP 500-234 and IEEE 1012 standards. If the ABT has programmable setpoints or calibration, see 3.2.9.

3.2.7 Interface or communication ports. Interface or communication ports installed during manufacture of the ABT shall be permanently disabled or removed prior to delivery.

3.2.8 Processes. Corrosion treatment, painting, soldering, brazing, and welding shall be in accordance with MIL-DTL-917.

3.2.8.1 Plating. ABT bus bars shall be designed and plated in accordance with MIL-DTL-917 and MIL-DTL-16036 in areas of current-carrying contact with lugs, terminals, bus ties, screw bolts, and so forth. The contact surfaces of bus bars shall be silver-plated up to 1 inch past the joint area. In lieu of this, the entire bus may be silver-surfaced, or on each copper bus bar, an area around each hole may be silvered, provided the silvered area around the hole is not less than a ⅛-inch wide band. Threaded surfaces, used as electrical contact surfaces, shall have silver thickness of at least 0.0002 inch.

3.2.8.2 Painting. The painting process shall be in accordance with the requirements of MIL-DTL-917. Color shall be No. 26307 as specified by FED-STD-595. Powder coating in accordance with MIL-PRF-24712 is the preferred method for painting.

3.2.9 Electrical interface.

3.2.9.1 Cable entrance. Unless otherwise specified (see 6.2), cable entrance shall be in accordance with MIL-DTL-2036. ABTs shall enable cable entry and exit from the top or the bottom of its enclosure.

3.2.9.2 Wire, wiring methods, marking, and bus bars. Wire, wiring methods, marking, and bus bars shall be in accordance with the requirements of MIL-DTL-917. Color-coded wire may be used in accordance with MIL-STD-681.

3.2.9.3 Wire identification. Wire identification shall be in accordance with MIL-DTL-917.

3.2.9.4 Terminal markings for supply lines and loads. Terminal markings for supply lines and loads shall be in accordance with table I. Like phases shall be arranged in the same manner. The phase rotation shall be A, B, C, respectively, from right to left (facing the front), top to bottom, and front to back.

TABLE I. Terminal markings.

| Sources and Load | AC | | | DC 2-Wire | | DC 3-Wire | | |
|---|---|---|---|---|---|---|---|---|
| | Phases | | | Polarity | | Polarity | | |
| Normal (N) source | SA | SB | SC | S+ | S- | S+ | S± | S- |
| Alternate (A)/Emergency (E) source | EA | EB | EC | E+ | E- | E+ | E± | E- |
| Load | Ll | L2 | L3 | L+ | L- | L+ | L± | L- |
| Normal (N) source | S1A | S1B | S1C | S1+ | S1- | S1+ | S1± | S1- |
| Alternate (A) source | S2A | S2B | S2C | S2+ | S2- | S2+ | S2± | S2- |
| Load | Ll | L2 | L3 | L+ | L- | L+ | L± | L |

3.2.10 Diagrams. Each ABT supplied in its own enclosure shall include a wiring diagram and a schematic diagram. The information shall be protected and attached to the inside of the enclosure in accordance with Method 1 of MIL-DTL-2036. Wiring diagrams shall include wire numbers, component identification, and fuse size and type, if applicable.

3.2.11 Instruction sheets. As specified (see 6.2), instruction sheets for installation shall be in accordance with MIL-DTL-2036.

3.2.12 Warning labels. Warning labels shall be in accordance with MIL-DTL-917.

3.2.13 ABT identification. Unless otherwise specified (see 6.2), the ABT shall be marked with the following information in accordance with MIL-STD-130 for unique item identifier data set construction #2:

a. Issuing agency code
b. Manufacturer
c. PIN (see 1.3)
d. Lot
e. Serial number
f. Current rating
g. Total transfer time
h. National stock number (when available)

3.3 Weight and size. Unless otherwise specified (see 6.2), the ABT shall weigh not more than 300 pounds and shall be not more than 40 inches high by 30 inches wide by 20 inches deep in size. 400-amp and 600-amp ABTs shall be no more than 56 inches high by 30 inches wide by 20 inches deep and no more than 300 pounds.

3.4 Performance characteristics. ABTs shall operate automatically and manually and shall have a transfer test feature. When applicable (see 6.2), special features shall be as specified.

3.4.1 Automatic operation. The ABT shall monitor the power supplied from both the normal power source and the alternate power source. A source shall be considered “available” when the source is within preset levels. When the active source (see 6.4.3) becomes unavailable, the ABT shall transfer to the alternate source, provided the alternate source is available (see 6.4.4).

3.4.1.1 Automatic seeking modes. The ABT shall provide automatic seeking modes as specified by configuration type (see 1.2.3): normal-seeking and power-seeking. It is not necessary for the ABT to support seeking modes other than that specified by the configuration type.

3.4.1.1.1 Normal-seeking. A normal-seeking ABT shall allow for operation with a preferred source (see 6.4.19). After a transfer to the alternate source, a normal-seeking ABT shall return to the preferred source when it becomes available.

3.4.1.1.2 Power-seeking. A power-seeking ABT shall not follow a preferred source (see 6.4.19). After a transfer to the alternate source, a power-seeking ABT shall automatically return to the initial source only if the active source becomes unavailable or if so commanded by the operator.

3.4.1.2 Automatic transfer modes. The ABT shall provide two automatic transfer modes as specified by configuration type (see 1.2.3): in-phase transfer and random transfer.

3.4.1.2.1 In-phase transfer. ABTs with in-phase transfer (see 6.4.11) capability as specified by configuration type (see 1.2.3) shall be provided with in-phase monitoring to allow completion of the transfer when sources are within ±60 electrical degrees of each other unless otherwise specified (see 6.2).

3.4.1.2.2 Random transfer. Random transfer occurs independent of the phase angle difference (see 6.4.16) between sources. ABTs shall initiate a random transfer when the normal source voltage or frequency, or both, as specified by configuration type (see 1.2.3) falls below the transfer threshold voltage as identified in table II. The control circuit time delay (CCTD) shall be disregarded.

3.4.1.3 Operating voltages. ABTs shall operate with tolerances in accordance with MIL-STD-1399-300 as specified (see 1.2.1 and 6.2).

3.4.1.4 Drop-out voltages. Drop-out voltages for configuration types (see 1.2.3) shall be in accordance with table II. A tighter tolerance may be specified (see 6.2). Random transfer shall occur in accordance with table II.

TABLE II. Transfer threshold voltages.

| **Drop-Out Voltage Percentage (%) (percentage of rated voltage)** | **Random Transfer Voltage Percentage (%) (percentage of rated voltage)** | **Configuration Types** |
|---|---|---|
| 60-70% | 25% | CT25 [1/] |
| 60-70% | N/A | CT21, CT22, CT26 |
| 60-70% | 20-30% | CT23 [1/], CT30, CT31 [1/], CT40, CT41 |
| 75-85% | 20-30% | CT24 |
| 76-80% | N/A | CT27, CT28 |
| NOTE:<br>[1/] In-phase drop-out voltage levels for these PINs. | | |

3.4.1.5 Pickup voltages. Pickup voltages (see 6.4.17) for configuration types (see 1.2.3) shall be in accordance with table III. A tighter tolerance may be specified (see 6.2).

TABLE III. Pickup voltages.

| Pickup Voltage Percentage (%) (percentage of rated voltage) | Configuration Types |
|---|---|
| 85-95% | CT21, CT22, CT23, CT24, CT25, CT26, CT29, CT30, CT40, CT41 |
| 86-90% | CT27, CT28 |

3.4.1.6 Total transfer time. When specified (see 6.2), the timing parameter below shall be specified by configuration type (see 1.2.3). As seen in the below equation, total transfer time ($T_{Total}$) is the sum of the detection time ($T_D$), control circuit time delay ($T_{CCTD}$), line circuit time delay ($T_{LCTD}$), and the transfer mechanism time from source to source ($T_M$). All time is expressed in seconds.

$$T_{Total} = T_D + T_{CCTD} + T_{LCTD} + T_M$$

Note: $T_{Total}$ does not include the delay for transfer to initiate which can occur when using an ABT with in-phase monitoring. Low voltages deviating from MIL-STD-1399-300 may occur during this delay and require a waiver.

3.4.1.7 Fast acting. A fast acting ABT's $T_{Total}$ shall not exceed 50 milliseconds.

3.4.1.8 Control circuit time delay (CCTD). CCTD (see 6.4.6) shall be specified by configuration type (see 1.2.3). CCTD shall be ignored after the voltage level falls between 20 and 30 percent.

3.4.1.9 Line circuit time delay (LCTD). When specified by configuration type (see 1.2.3), ABTs shall be provided with an LCTD (see 6.4.13) between the opening of the normal source contacts (off-going) and the closing of the alternate source contacts (on-coming) as shown in table IV. The CCTD and the LCTD may be incorporated into a single device, provided that the total time delay does not exceed 4.0 seconds.

TABLE IV. LCTDs.

| Current Rating of Switching Mechanism | Time Delay (seconds) |
|---|---|
| 50 A or less | 1.0 to 3.5 |
| Over 50 A | 2.5 to 3.5 |

3.4.1.10 Re-transfer stabilization time. When specified by configuration type (see 1.2.3), re-transfer (see 6.4.21) shall be inhibited for 100 to 150 milliseconds after transfer to allow for source stabilization.

3.4.1.11 Drop-out and pickup frequency (60-Hz applications). Drop-out and pickup frequency for configuration types (see 1.2.3) shall be in accordance with table V. Tighter tolerances may be specified (see 6.2).

TABLE V. Drop-out and pickup frequencies.

| Configuration Type (CT) | Drop-Out Frequency (below rated frequency, 60 Hz) | Pickup Frequency (below rated frequency, 60 Hz) |
|---|---|---|
| CT25 | 2-3 Hz | Less than 2 Hz |
| CT27 | 4-7 Hz | Less than 3 Hz |
| CT28 | 4-7 Hz | Less than 3 Hz |

3.4.1.12 Three-phase monitoring. Unless otherwise specified (see 6.2), three-phase monitoring shall be in accordance with configuration type (see 1.2.3). Operating voltages and frequency shall be in accordance with 1.2.1 and 1.2.2.

3.4.1.13 Single-phase monitoring. Unless otherwise specified (see 6.2), single-phase monitoring shall be in accordance with configuration type (see 1.2.3). Operating voltages and frequency shall be in accordance with 1.2.1 and 1.2.2.

3.4.1.14 In-phase monitoring control circuit. Unless otherwise specified (see 6.2), ABTs with in-phase monitoring shall complete the transfer when the two sources are in-phase within ±60 electrical degrees of each other as required by configuration type (see 1.2.3). The ABT shall monitor the phase angle rate of change between normal and alternate power sources to assure the ABT completes the transfer.

3.4.1.15 Transfer inhibit on overload. Unless otherwise specified (see 6.2), transfer shall be inhibited if the load current supplied by the ABT exceeds 125±5 percent of the ABT ampere rating as required by configuration type (see 1.2.3).

3.4.2 Manual operation of ABTs. The ABT shall have a manual mode for selecting power sources. During the manual mode of operation, the ABT automatic functions shall be disabled. Warning labels in accordance with MIL-DTL-2036 shall be marked "WARNING – Verify the condition of the power source prior to manually transferring or testing. Manual operation may result in out-of-phase transfer when both sources are energized." Warning label shall be visible to the operator during manual operation.

3.4.3 Transfer test. The ABT shall include an automatic mode test. The test shall simulate a power source fault (see 6.4.8) to verify that the ABT transfers power to the other source.

3.4.4 Maintainability. Mean time to repair (MTTR) shall be as specified (see 6.2). See MIL-HDBK-470 for guidance.

3.4.5 Front panel. The front panel shall provide the operator with the controls and indicators necessary to monitor the status of the normal and alternate power sources. ABT controls and indications shall be visible from the front of the unit.

3.4.5.1 Indicator lights, lamps, light emitting diodes (LEDs), and lenses. Indicator lights, lamps, LEDs, and lenses shall be in accordance with MIL-DTL-917. Use of LEDs shall be the preferred indicator lighting method. Indicator light color shall be in accordance with MIL-STD-1472.

3.4.5.2 Power available indication. When specified (see 6.2), a power available indication shall be provided for each input source to the ABT when that source is above pickup voltage.

3.4.5.3 In-phase indication. When specified (see 6.2), an in-phase indication or an in-phase transfer process indication shall be provided.

3.4.5.4 Controls.

3.4.5.4.1 Selector switch. ABTs shall be provided with a selector switch that controls manual or automatic ABT operation (see 6.4.2).

3.4.5.4.2 Preferred source selector switch and control circuit. When specified (see 6.2), ABTs with normal-seeking configuration shall be provided with a preferred source selector switch which can select normal (see 6.4.15) or alternate supply sources as the preferred source (see 6.4.19) of power.

3.4.5.4.3 Indicator test feature. When specified (see 6.2), the ABT shall provide a feature for indicator testing.

3.4.5.4.4 Manual operation mechanism. The ABT shall provide a manual operation mechanism for the purpose of transferring power sources in manual mode. This mechanism may employ a hand-wheel, mechanical selector, or lever. A manually operated electrical switch separate from the ABT's control circuitry, such that a failure of the control circuit does not prevent manual operation, may be used only if specified design constraints preclude use of a mechanical mechanism. See warning in 3.4.2.

3.4.5.4.5 Transfer test switch. The ABT shall provide a transfer test switch for the purpose of initiating a transfer test. The test switch shall be of the momentary spring return type. The transfer test switch shall not disable automatic functionality. See warning in 3.4.2.

3.4.6 Fusing of control circuits and indicator circuits. ABTs shall have fused control circuits (see 6.4.7) and indicator circuits as necessary to prevent damage in the event of operating component malfunction. The ABT shall have external blown-fuse indicators in accordance with MIL-PRF-19207.

3.4.7 Manual operating controls. Manual operating controls shall be external to the enclosure and located in a readily accessible position.

3.4.8 Manual operating handle or lever for automatic bus transfers. Protruding manual operating handles or levers for ABTs may rotate when the transfer switch is on automatic operation. When on manual operation, the operating handle or other visible method shall indicate by mechanical position which source of supply is connected to the load circuit.

3.4.9 Interlocks. Interlocks (see 6.4.12) shall be provided to prevent simultaneous operation of elements of the switching mechanism which could result in improper operation or a short-circuit condition. The interlocking mechanism shall be either electromechanical or mechanical. Electromechanical interlocks shall require power to defeat. If simultaneous operation may be caused by only electrical means, the interlocking may be electrical only. The interlocks shall prevent one set of switching elements from closing when the other set of switching elements are not fully open so that two power supply lines are not simultaneously connected to the load or cause an arc between the two supply lines.

3.4.10 Auxiliary switches. When specified (see 6.2), auxiliary switches shall be in accordance with MIL-DTL-917. ABTs over 100 amps shall be provided with one double pole, double throw (DPDT) auxiliary switch, and ABTs 100 amps and under shall be provided with one single pole, double throw (SPDT) auxiliary switch for remote indication of the supply line connected to the load circuit or for a function limiting device, or both. The auxiliary switch contacts shall be wired to a terminal board in the ABT.

3.4.11 Switching mechanisms. Switching mechanisms of ABTs shall use circuit breakers, transfer contactors, or contactor relays (sizes 0 to 6) as specified in table VI.

TABLE VI. Circuit breaker types and contactor sizes for ABTs.

| Amperes (A) | Acceptable Type 1/ |
|---|---|
| Above 600 2/ | ACB type circuit breaker |
| 25 to 600 3/ | Transfer contactors |
| 15 to 540 | Contactor relays (sizes 0 to 6) |

NOTES:
1/ For specific sizes of ACB type circuit breakers available, refer to MIL-DTL-17587. For specific sizes of contactor relays available, refer to MIL-DTL-2212.
2/ Sizes above 600 A shall be as specified (see 6.2).
3/ Standard sizes of transfer switches utilizing transfer type contactors shall be 25, 50, 100, 150, 250, 300, 400, and 600 A.

3.4.12 Contactors. Actuation will be either by magnetic coils or motor-driven cams and shall be mechanically held. Contacts may engage/disengage in ambient air or vacuum chambers.

3.4.13 External cable connections. When specified (see 6.2), terminal boards or studs shall be provided for external connections in accordance with MIL-DTL-917. Terminal boards and studs shall be accessible from the front of the enclosure with the front panel open, and the connection points shall be accessible and identified.

3.4.14 Grounding. Grounding shall be in accordance with MIL-STD-1310.

3.4.14.1 Chassis grounding. All external parts capable of electrical conduction shall be at ground potential at all times in accordance with MIL-STD-1310. Each chassis within the enclosure shall be electrically bonded to minimize electromagnetic interference (EMI).

3.4.14.2 Line-to-ground impedance. The insulation resistance or impedance to ground shall be measured with all operating components attached and connected in the ABT's normal operational condition with no internal wiring disconnected or jumpers around sensitive circuits. The insulation resistance testing shall be conducted on all electrically isolated circuits in the ABT as determined by the following criteria:

a. Circuits whose only connection to each other is by electromagnetic coupling through a magnetic core, which is shared in common by the circuits, shall be considered to be electrically isolated from each other.

b. Circuits whose only connection to each other is through a capacitor shall not be considered to be electrically isolated from each other. When the purpose is to test the insulation resistance of circuits internal to the equipment, and only then, such circuits shall be temporarily interconnected with a jumper wire, or test load.

3.4.15 Electrostatic discharge (ESD) protection requirements. The use of ESD sensitive components is discouraged. When specific parts, modules, connectors/receptacles, or subassemblies sensitive to damage by ESD are used, the devices shall be clearly marked with ESD labeling in accordance with MIL-STD-1686. The symbol shall be located in a position readily visible to personnel when that assembly is incorporated into its next higher assembly.

3.4.16 Ungrounded circuits. ABTs shall operate in ungrounded systems.

3.4.17 Continuous duty. ABTs shall operate at continuous duty (100 percent) (see 6.4.5).

3.4.18 Radiated susceptibility, DC magnetic field. The ABT shall be compatible with the magnetic field environment interface constraints of DOD-STD-1399-070-1.

3.4.19 Electromagnetic interference (EMI). The ABT shall meet the EMI requirements specified in MIL-STD-461 for surface ship, below deck, and submarine, internal to pressure hull, installations. The ABT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications when tested in accordance with MIL-STD-461.

3.4.20 Power quality. AC ABTs shall conform to the power quality requirements of MIL-STD-1399-300 (see 4.6.6). Unless otherwise specified (see 6.2), DC ABTs shall conform to the power quality requirements of MIL-STD-1399-390 and IEEE 1709.

3.4.21 Safety. ABTs shall be designed and constructed in accordance with MIL-DTL-917.

3.4.21.1 Grounding and bonding protection. All electrical parts capable of electrical conduction shall be at ground potential in accordance with MIL-STD-1310 (see 4.6.7).

3.4.21.2 Source-to-source leakage current for maintenance. When specified (see 6.2), leakage current to the non-energized side of the ABT shall be controlled by air gap isolation between sources to allow for safe load center maintenance.

3.4.22 Electrical bonding. Electrical bonding shall be in accordance with MIL-STD-1310.

3.4.23 Mechanical hazards. Suitable protection shall be provided to prevent contact with moving mechanical parts such as gears and chains when the equipment is operating. Sharp projections on cabinets, doors, and similar parts shall be avoided. Rack-mounted equipment shall maintain the center of gravity as low as possible to minimize tipping over. Door or hinged covers shall be rounded at the corners, provided with stops to hold them open, and shall be removable. ABT design shall include provisions to prevent accidental pulling out of drawers or rack mounted equipment components, which would cause equipment damage or injury. Equipment power switches, if used, shall be located so that accidental contact shall not place the equipment in operation, secure the equipment, or change its mode of operation.

3.4.24 Component heat removal. If forced air-cooling is used, the unit shall generate no more than the structureborne and airborne noise acceptance criteria as specified in MIL-STD-740-2 and MIL-STD-1474. The unit shall be capable of operating normally for a period of at least 24 hours at rated load, in 122 °F (50 °C) ambient air, with a loss of ⅓, minimum, of the active cooling capacity, and support the rated load for a minimum of 6 hours, in 82 °F (28 °C) ambient air, with a loss of all (100 percent) of the active cooling capacity.

3.4.25 Current ratings. The continuous duty current ratings (see 1.2.5) for ABTs shall be in accordance with their configuration type (see 1.2.3) and table VI.

3.4.26 Compatibility with shipboard ground fault detector circuits. When specified (see 6.2), an ABT connected to both power sources and to the load shall:

a. Have a source-to-source impedance as high as possible, but no less than 10 megohms at 77 °F (25 °C).

b. Have a minimum line-to-ground impedance of at least 10 megohms in accordance with MIL-DTL-917.

c. Not cause a low-impedance to a ground fault condition detected on one source to be imposed on, transferred to, or reflected on the other source when either source is active.

3.4.27 Endurance and overload. Unless otherwise specified (see 6.2), ABTs shall meet endurance and overload requirements when tested in accordance with 4.6.10.

3.4.28 Short-circuit withstand capability. Unless otherwise specified (see 6.2), ABTs shall meet the short-circuit withstand capability (see 6.4.22) requirements specified in table VII and pass the tests specified in 4.6.11.

TABLE VII. ABT short-circuit withstand capability.

| ABT Continuous Rating (A) | Short-Circuit Current (A) at pf 0.15-0.20 | | Duration (milliseconds) | |
|---|---|---|---|---|
| | 60 Hz | 400 Hz | 60 Hz | 400 Hz |
| To 50 | 10000 | 10000 | 17.0 | 21.0 |
| 100 | 15000 | 10000 | 17.0 | 21.0 |
| 250 | 20000 | 10000 | 25.0 | 28.0 |
| 400 | 30000 | 10000 | 28.0 | 33.0 |
| 600 | 50000 | 10000 | 28.0 | 33.0 |
| Over 600 1/ | | | | |

NOTE:
1/ AC and DC special short-circuit withstand capability requirements shall be as specified (see 6.2).

3.4.29 Dielectric withstanding voltage. ABTs shall meet the dielectric withstanding voltage requirements when tested in accordance with MIL-DTL-917.

3.4.30 Enclosures. Enclosures for the ABT shall be drip-proof, watertight, splash-proof, or open-mounted as specified (see 6.2) and shall meet the performance requirements of MIL-DTL-2036 for Class 1 enclosures for electronic equipment. Unless otherwise specified (see 6.2), all enclosures shall be bulkhead mounted.

3.4.31 Lifting provisions. Lifting provisions shall be in accordance with MIL-DTL-2036 and lifting channels, angles, and lifting eyes shall be provided on the top of the ABT of sufficient strength and number for lifting, handling, and installation on the ship. Maximum design weight limits for lifting without lifting provisions are specified in MIL-STD-1472. Additionally, replacement bolts, with all necessary washers to maintain drip-proof integrity, shall be provided in order for the lifting components to be replaced when the ABT is installed on the ship. Enclosure shall not fracture or deform when tested in accordance with 4.6.13.

3.5 Environmental conditions.

3.5.1 Ambient temperature. ABTs shall operate at rated load over an ambient temperature range of 32 to 122 °F (0 to 50 °C) in accordance with MIL-DTL-917.

3.5.2 Humidity. The ABT shall operate satisfactorily during and subsequent to exposures to relative humidities ranging up to 95 percent for both continuous and intermittent periods, including conditions wherein condensation occurs on the equipment.

3.5.3 Pressure. ABTs shall operate within performance limits of MIL-STD-202 while subjected to an atmospheric pressure from 24 to 36 inches of mercury.

3.5.4 Temperature rise. Temperature rise shall be accordance with MIL-DTL-16036.

3.5.5 Inclined operation. ABTs shall perform satisfactorily during inclined operation as specified in MIL-DTL-917.

3.5.6 Shock. ABT principal units shall meet the Grade A, Class I, Type A shock acceptance requirements of MIL-S-901 when subjected to high-impact shock testing as specified in 4.6.20.

3.5.7 Vibration. ABTs shall meet Type I vibration tests specified in MIL-STD-167-1. When the ABT is operating on the normal (active) power source, it shall not have contact chatter or shall not have chatter or momentary closure of alternate (inactive) power source contacts during vibration testing. When the ABT is operating on the alternate power source, after a bus transfer, it shall not have contact chatter or shall not have chatter or momentary closure of normal power source contacts during vibration testing.

3.5.8 Airborne noise. The ABT airborne noise requirements shall be in accordance with MIL-STD-1474 and the noise limit shall be as specified (see 6.2).

3.5.9 Structureborne noise. The ABT structureborne noise requirements shall be in accordance with MIL-STD-740-2 and the noise limit shall be as specified (see 6.2).

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall be performed on one complete ABT of each rating and shall include the examinations and tests specified in table VIII. Testing will be requested and approved by Naval Sea Systems Command (NAVSEA).

4.2.1 Periodic retention of qualification. At intervals of not more than 4 years after initial qualification, inspection for retention of qualification shall be performed on an ABT of a given design and shall include the tests specified in table IX, in the order listed.

4.2.2 Change approval. A change in material, production processes, or production equipment used in the manufacture of the ABT, which have been qualified, shall require written approval of NAVSEA. Incorporation of any changes, which have not been so approved, shall require requalification of the item in question.

4.2.3 Failure. Failure of any sample to meet the requirements specified herein shall be cause for disapproval of or removal of product qualification.

4.3 Conformance inspection. Conformance inspection shall be performed on each unit to verify that the ABT meets specification requirements prior to acceptance and shall include the tests specified in table VIII.

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in the general requirements of MIL-STD-202.

TABLE VIII. Qualification tests and conformance inspections.

| Tests | Requirement Paragraph | Qualification Test | Conformance Inspection |
|---|---|---|---|
| Examination | 3.2.1 – 3.3, 3.4.4 – 3.4.14.1, 3.4.15, 3.4.21, 3.4.21.2, 3.4.22, 3.4.23 | 4.5 | 4.5 |
| Embedded Software V&V | 3.2.6.1 | 4.7 | 4.7 |
| Operational | 3.4 – 3.4.3, 3.4.21 | 4.6.1.2 – 4.6.1.7 | 4.6.1.2 – 4.6.1.7 |
| Interlocks | 3.4.9 | 4.6.1.8 | 4.6.1.8 |
| Line-to-Ground Impedance | 3.4.14.2 | 4.6.2 | 4.6.2 |
| Ungrounded Circuit | 3.4.16 | 4.6.3 | --- |
| Continuous Duty | 3.4.17 | 4.6.10, 4.6.18 | --- |
| Radiated Susceptibility, DC Magnetic Field | 3.4.18 | 4.6.4 | --- |
| EMI | 3.4.19 | 4.6.5 | --- |
| Power Quality | 3.4.20 | 4.6.6 | --- |
| Grounding and Bonding Protection | 3.4.21.1 | 4.6.7 | 4.6.7 |
| Component Heat Removal | 3.4.24 | 4.6.8 | --- |
| Current Rating | 3.4.25 | 4.6.8, 4.6.18 | --- |
| Compatibility with Active Ground Fault Detector Circuit | 3.4.26 | 4.6.9 | --- |
| Endurance and Overload | 3.4.27 | 4.6.10 | --- |
| Short-Circuit Withstand Capability | 3.4.28 | 4.6.11 | --- |
| Dielectric Withstanding Voltage | 3.4.29 | 4.6.12 | --- |
| Degree of Enclosure | 3.4.30 | 4.6.13 | --- |
| Lifting | 3.4.31 | 4.6.14 | --- |
| Ambient Temperature | 3.5.1 | 4.6.15 | --- |
| Humidity | 3.5.2 | 4.6.16 | --- |
| Pressure | 3.5.3 | 4.6.17 | --- |
| Temperature Rise | 3.5.4 | 4.6.18 | --- |
| Inclined Operation | 3.5.5 | 4.6.19 | --- |
| Shock | 3.5.6 | 4.6.20 | --- |
| Vibration | 3.5.7 | 4.6.21 | --- |
| Airborne Noise | 3.5.8 | 4.6.22 | --- |
| Structureborne Noise | 3.5.9 | 4.6.23 | --- |

TABLE IX. Periodic tests.

| Tests | Requirement Paragraph | Test Paragraph |
|---|---|---|
| General Examination | 3.2.1 – 3.3, 3.4.4 – 3.4.14.1, 3.4.15, 3.4.21, 3.4.21.2 3.4.22, 3.4.23 | 4.5 |
| Embedded Software V&V | 3.2.6.1 | 4.7 |
| Effectiveness of Enclosure | 3.4.30 | 4.6.13 |
| General Operation | 3.4 – 3.4.3 | 4.6.1.2 – 4.6.1.7 |
| Endurance and Overload | 3.4.27 | 4.6.10 |
| Shock | 3.5.6 | 4.6.20 |
| Vibration | 3.5.7 | 4.6.21 |
| Insulation Resistance | 3.4.14.2 | 4.6.2 |
| Dielectric Withstanding Voltage | 3.4.29 | 4.6.12 |

4.5 Examination. Each ABT shall be examined for compliance with the requirements specified in table VIII. This element of inspection shall encompass all visual examinations and dimensional measurements. The examination shall be conducted using the classifications of defects as specified in table X as applicable. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.

TABLE X. Classification of defects.

| Category | Defect | Related Requirements Paragraph |
|---|---|---|
| **Critical** | | |
| 001 | Prohibited materials are used. | 3.2.1.2 |
| 002 | Insulating material not as specified or not provided as required. | 3.2.2 |
| 003 | Supply line and load terminal markings not as specified. | 3.2.9.4 |
| 004 | When specified (see 6.2), special features not as specified. | 3.4 |
| 005 | Total transfer time and timing parameters not as specified. | 3.4.1.6, 3.4.1.7, 3.4.1.8, 3.4.1.9 |
| 006 | Single- or three-phase monitoring not provided as specified. | 3.4.1.12, 3.4.1.13 |
| 007 | Manual operation for ABT not provided as required. | 3.4.2 |
| 008 | When specified (see 6.2), power available indication not as specified. | 3.4.5.2 |
| 009 | When specified (see 6.2), in-phase indication not as specified. | 3.4.5.3 |
| 010 | Controls not as specified. | 3.4.5.4, 3.4.5.4.1, 3.4.5.4.2, 3.4.5.4.3, 3.4.5.4.4, 3.4.5.4.5 |
| 011 | Fusing of control circuits and indicator circuits not as specified. | 3.4.6 |
| 012 | Manual operator does not have a mechanical position indicator for supply line indication. | 3.4.7 |
| 013 | Manual operating handle or lever for automatic bus transfers not as specified. | 3.4.8 |
| 014 | Safety not as required. | 3.4.21 |
| 015 | When specified (see 6.2), source-to-source leakage current for maintenance not as required. | 3.4.21.2 |
| 016 | Bonding not as specified. | 3.4.22 |
| 017 | Mechanical hazards protection not as required. | 3.4.23 |
| **Major** | | |
| 101 | Materials not as required. | 3.2.1 |
| 102 | Use of recycled, recovered, environmentally preferable, or biobased materials are not considered. | 3.2.1.1 |
| 103 | Parts not in conformance with applicable specifications. | 3.2.3 |
| 104 | Relays not as specified. | 3.2.4 |
| 105 | Creepage and clearance distances not as specified. | 3.2.5 |
| 106 | Information plates, identification plates, and markings not as specified. | 3.2.6 |
| 107 | Embedded software identification not as specified. | 3.2.6.1 |
| 108 | Communication port not permanently disabled prior to delivery, if the ABT has programmable setpoints or calibration. | 3.2.7 |
| 109 | Soldering, brazing, and welding not as specified. | 3.2.8 |
| 110 | Plating not as specified. | 3.2.8.1 |
| 111 | Cable entrances not as specified. | 3.2.9.1 |
| 112 | Wire, wiring methods, marking, and bus bars not as specified. | 3.2.9.2 |

TABLE X. Classification of defects - Continued.

| Category | Defect | Related Requirements Paragraph |
|---|---|---|
| **Major** | | |
| 113 | Wire identification not as specified. | 3.2.9.3 |
| 114 | Diagrams and descriptions of operation not provided as specified. | 3.2.10 |
| 115 | Instruction sheets not provided as required. | 3.2.11 |
| 116 | Warning labels not as specified. | 3.2.12 |
| 117 | ABT identification not as required. | 3.2.13 |
| 118 | MTTR not as specified. | 3.4.4 |
| 119 | Indicator lights, lamps, LEDs, and lenses not as required. | 3.4.5.1 |
| 120 | Auxiliary switches not as specified. | 3.4.10 |
| 121 | Switching mechanisms not as specified. | 3.4.11 |
| 122 | Contactors not as specified. | 3.4.12 |
| 123 | Terminal boards not provided or wire connection points not accessible and identifiable. | 3.4.13 |
| 124 | Grounding not as specified. | 3.4.14 |
| 125 | Chassis grounding not as specified. | 3.4.14.1 |
| 126 | Devices not marked with ESD labeling as required. | 3.4.15 |
| 127 | Degree of enclosure not as specified. | 3.4.30 |
| **Minor** | | |
| 201 | Painting not as specified. | 3.2.8.2 |

4.6 Methods of inspection.

4.6.1 Operational tests.

4.6.1.1 Order of precedence. The following tests shall be completed in the following order and a successful completion is required to continue:

a. Shock (see 4.6.20)

b. Vibration (see 4.6.21)

c. Short-circuit withstand capability (see 4.6.11)

d. Dielectric withstand capability (see 4.6.12)

4.6.1.2 ABT automatic function testing. ABTs shall be operated and monitored for conformance to the automatic functional requirements referenced from section 3 in each of the following test paragraphs. Not less than five transfers and five re-transfers shall be made under conditions of constant temperature, voltage or frequency, and rate of change of voltage or frequency.

4.6.1.2.1 Operating voltage test. ABTs shall be operated to determine that the operating voltages are as specified in 3.4.1.3, 3.4.1.4, and 3.4.1.5.

4.6.1.2.2 Total transfer time. Timing, time delay, and operating transfer time, as specified by the ABT configuration type (see 1.2.3), shall be measured for conformance with the required time periods as specified in 3.4.1.6. Adjustable time delay devices shall be operated over their adjustable range, including the limits of the range, to determine that the specified time range can be achieved.

4.6.1.2.3 Re-transfer to normal. ABTs shall be tested for re-transfer (normal to alternate and back to normal) as specified by 3.4.1.9, 3.4.1.10, and configuration type (see 1.2.3). Normal rated power shall be adjusted to reduced and zero voltage and returned to normal at the start, middle, and end point of the test. Alternate or emergency power, or both, shall be maintained at rated power throughout the test. No additional delay in time other than those stated in 3.4.1.9 and 3.4.1.10 shall occur.

4.6.1.2.4 Three-phase monitoring. When specified (see 6.2), the ABT shall be tested to determine if it meets three-phase monitoring requirements as specified by the ABT configuration type (see 1.2.3) by interrupting power completely (voltage and frequency) to each of the three phases one at a time to determine that transfers and re-transfers meet the transfer criteria specified for that configuration type (see 1.2.3).

4.6.1.2.5 Single-phase monitoring. When specified (see 6.2), the ABT shall be tested to determine if it meets single-phase monitoring requirements by varying all three phases simultaneously for voltage or frequency, or both, of the active power source to determine that transfers and re-transfers meet the transfer criteria specified for that configuration type (see 1.2.3).

4.6.1.2.6 In-phase monitoring (not applicable to 400–Hz ABTs). The frequency of the two sources shall be at 60 Hz. ABTs shall be operated in each direction of transfer by changing the voltage levels of the sources. Phase angle difference between sources shall be varied during testing to demonstrate the in-phase monitoring capability. After these operations are completed, the voltage on the normal source shall be rapidly reduced to below random transfer threshold for instantaneous random transfer verification.

Testing shall be performed with a motor load sized for the maximum current rating of the ABT. A calibrated phase angle sensing instrument shall be used to record the phase angle difference between the normal and alternate sources at the completion of each transfer. In each operation, except the instantaneous random transfer when voltage is reduced to below random transfer threshold, the phase angle difference at the completion of transfer shall not exceed the in-phase monitoring setting.

4.6.1.2.7 Frequency sensing. The frequency, as specified (see 6.2), shall be tested at the high and low frequency pickup points to determine compliance with the frequency requirements as specified (see 3.4.1.11).

4.6.1.3 Manual operation. When manual mode has been selected (see 3.4.2), it shall be verified that automatic functions are disabled.

4.6.1.4 Preferred source selection. The preferred source selector switch shall be switched to each position and the ABT shall automatically transfer to that preferred source.

4.6.1.5 Test switch. The test switch shall be operated to determine both that it simulates a voltage failure and that a subsequent transfer action occurs.

4.6.1.6 Overload transfer inhibit. When transfer inhibit on overload has been specified (see 6.2), the ABT shall be tested reducing the voltage on the connected power source to less than the drop-out voltage level while maintaining load current above the load current limit to determine that transfer will not occur if the load current is above the overload inhibit value specified in 3.4.1.15.

4.6.1.7 Power available indicator. ABTs shall be operated to determine that each power available indicator operates properly when power is supplied and removed from each supply line.

4.6.1.8 Interlocks. ABTs shall be operated to determine that the interlock methods selected to prevent simultaneous operation of elements of the switching mechanism do not result in improper operation or short circuit. The ABT is considered to have failed the test if it does not operate properly following the test or if the following occurs during the tests:

a. Interlock results in improper operation of the ABT such as failure to transfer.

b. Interlock results in failure in mechanical operation of the ABT, either in automatic or manual mode.

c. Mechanical slide bar or other mechanical means allows one set of switching elements to close when the other set of switching elements are not fully open allowing two sources of power to be connected simultaneously or cause an arc between supply lines.

d. Electromechanical relays or other electromechanical device logic failure allows one set of switching elements to close when the other set of switching elements are not fully open allowing two sources of power to be connected simultaneously or cause an arc between supply lines.

e. Electronic control is used in conjunction with relays after loss of power and re-initiation of interlock results in the ability of one set of switching elements to close when the other set of switching elements are not fully open allowing two sources of power to be connected simultaneously or cause an arc between supply lines.

4.6.2 Line-to-ground impedance. Line-to-ground impedance tests shall be conducted in accordance with Method 302, test condition "B" of MIL-STD-202. Test conditions shall be as follows:

a. Points of measure - Between each electrically isolated circuit and all other circuits connected together to ground (frame, chassis or enclosure).

b. Electrification time - 60 seconds minimum for insulation suitability test, and only sufficient time to take resistance readings for all other tests.

c. Temperature at time of test shall be in accordance with S9086-KC-STM-010/300.

4.6.3 Ungrounded circuits. The ABT shall operate satisfactorily in ungrounded systems and in high resistance ground Wye connected systems.

4.6.4 Radiated susceptibility, DC magnetic field. The ABT shall be tested for radiated susceptibility, DC magnetic field in accordance with DOD-STD-1399-070-1.

4.6.5 Electromagnetic interference (EMI). The ABT shall be subjected to the EMI test specified in 3.4.19. Acceptance criteria shall be as specified in 3.4.19.

4.6.6 Power test. Power tests shall be conducted in both steady-state and transient modes for the following in accordance with MIL-STD-1399-300:

a. Voltage and frequency tolerance

b. Voltage and frequency transient tolerance

c. Voltage spike

d. Emergency condition

e. Grounding

f. User equipment power profile (at no load)

g. Current waveform

h. Equipment (insulation resistance)

i. Voltage and frequency modulation

j. Simulated human body leakage current tests for personnel safety

4.6.7 Grounding and bonding. The ABT grounding and bonding shall be in accordance with MIL-STD-1310.

4.6.8 Component heat removal. If forced air cooling is used, the ABT shall meet the requirements of 3.4.25 under full rated load during the following heat removal conditions:

a. Energize the ABT for 24 hours in 122 °F (50 °C) ambient air, with a loss of ⅓, minimum, of the active cooling capacity. Test operate the ABT every hour.

b. Energize the ABT for 6 hours in 82 °F (28 °C) ambient air, with a loss of all (100 percent) of the active cooling capacity. Test operate the ABT every hour.

4.6.9 Compatibility with active ground fault detector circuit. When specified (see 3.4.27 and 6.2), the ABT shall be tested with an active ground fault detector circuit utilizing a 500-VDC power supply and shall meet the requirements of 3.4.27.

4.6.10 Endurance and overload. ABTs shall be tested for endurance and overload in accordance with UL 1008 for emergency systems. ABTs shall fail the endurance and overload tests if they fail to perform their intended operating functions during or after the tests without adjustment, calibration, or replacement of parts, excluding a one-time replacement of contacts. ABTs shall also meet the pass/fail criteria in UL 1008.

4.6.11 Short-circuit withstand capability. Unless otherwise specified (see 6.2), ABTs shall be tested for short-circuit withstand capability for conformance with 3.4.28. The ABTS shall be subjected to and pass the dielectric withstanding voltage test as specified in 4.6.12 after the short-circuit withstand capability tests without adjustment or replacement of parts.

4.6.11.1 AC short-circuit withstand capability test. The test circuit current shall be measured, instrumented, and calibrated in accordance with UL 1008.

4.6.11.2 DC short-circuit withstand capability test. For short-circuit DC withstand capability tests, the current measurement shall be the maximum value. The test circuit shall be so adjusted that the initial rate of current used is within the limits of 2,000,000 and 3,000,000 amps per second.

4.6.11.3 Failure of tests. ABTs shall fail the short-circuit withstand capability tests if they can no longer operate as intended, except for contact welds that can easily be freed.

4.6.12 Dielectric withstanding voltage. Dielectric withstanding voltage tests shall be conducted in accordance with Method 301 of MIL-STD-202, including source-to-source testing. Testing shall be performed after vibration testing. Magnitude of test voltages for circuits shall be in accordance with MIL-DTL-917.

4.6.13 Degree of enclosure. ABTs shall be tested in accordance with MIL-DTL-2036 for Class 1 enclosures, as supplemented by MIL-STD-108, to determine the effectiveness of the enclosure as specified in 3.4.31. Failure of the equipment to operate satisfactorily or accumulation of water within the enclosure shall be cause for rejection. Additionally, the unit shall not be a hazard to personnel in case of minor water intrusion.

4.6.14 Lifting. The ABT shall meet the lifting acceptance criteria of 3.4.31. With the ABT in the suspended configuration for installation aboard ship, add an additional 25 percent of weight to the enclosure and suspend the ABT by the lifting provisions for a minimum of 5 minutes.

4.6.15 Ambient temperature. ABTs shall be designed for continuous reliable operation within specified limits over an ambient temperature range of 32 to 122 °F (0 to 50 °C). The ABT shall not be damaged nor shall the operational performance be degraded when restored to operating temperature range after exposure for long periods, 24-hour minimum, in a non-operating air temperature range of –13 to +140 °F (–25 to +60 °C). The test shall be conducted in accordance with MIL-STD-202.

4.6.16 Humidity. The ABT shall be subjected to the humidity testing in accordance with MIL-STD-810.

4.6.17 Pressure. ABTs shall operate within the specified performance limits while subjected to an atmospheric pressure from 24 to 36 inches of mercury in accordance with MIL-STD-202. The ABT shall reliably operate within specified performance limits after exposure to an atmospheric overpressure of 2 atmospheres (14.7 pounds per square inch positive differential on the ABT).

4.6.18 Temperature rise. ABTs shall be subjected to a temperature rise test. The test shall be conducted with the ABT carrying rated current, both normal and alternate sources available, with control circuit energized. Component temperature rises shall be measured by the resistance method or by thermographic equipment. Sufficient thermocouples (or equivalent temperature sensors) shall be installed on representative current-carrying parts such as coils, contacts, and terminals. Temperature rises shall be measured at the hottest point where current-carrying parts are closest to insulating material. The test shall be conducted in accordance with MIL-DTL-917. The test shall be conducted with the load connected to the normal source and repeated with the load connected to the alternate source.

4.6.19 Inclined operation. ABTs shall be tested for inclined operation in accordance with MIL-DTL-917.

4.6.20 Shock. ABT principal units shall be high-impact shock tested in accordance with the Grade A, Class I, Type A requirements of MIL-S-901. The ABT shock test setup (mounting plane and attachment to shipboard structure or foundation) shall represent the same mounting configuration and mounting location as the shipboard installation. For purposes of the shock test, the following MIL-S-901 classifications shall be applied to the ABT:

a. Shock grade: Grade A.

b. Equipment type: Principal unit.

c. Equipment class: Class I.

d. Shock test type: Type A.

e. Equipment mounting location aboard ship: Hull or deck mounted. If submarine frame mounted, test in accordance with MIL-S-901, (such that shock test extensions to hull and deck mounted installations are permitted).

f. Equipment mounting plane aboard ship: Back mounted or base mounted.

g. Equipment mounting orientation aboard ship: Unrestricted orientation.

h. Method of mounting items for tests: Test items shall be attached to their shock test fixtures in accordance with the manufacturer's installation drawings. Equipment shall be mounted for tests upon the same type and arrangement of isolation devices used to support the equipment aboard ship.

i. Method of simulating shipboard connections: In accordance with MIL-S-901.

j. Mode or conditions of equipment operation: The tests shall be conducted with the ABT carrying current, at rated voltage and frequency. Control circuits shall be energized as in actual service.

k. Acceptance criteria and associated post-shock functional testing and inspection requirements: In accordance with MIL-S-901.

l. Acceptance authority: NAVSEA.

An oscillograph shall be used to check the closed contacts for excessive contact bounce and to check the open contacts for momentary closures. Fuses (or other indicators which provide a positive indication) shall be connected in a manner to detect any momentary shorting between live parts or live parts and ground. The ABTs being tested shall not be reconditioned or adjusted during the testing. When the ABT is operating on the normal (active) power source, it shall have total contact bounce per shock blow not exceeding 20 milliseconds (multiple contact bounces are acceptable providing this total elapsed time is not exceeded), and shall not have bounce or momentary closure of alternate (inactive) power source contacts during shock testing. When the ABT is operating on the alternate power source, after a bus transfer, it shall have total contact bounce per shock blow not exceeding 20 milliseconds (multiple contact bounces are acceptable providing this total elapsed time is not exceeded), and shall not have bounce or momentary closure of normal power source contacts during shock testing. An ABT shall fail the test if it cannot perform its intended operating functions during and after such tests or if one or more of the following occurs during the tests:

m. Contact occurs between live parts and the enclosure.

n. Enclosure door opens.

o. Structural parts are damaged or loosened such that the ABT will no longer perform its primary mission in a safe manner.

p. Functional parts are damaged or loosened such that the ABT will no longer perform its primary mission in a safe manner.

q. Inadvertent transfer of load due to the force of shock blow.

r Re-transfer operation is initiated.

s. Normal and alternate power source main contacts have total contact bounce in excess of 20 milliseconds per bounce when in use.

t. Normal and alternate power source main contacts have any contact bounce or momentary closure when not in use.

u. Closed auxiliary contacts momentarily open or open auxiliary contacts momentarily close.

Note: The ABTs shall be thoroughly examined after the tests to determine whether there is evidence of items c and d above. The vibration test shall follow the shock test.

4.6.21 Vibration. ABTs shall be subjected to Type I vibration tests in accordance with MIL-STD-167-1. The tests shall be conducted with the ABT in each of the three rectilinear orientation axis of the ABT as installed on shipboard, with the ABT carrying current, at rated voltage and frequency specified by the PIN code in 1.2.1 and 1.2.2. Current used for vibration testing should be from 1 to 5 amperes independent of the current rating of the ABT. Control circuits shall be energized as in actual service. An oscillograph or other suitable instrument shall be used to check correct power transfer and operation of any auxiliary contacts. Fuses (or other indicators which provide a positive indication) shall be connected in a manner to detect any momentary shorting between live parts or live parts and ground. ABTs shall be tested in the same mounting configuration as the one chosen for shipboard installation (if shock or isolation mounts are utilized, these shall not cause resonance). An ABT shall fail the test if it cannot perform its intended operating functions during and after such tests, or if one or more of the following occurs during the tests:

a. Contact between live parts and the enclosure.

b. Enclosure door opens.

c. Structural parts are damaged or loosened.

d. Functional parts are damaged or loosened.

e. Inadvertent transfer of load.

f. Re-transfer operation is initiated.

g. Closed auxiliary contacts momentarily open or open auxiliary contacts momentarily close.

h. Normal and alternate power source main contacts have contact chatter when in use.

i. Normal and alternate power source main contacts have any contact chatter or momentary closure when not in use.

Note: The ABTs shall be thoroughly examined after the tests to determine whether there is evidence of items c and d above.

4.6.22 Airborne noise. When specified (see 6.2), the ABT shall be tested for airborne noise in accordance with MIL-STD-1474.

4.6.23 Structureborne noise. When specified (see 6.2), the ABT shall be tested for structureborne noise in accordance with MIL-STD-740-2.

4.7 Embedded software. The ABT embedded software shall be verified and validated to NIST SP 500-234 and IEEE 1012 standards.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. ABTs are intended for use in applications as devices that automatically or manually transfer power supply lines to a connected load. When accomplished automatically, control circuits determine when and in what manner the transfer will occur.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Requirement for CCTD (see 1.2.3).
c. LCTD value or in-phase monitoring (see 1.2.3).
d. PIN (see 1.3).
e. Specific issue of the individual documents referenced, if required (see 2.2.1 and 2.3).
f. Cable entrance requirements if other than as specified in MIL-DTL-2036 (see 3.2.9.1).
g. Instruction sheets (see 3.2.11).
h. Marking other than specified (see 3.2.13).
i. Different weight and size requirements (see 3.3).
j. Special features (see 3.4).
k. rms voltage level, if applicable (see 3.4.1.2.2).
l. Operating voltage (see 3.4.1.3).
m. Special transfer threshold voltages, if required (see 3.4.1.4 and 3.4.1.5).
n. Total transfer time and timing parameters other than as specified (see 3.4.1.6 and 1.2.3).
o. Operating frequency (see 3.4.1.11).
p. Special frequency variation or time delay requirements for frequency sensing ABTs (see 3.4.1.11).
q. Three- or single-phase monitoring for ABTs (see 3.4.1.12 and 3.4.1.13).
r. In-phase monitoring control circuit for ABTs (see 3.4.1.14).
s. Setting for inhibiting transfer on overload (see 3.4.1.15).
t. MTTR and the scope of the time frame (see 3.4.4).
u. When a power available indication shall be provided (see 3.4.5.2).
v. When an in-phase indication or in-phase transfer process indication shall be provided (see 3.4.5.3).
w. Requirement for a preferred source selector switch for ABTs with normal-seeking configuration (see 3.4.5.4.2).
x. Indicator test feature (see 3.4.5.4.3).
y. Special auxiliary switch requirements (see 3.4.10).
z. Type switching mechanism for ABTs greater than 600 amps (see 3.4.11).
aa. Need and type of external control connections (see 3.4.13).
bb. Power quality requirements for DC ABTs if other than as specified in MIL-STD-1399-390 and IEEE 1709 (see 3.4.20).
cc. Source-to-source leakage current for maintenance (see 3.4.21.2).
dd. Active ground fault detection requirement (see 3.4.26).
ee. Special endurance and overload requirements, if required (see 3.4.27).
ff. AC and DC special short-circuit withstand capability test, if required (see 3.4.28).
gg. Degree of enclosure (see 3.4.30).
hh. Lifting provisions (see 3.4.31).
ii. Airborne noise limit, if required (see 3.5.8).
jj. Structureborne noise limit, if required (see 3.5.9).
kk. DC test voltage (see 4.6.10).
ll. Manufacturer provided written warranty.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products, which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 17773 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.3.1 Provisions governing qualification. Copies of SD-6, “Provisions Governing Qualification”, are available online at http://quicksearch.dla.mil.

6.4 Definitions. For the purpose of the following definitions, the ABT is assumed to be in automatic mode with the normal source supplying the loads unless specifically indicated otherwise. Note that in the manual mode, the ABT will remain lined up to the operator-selected power source regardless of the availability of either source.

6.4.1 Automatic bus transfer switch (ABT). The ABT is a self-acting device for transferring one or more load cable connections from one power source to another.

6.4.2 ABT operation. ABT operation is the transfer or the re-transfer of the connected load from one power source to another.

6.4.3 Active source. The active source is the source that is connected to the load. The active source is indicated on the front panel.

6.4.4 Available source. A power source is available when the voltage and frequency are above pickup voltage levels (see table V).

6.4.5 Continuous duty. Operation at substantially constant load for an unlimited period of time is considered continuous duty (100 percent).

6.4.6 Control circuit time delay (CCTD). The CCTD is the preset time that the switch will not operate after an under voltage condition has been detected. At the completion of the CCTD, if the under voltage condition has been resolved, then the switch will not transfer. If the under voltage condition still exists, then the switch will continue on with the transfer operation.

6.4.7 Control circuits. Control circuits are circuits that sense and control the transfer (relay-logic or electronic) from normal to alternate power sources and re-transfer or otherwise control operation of the ABT.

6.4.8 Fault. A condition whereby a power source voltage or frequency falls outside its preset limits, causing it to become not available.

A fault of the type described above will always trigger a transfer or a transfer inhibit. Most faults of the type described above can be cleared when conditions external to the ABT change (i.e., restoration of a source from not available to available status).

6.4.9 Three-phase monitoring. Three-phase monitoring is monitoring all three line-to-line voltages. Three-phase monitoring is when an ABT simultaneously monitors all three phases of the active power source for transfer drop-out voltage levels (voltage alone or voltage and frequency together, depending on configuration type), monitors the alternate (available) power source for a suitable transfer pickup voltage level, and performs a transfer after a preset time delay to the alternate power source when all three phases of the active power source simultaneously fall below the transfer drop-out voltage level or any one active phase drops to 0.0 volts. If normal-seeking, the ABT continues to monitor the preferred power source for normal pickup voltage levels and initiates re-transfer to the preferred power source when all phases return to within specified pickup limits.

6.4.10 In-phase monitoring. In-phase monitoring is the use of a device to sense the phase angle difference between power sources, calculate rate of change of phase angle difference, and initiate transfer mechanism to allow phase angle difference to be within a preset phase angle prior to load transfer. In-phase monitoring is used with an ABT type to initiate transfer only when the two sources are within ±60 electrical degrees.

6.4.11 In-phase transfer. In-phase transfer is the voltage threshold below which the unit senses an in-phase under-voltage condition. If the condition is on the active source, the source will no longer be considered available and the ABT will transfer the load to the alternate source. Transfer of the load will be initiated only if the alternate source is available. If the phase angle difference feature is enabled, transfer of the load will occur only if the phase mismatch between the sources is less than the preset phase angle difference.

6.4.12 Interlock. Interlock is a device used to prevent undesired states or combination of states in a machine, which in a general sense can include any electrical, electronic, mechanical, or electromechanical device or system. In most applications, an interlock is used to help prevent a machine from harming its operator or damaging itself by stopping the machine when tripped.

6.4.13 Line circuit time delay (LCTD). A designated time delay specified by configuration type (see 1.2.3). LCTD is the delay in transfer to the alternate source to allow power to be dissipated. This may be accomplished by an individual electronic circuit or may be accomplished by the inherent design of the ABT.

6.4.14 Normal-seeking. Function of the ABT preferentially to seek out and provide power to the load from the normal power source whenever the normal power source is available. However, it will transfer to the alternate power source and provide power to the load from that source if the normal power source drops below preset values and the alternate power source is available.

6.4.15 Normal source. This establishes an arbitrary convention to distinguish between the two sources. Which source is normal and which is alternate depends entirely on which set of bus bars the cables from the two available power sources are connected to inside the ABT and hence is independent of which source should supply the load under normal operation. The term “normal” should therefore not be confused with “preferred”.

6.4.16 Phase angle difference. Phase angle difference is monitored only if the in-phase transfer feature is enabled. The phase angle difference is measured between the normal and alternate sources.

6.4.17 Pickup voltage. Pickup voltage is the lowest voltage of a power source at which the ABT will consider that source available, provided the other monitored parameters are specified and are also within their acceptable ranges. The pickup voltage of an ABT is the minimum voltage when detected that the ABT will initiate transfer or re-transfer.

6.4.18 Power-seeking. A power-seeking ABT will not follow a preferred source (see 6.4.19) to provide power to the load. It will provide power to the load from whichever source becomes available first. It will remain on that source and stay on that source until that power source drops below preset values and transfer the other power source if it is available or if so commanded by the operator.

6.4.19 Preferred source. The source to which a normal-seeking ABT will automatically re-transfer the load in the event both power sources become available. Either normal or alternate source can be selected to be preferred. When a source is selected as preferred, it will be so indicated on the front panel.

6.4.20 Random transfer. The voltage or frequency, or both, threshold of the active power source at which the ABT initiates a random transfer of the load to the inactive power source, provided the inactive source is available. When this threshold is reached, transfer of the load will occur regardless of phase mismatch between power sources.

6.4.21 Re-transfer. The automatic switching of loads from the non-preferred to the preferred source after a transfer has occurred earlier and subsequently the preferred source has become available. If the ABT has in-phase monitoring, the re-transfer is performed only within the maximum allowed phase angle difference.

6.4.22 Short-circuit withstand capability. Short-circuit withstand capability is the ability of the ABT switching mechanism to carry the required short-circuit current without permanent damage for the period of time necessary for circuit protective devices in the system to clear the fault.

6.4.23 Single-phase monitoring. Single-phase monitoring is line-to-line voltage monitoring. Single-phase monitoring occurs when an ABT monitors a single phase of the active power source for transfer drop-out voltage levels (voltage alone or voltage and frequency together, depending on configuration type), monitors the alternate (available) power source for a suitable transfer pickup voltage level, and performs a transfer after a preset time delay to the alternate power source when transfer drop-out voltage levels on the single monitored phase of the active power source fall below the drop-out voltage levels. The ABT continues to monitor the active power source for normal pickup voltage levels and initiates re-transfer to the active power source when the single monitored phase returns to within specified pickup limits.

6.4.24 Transfer. Transfer is the switching of loads from the active to the inactive source.

6.5 Abbreviations.

ABT Automatic Bus Transfer

CCTD Control Circuit Time Delay

DPDT Double Pole, Double Throw

EMI Electromagnetic Interference

EMF Electromotive Force

ESD Electrostatic Discharge

LCTD Line Circuit Time Delay

LED Light Emitting Diode

MTTR Mean Time To Repair

RMS Root Mean Square

SPDT Single Pole, Double Throw

V&V Verification and Validation

6.6 Subject term (key word) listing.

ABT

Switchgear

Switching mechanism

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

Preparing activity:
Navy – SH
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NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.