

METRIC

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SUPERSEDING
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 (See 6.9)

MILITARY SPECIFICATION

**SWITCHES, BUS TRANSFER, ELECTRIC POWER,
 AUTOMATIC AND MANUAL (METRIC)**

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

1. SCOPE

1.1 Scope. This specification covers alternating current (a.c.) and direct current (d.c.) electric power bus transfer switches for Naval shipboard use. Semiconductor (solid-state) devices used for transfer switch control circuits are included. Solid-state transfer switches are not included.

1.2 Classification. Bus transfer switches shall be classified by standard part numbers as specified in 1.2.1 through 1.2.1.6 (see 6.2.1).

1.2.1 Bus transfer switch part numbers. The standard part numbers for the bus transfer switches shall be designated as follows:

<u>ABT</u>	<u>4</u>	<u>A</u>	<u>1</u>	<u>S</u>	<u>XXX</u>
Type (see 1.2.1.1)	Voltage (see 1.2.1.2)	Frequency (see 1.2.1.3)	Application (see 1.2.1.4)	Special features (see 1.2.1.5)	Current rating (see 1.2.1.6)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.2.1.1 Type.

ABT - denotes automatic bus transfer switch.

MBT - denotes manual bus transfer switch.

1.2.1.2 Voltage.

1 - 120 Volt (V) a.c. 115 Vd.c.

2 - 208 Va.c. 230 Vd.c.

4 - 450 Va.c.

1.2.1.3 Frequency.

A - denotes 60 hertz (Hz) application.

D - denotes d.c. application.

F - denotes 400 Hz application.

1.2.1.4 Application.

1 - denotes transfer switch has control circuit time delay and is instantaneous and selective.

2 - denotes transfer switch has control circuit time delay and full phase protection and is instantaneous and selective.

3 - denotes transfer switch has control circuit time delay and line circuit delay or inphase monitor and is selective.

4 - denotes transfer switch is instantaneous and non selective.

5 - denotes transfer switch has control circuit time delay on voltage sensing, instantaneous drop-out on frequency sensing, instantaneous drop-out below 60 to 70 percent voltage and contains an inphase monitor.

6 - Same as 3 except transfer switch is non-selective and d.c. has no line circuit time delay.

9 - Same as 3 except 3-way transfer switch with selective transfer between normal and alternate, and non selective to emergency. D.c has no line circuit time delay.

Note: Unless otherwise specifically specified (see 3.5.2.10.8), full phase protection may be incorporated in automatic bus transfer switches.

1.2.1.5 Special features. "S" shall be added after the last significant designation of application to show special features, such as: a non standard pick-up and drop-out voltage setting, frequency sensitive, load fuses, and special timing. For item identification, substitute an abstract letter.

1.2.1.6 Current rating.

XXX - denotes current rating of bus transfer switch in amperes (A) (see 3.4.4 and table I).

2. APPLICABLE DOCUMENTS2.1 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

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SPECIFICATIONS

FEDERAL

- QQ-S-365 - Silver Plating, Electrodeposited: General Requirements For.

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- MIL-B-117 - Bags, Sleeves and Tubing-Interior Packaging.
 MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment And Systems, Requirements For.
 MIL-C-915 - Cable And Cord Electrical, For Shipboard Use General Specifications For.
 MIL-E-917 - Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
 MIL-R-2033 - Relays For Naval Shipboard Electrical Service.
 MIL-E-2036 - Enclosures For Electric and Electronic Equipment, Naval Shipboard.
 MIL-C-2212 - Controllers, Electric Motor, Ac or Dc And Associated Switching Devices, Naval Shipboard.
 MIL-L-3661/54 - Lenses, Indicator Light, Style LC40.
 MIL-L-3661/63 - Lampholder, Lights, Indicator (Housing), Style LH96.
 MIL-L-3661/65 - Lampholder, Lights, Indicator (Housing), Style LH98.
 MIL-P-15024 - Plates, Tags And Bands For Identification of Equipment.
 MIL-P-15024/5 - Plates, Identification.
 MIL-S-15291 - Switch, Rotary, Snap Action.
 MIL-S-16036 - Switchgear, Power, Naval Shipboard.
 MIL-C-17361 - Circuit Breakers, Air, Electric, Insulated Housing.
 MIL-E-17555 - Electronic And Electrical Equipment, Accessories, And Repair Parts; Packaging and Packing Of.
 MIL-C-17587 - Circuit Breakers, Air, Electric, Open Frame Removable Assembly (Shipboard Use).
 MIL-R-19523 - Relays, Control, Naval Shipboard.
 MIL-P-23928 - Panel, Electrical, Power Distribution and Manual Transfer, Circuit Breaker Type.
 MIL-P-23928/2 - Panel, Electrical, Power Distribution For ALB-5, NLB-5, AQB-A50 and NQB-A50 Circuit Breakers, Dripproof, Totally Enclosed And Watertight.
 MIL-P-23928/4 - Panel, Electrical, Power Distribution for Double AQB-A101 and NQB-A101 Circuit Breakers, 2-12 Circuits, With And Without Manual Transfer, Dripproof, Totally Enclosed And Watertight.
 MIL-P-23928/5 - Panel, Electrical, Manual Transfer For Double NQB-A101 Circuit Breakers, Dripproof, Totally Enclosed And Watertight.
 MIL-P-23928/8 - Panel, Electrical, Manual Transfer For Double NQB-A250 Circuit Breakers, Dripproof, Totally Enclosed And Watertight.

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STANDARDS

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- MIL-STD-105 - Sampling Procedures And Tables For Inspection By Attributes.
- MIL-STD-108 - Definitions Of And Basic Requirements For Enclosures For Electric And Electronic Equipment.
- MIL-STD-167-1 - Mechanical Vibrations Of Shipboard Equipment (Type I - Environmental And Type II - Internally-Excited).
- MIL-STD-202 - Test Methods For Electronic And Electrical Component Parts.
- MIL-STD-681 - Identification Coding And Application Of Hook Up And Lead Wire.
- DOD-STD-1399, Section 300 - Interface Standard for Shipboard Systems - Electric Power, Alternating Current. (Metric)
- MS15612 - Lamp, Incandescent, T-1-3/4, Midget Screw Base.

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

C37.2 - Electrical Power System Device Function Numbers.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

UNDERWRITERS LABORATORY (UL)

1008 - Automatic Transfer Switches.

(Application for copies should be addressed to Underwriters Laboratories, Inc., 207 East Ohio Street, Chicago, IL 60611.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Qualification. Automatic bus transfer switches furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.4 and 6.3).

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3.2 First article. When specified (see 6.2.1), a sample of one complete type (type MBT) manual bus transfer switch shall be subjected to first article inspection (see 4.5 and 6.4).

3.3 General requirements.

3.3.1 Ungrounded circuits. Bus transfer switches shall operate in ungrounded circuits.

3.3.2 Ambient temperature. Bus transfer switches shall operate in an ambient temperature from 0 to 50 degrees Celsius (°C).

3.3.3 Duty. Bus transfer switches shall be of the continuous duty type.

3.3.4 Safety. The safety requirements in accordance with MIL-E-917 shall be adhered to during the design and manufacture of bus transfer switches.

3.3.5 Materials. Materials shall be in accordance with MIL-E-917.

3.4 Detail requirements.

3.4.1 Operation and performance. Bus transfer switches shall operate manually (type MBT) or automatically (type ABT). Automatic transfer switches shall conform to the requirements of DOD-STD-1399, section 300. Unless otherwise specified (see 3.5.2.10.1), automatic bus transfer switches shall be operated manually, as well as automatically.

3.4.2 Transfer positions. Unless otherwise specified (see 6.2.1), bus transfer switches shall be two-way (see 6.5.22).

3.4.3 Voltage ratings.

3.4.3.1 Line voltages. Unless otherwise specified (see 6.2.1), a.c. bus transfer switches shall be rated for 120 or 450 line V (see 1.2). Unless otherwise specified (see 6.2.1), d.c. bus transfer switches shall be rated for 120 or 240 line V.

3.4.3.2 Control voltages. Unless otherwise specified (see 6.2.1), 60 Hz automatic bus transfer switches shall have 120 or 450 V rated control circuits. Control power transformers are permitted. Four hundred Hz automatic bus transfer switches shall have d.c. control circuits energized via a rectifier. Unless otherwise specified (see 6.2.1), d.c. and 400 Hz automatic bus transfer switches shall have 120 or 240 V rated control circuits. A dropping resistor may be provided for use when 120 V is selected for 240 V d.c. applications.

3.4.4 Current ratings. The continuous duty current ratings for bus transfer switches shall be in accordance with their type designation (see 1.2). Circuit breaker types, contactor or rotary switch sizes shall be in accordance with table I.

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TABLE I. Circuit breaker types and contactor sizes for bus transfer switches. 1/

Manual		Automatic	
Amperes	Type ^{1/}	Amperes	Type ^{1/}
250 or less	AQB refer to MIL-P-23928/2, /4, /5, and /8	50 to 1600 900 or greater	AQB ACB
greater than 250	AQB	^{2/} 25 to 1600	Transfer contactors
10 to 60	Rotary switch Type SR with/off	15 to 540	Contactor relays (sizes 0 to 6)

- ^{1/} For specific sizes of AQB circuit breakers available refer to MIL-C-17361.
 For specific sizes of ACB circuit breakers available refer to MIL-C-17587.
 For specific sizes of contactor relays available refer to MIL-C-2212.
 For specific sizes of rotary switches available refer to MIL-S-15291.
- ^{2/} Standard sizes of transfer switches utilizing transfer type contactors shall be 25, 50, 100, 150, 250, 300, 400 and 600 A. Sizes above 600 A shall be as specified. Sizes 150 and 300 are for replacement only.

3.4.5 Frequency. A.c. bus transfer switches shall operate at 60 or 400 Hz, in accordance with their type designation (see 1.2).

3.4.6 Line phases. Unless otherwise specified (see 6.2.1), a.c. bus transfer switches shall operate in three-phase circuits.

3.4.7 General examination. Bus transfer switches shall pass the general examination test as specified in 4.8.1.

3.4.8 Inclined operation. Bus transfer switches shall perform satisfactorily when inclined at all angles up to 45 degrees from the vertical in any direction. Transfer switches shall pass the inclined operation tests as specified in 4.8.2.

3.4.9 Shock. Bus transfer switches shall pass grade A, class I, type A, high-impact (H.I.) shock tests in accordance with MIL-S-901 as specified in 4.8.3.

3.4.10 Vibration. Bus transfer switches shall pass type I vibration tests in accordance with MIL-STD-167-1 as specified in 4.8.4. Bus transfer switches shall pass the dielectric withstanding voltage test as specified in 4.8.9 following the vibration tests.

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3.4.11 Temperature rise. Temperature rise shall not exceed the values as specified in table II when the bus transfer switches are continuously carrying rated current as specified in 4.8.5.

TABLE II. Maximum temperature rises.

Part	Allowable temperature rise over ambient (°C)	
	a.c.	d.c.
Shunt coils: <u>1/</u>		
Class A insulation	55	50
Class B insulation	80	75
Class F insulation	105	100
Class H insulation	130	125
Class N insulation	150	145
Bolted connections and terminal studs for external connections	65	65
Contacts:		
Used with class B insulation	70	70
Used with class H insulation	130	130

1/ Shunt coils in watertight and spraytight enclosures shall be permitted an additional 5°C rise over the specified values.

3.4.12 Endurance and overload. Unless otherwise specified (see 6.2.1), bus transfer switches shall pass the endurance and overload tests as specified in 4.8.6.

3.4.13 Short-circuit withstandability. Unless otherwise specified (see 6.2.1), bus transfer switches shall pass the short-circuit withstandability tests as specified in table III and 4.8.7.

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TABLE III. Bus transfer switches short-circuit withstandability currents.

Continuous rating (A)	Short circuit current (A) at pf .15-.20	(A) Duration seconds
to 15	5000	0.024
16-30	7000	0.024
31-75	12000	0.032
76-200	15000	0.032
201-300	20000	0.048
301-600	25000	0.064
<u>1/</u> above 600		

1/ Short-circuit withstandability requirements shall be as specified (see 6.2.1).

3.4.14 Insulation resistance. Insulation resistance of bus transfer switches shall be not less than 10 megohms when tested in accordance with 4.8.8.

3.4.15 Dielectric withstanding voltage. Bus transfer switches shall pass the dielectric withstanding voltage test of 4.8.9.

3.5. Design and construction.

3.5.1 General design and construction.

3.5.1.1 Parts. The following parts, when used in bus transfer switches, shall be in accordance with the requirements of MIL-E-917:

- (a) Fuses and fuseholders
- (b) Resistors and rheostats
- (c) Capacitors
- (d) Switches
- (e) Motors
- (f) Terminal boards
- (g) Terminal lugs
- (h) Transformers
- (i) Semiconductor devices
- (j) Semiconductor integrated circuits

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3.5.1.1.1 Contactors. Unless otherwise specified (see 6.2.1), contactors shall be in accordance with this specification or MIL-C-2212, as applicable.

3.5.1.1.2 Circuit breakers. Circuit breakers shall be in accordance with the requirements of MIL-C-17587 or MIL-C-17361, as applicable. Unless otherwise specified (see 6.2.1), circuit breakers shall not be provided with overload trip devices.

3.5.1.1.3 Relays. Relays shall be in accordance with the requirements of MIL-R-2033 or MIL-R-19523, as applicable, and shall have operating voltages as specified in 3.5.2.10.4. Dashpots operating with oil or air as the retardant for controlling the speed of operation of a relay shall be hermetically sealed. Additional requirements for relays used with bus transfer switches shall be as specified (see 6.2.1).

3.5.1.1.4 Magnetic coils. Magnetic coils, when of the removable type, shall be readily removable from the pole or yoke without damage to the coil. The coils shall be rigidly held so as to prevent damage to the coil leads. In general, shunt coils shall be front connected.

3.5.1.1.5 Indicator lights, lamps and lenses. A.c. indicator lights shall conform to type LH98/4 for 450-V service and type LH98/3 for 120-V service in accordance with MIL-L-3661/65. Lamps for a.c. indicator lights shall be in accordance with MS15612. D.c. indicator lights shall conform to style LH96/5 for 120-V service and type LH96/6 for 240-V service in accordance with MIL-L-3661/63. Lamps for d.c. indicator lights shall be in accordance with MS15612. Lenses shall be style LC40 in accordance with MIL-L-3661/54, with lens color as specified herein.

3.5.1.2 Electrical insulation. Electrical insulating materials shall be in accordance with the requirements of MIL-E-917.

3.5.1.3 Plating. Bus transfer switch bus bars shall be silver plated in areas of current-carrying contact with lugs, terminals, bus ties, screw bolts and so forth. Silver plating shall be in accordance with QQ-S-365, except that the silver plate shall be not less than 0.0002-inch thick. The contact surfaces of bus bars shall be silvered 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 1/8-inch wide band. Threaded surfaces, used as electrical contact surfaces, shall have silver thickness of at least 0.0002-inch.

3.5.1.4 Painting. Painting of the parts of bus transfer switches shall be in accordance with the requirements of MIL-E-917.

3.5.1.5 Creepage and clearance distances. Electrical creepage and clearance distances shall be in accordance with MIL-E-917 or MIL-S-16036 as applicable.

3.5.2 Detail design and construction for bus transfer switches.

3.5.2.1 Switching mechanisms. Switching mechanisms of bus transfer switches shall use contactors, circuit breakers or rotary snap switches as specified in table I.

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3.5.2.1.1 Contactors. Unless otherwise specified (see 6.2.1), contactors shall be actuated by magnetic coils or motor-driven cams, and shall be mechanically held.

3.5.2.2 Interlocks. Interlocks 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.

3.5.2.3 Fusing of control circuits and indicator light circuits. Bus transfer switches that are self contained shall not have fused control circuits and indicator light circuits. Other transfer switches shall have fused control circuits and indicator light circuits, as specified in the applicable specification. Circuits leaving the unit shall be fused. Blown fuses for remote circuits shall not affect local control.

3.5.2.4 Manual operating mechanism. Manual operating mechanisms for bus transfer switches shall be external to the enclosure and located in a readily accessible position.

3.5.2.5 Auxiliary switches. Unless otherwise specified (see 6.2.1), bus transfer switches over 100 A shall be provided with one double pole, double throw (DPDT) auxiliary switch, and bus transfer switches 100 A 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 transfer switch for connection to the remote equipment. Auxiliary switches shall have a minimum rated continuous current of 5 A and a rated voltage of 500 Va.c. and 250 Vd.c. and meet the endurance requirements as specified in 4.8.10.

3.5.2.6 External control cable connections. Terminal boards or studs shall be provided for external control connections if more than 12 external control wires are required. Terminal boards and studs shall be accessible from the front of the enclosure, with the front panel open and the control wire connection points shall be accessible and identified.

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

3.5.2.7.1 Terminal markings for supply lines and loads. Terminal markings for supply lines and loads of bus transfer switches shall be in accordance with table IV. For a.c. bus transfer switches, like phases shall be arranged in the same manner. Whenever practicable, the phase rotation shall be A, B, C, respectively, from right to left (facing the front), top to bottom and front to back.

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TABLE IV. Marking of terminals.

Sources and load	A.c.	D.c. 2-wire	D.c. 3-wire
Two-way switches:			
Normal (N) source	SA,SB,SC	S+, S-	S+, S ₊ , S-
Emergency (E) source	EA,EB,EC	E+, E-	E+, E ₊ , E-
Load	L1,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	L1,L2,L3	L+, L-	L+, L ₊ , L-
Three-way switches:			
Normal (N) source	S1A,S1B,S1C	S1+, S1-	S1+, S1 ₊ , S1-
Alternate (A) source	S2A,S2B,S2C	S2+, S2-	S2+, S2 ₊ , S2-
Emergency (E) source	EA,EB,EC	E+, E-	E+, E ₊ , E-
Load	L1,L2,L3	L+, L-	L+, L ₊ , L-

NOTE: Circuit breaker terminals do not require markings.

3.5.2.8 Diagrams and description of operation. Each bus transfer switch shall include a wiring diagram, a schematic diagram and a description of operation. The information shall be protected in accordance with method 1 of MIL-E-2036 and shall be attached to the inside of the enclosure door in accordance with MIL-E-2036. Wiring diagrams shall include wire numbers, component identification and fuse size and type, if applicable.

3.5.2.9 Enclosures. Enclosures for bus transfer switches shall be open, dripproof protected, watertight or spraytight, as specified (see 6.2.1), and shall meet the requirements as specified in MIL-STD-108 as supplemented by MIL-E-2036 for class 1 enclosures for electric equipment. The degree of enclosure shall be tested in accordance with 4.8.11.

3.5.2.9.1 Protection against arcs. The interior of enclosing cases shall be protected by insulating material selected in accordance with the requirements of MIL-E-917 in the wake of arcing contacts or where liable to cause short circuits with current-carrying parts. This insulating material shall be secured to the enclosure surface by mechanical means other than adhesives.

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3.5.2.9.2 Cable entrance. Unless otherwise specified (see 6.2.1), drip-proof protected, watertight and spraytight enclosures above 400 A shall have removable cable entrance plates. The cable entrance plates shall be furnished blank and of adequate size to accept terminals or stuffing tubes for passage of type TSGU cables in accordance with MIL-C-915. The plates shall be sealed to the level of effectiveness of the enclosures.

3.5.2.10 Detail design for automatic bus transfer switches, self contained.

3.5.2.10.1 Provision for manual operation. Unless otherwise specified (see 6.2.1), automatic bus transfer switches shall provide for alternate manual operation. The operation of automatic control circuit devices shall not cause automatic transfer during the period of manual operation.

3.5.2.10.1.1 Manual operating handle or lever for automatic bus transfers. Protruding manual operating handles or levers for automatic bus transfer switches shall remain stationary in a neutral position and a handwheel or knob may rotate when the transfer switch is on automatic operation. When on manual operation, the operating handle shall provide the time delay as specified in 3.5.2.10.5.3 and shall indicate by mechanical position of the parts for which source of supply is connected to the load circuit. For automatic bus transfer switches which utilize an inherent double-throw transfer mechanism, a solenoid locking device may be used in lieu of the time delay. This locking device shall be a fail-safe design and allow manual operation only when one or both sources are dead.

3.5.2.10.2 Manual-automatic selector switch and control circuit. Automatic bus transfer switches shall be provided with a manual-automatic selection switch and control circuit that controls the selection of manual or automatic transfer switch operation.

3.5.2.10.3 Preferred source selector switch and control circuit. Two-way automatic bus transfer switches with normal (ship's service) and alternate (ship's service) supply sources when required by 6.2.1, and three-way automatic bus transfer switches shall be provided with a preferred source selector switch that controls the selection of the preferred source of power.

3.5.2.10.4 Operating voltages. Unless otherwise specified (see 6.2.1), voltage sensing devices for automatic bus transfer switches (except types A4 and F4), when operating at rated frequency, shall dropout between 60 and 70 percent of rated line voltage for transfer to the non-preferred supply line and shall pickup between 85 and 95 percent of rated line voltage for retransfer to the preferred supply line. For types A4 and F4 and other types when supplied with an inphase monitor, transfer to the non-preferred side will be initiated when preferred source voltage falls below 80 to 85 percent. Should the voltage fall below 60 to 70 percent, when inphase monitor is supplied, a random transfer shall occur after a time delay period as shown in table V (except A4 and F4 (see 1.2.1.2 and 1.2.1.3)).

3.5.2.10.5 Timing. Unless otherwise specified (see 6.2.1), instantaneous action or time delay shall be provided as specified by the switch type designation (see 1.2.1).

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3.5.2.10.5.1 Instantaneous. On types requiring instantaneous transfer, the time from initiating the transfer to the closing onto the other source shall not exceed 50 milliseconds.

3.5.2.10.5.2 Control circuit time delay to override monitored voltage source deviation. When specified by type designation (see 1.2.1), a 0.3 to 0.5 second dropout time delay shall be provided when the voltage is below the dropout voltage (see 3.5.2.10.4). This time delay need be effective only when the reduced value of line voltage is between the dropout voltage value as specified in 3.5.2.10.4 and 20 percent of rated line voltage and may be proportionate.

3.5.2.10.5.3 Line circuit or off position time delay. When specified by type designation (see 1.2.1), automatic bus transfer switches shall be provided with a time delay between the opening of the main line contacts and the closing of the other set of main line contacts as shown in table V. The control circuit time delay and the off position time delay may be incorporated into a single actuating device utilizing motor-driven cams and gear arrangements, provided that the time delay of 4 seconds for the combination of both time delays are not exceeded and minimum control circuit time delay is met. When supplied with an inphase monitor, and voltage falls below or between 60 and 70 percent, the main line contacts shall remain connected to the supply line for an additional time delay period as specified in table V, prior to random transfer to the other power supply. Line circuit delay may be suspended after the voltage falls below 20 percent.

TABLE V. Line circuit time delays.

Current rating of switching mechanism	Time delay (seconds)
50 A or less	1 to 3.5
Over 50 A	2.5 to 3.5

3.5.2.10.6 Operating frequency. When specified by type designation (see 1.2.1), transfer shall be initiated when the frequency falls 3 to 4 Hz below operating frequency. Unless otherwise specified (see 6.2.1), if transfer is not completed before the voltage drops to between 60 and 70 percent of operating voltage, instantaneous transfer shall occur.

3.5.2.10.7 Test switch. Automatic bus transfer switches shall be provided with a test switch so connected in the control circuits that the operator may check the transfer operation by simulating voltage failures to the voltage sensing devices. The test switch shall be of the momentary spring return type.

3.5.2.10.8 Full phase protection. When specified by the automatic bus transfer switch type (see 1.2.1.1), full phase protection shall be provided. Operating voltages shall be in accordance with 3.5.2.10.4. Switches may be full phase protection unless specifically specified as single phase protection (see 6.2.1).

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3.5.2.10.9 Inphase monitor control circuit. When specified (see 6.2.1), automatic bus transfer switches shall be provided with an inphase monitor that will allow transfer only when the phase angle of both power sources is within 60 electrical degrees or less.

3.5.2.11 Detail requirements for automatic bus transfer switches mounted in emergency and auxiliary switchboards. Detail requirements for automatic bus transfer switches mounted in emergency and auxiliary switchboards are types ABT-AL and ABT-A9.

3.5.2.11.1 General. Transfer switches used in conjunction with automatic starting of an emergency or auxiliary ship service generator shall be of the open mounting type with auxiliaries for dead front mounting. The transfer switches shall be two-way or three-way, as specified (see 6.2.1).

3.5.2.11.2 Function. Three-way transfer switches shall automatically transfer between two ships service (SS) sources; and on the loss of both SS supplies, automatically signal the start of a generator engine and transfer to that source when the generator is up to voltage. Re-transfer to the ships service source shall be done manually except on loss of emergency power. Two-way transfer switches shall operate the same as three-way switches except there will be only one ships service supply.

3.5.2.11.3 Device numbers. Device numbers when used, shall be in accordance with ANSI C37.2.

3.5.2.11.4 Contactor type. Contactors may be used in emergency switchboard rated up to 600 A. The generator circuit breaker may be an AQB type, maximum size 400 A, placed in the line between the contactor and the generator or a type ACB used in conjunction with the contactors, (see table I).

3.5.2.11.4.1 Circuit breaker type. Circuit breakers shall be used for the switching device in emergency switchboards and ships service auxiliary switchboards rated over 600 A.

3.5.2.11.5 Interlocks. In general, the interlock described in 3.5.2.2 shall apply. Circuit breakers that do not have protruding handles may be electrically interlocked in lieu of a lock-open device. The electrical interlock shall be set to trip both transfer circuit breakers in both the manual mode when the synchronizing switch is off, and in the automatic mode, when a second circuit breaker is closed manually. The two circuit breakers shall trip before the second circuit breaker makes contact. Removal of a circuit breaker or other interlocking device shall not disable the entire automatic operation.

3.5.2.11.6 Time delay. The time delay requirements of 3.5.2.10.5 shall apply. Inphase monitors may be used.

3.5.2.11.6.1 Manual operation. The time delay or inphase devices shall be active for manual operation when control switches are used to operate the switching devices.

3.5.2.11.6.2 Control circuit for a battery started generator engine. The control circuit shall not crank the generator engine for more than 15 seconds.

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3.5.2.11.7 Ratings. Unless otherwise specified, the voltage shall be 450 Va.c. The current rating shall be for standard size generators from 100 kilowatts (kW) (160 A) to 2.5 megawatts (4,000 A) in standardized switchgear units having current ratings as specified in MIL-S-16036.

3.5.2.11.8 Control switches. Handles shall be in accordance with MIL-S-16036. Control and transfer switches shall be provided and operate as follows:

- (a) Operation selector switch for selecting between automatic and manual operation. Operation of this switch shall not cause a circuit breaker to open except for transfer to preferred position.
- (b) Preferred source selector switch (device 43) for selecting either ship's service supply as the normal source.
- (c) Transfer test switch shall be a three-position spring return switch disconnecting the power to the entire control circuit except the power available lamps and high power consuming devices operated by auxiliary relays. The clockwise position shall transfer the preferred source to the non-preferred source. The counterclockwise position shall transfer the supply to the emergency source.
- (d) Generator start switch for starting the generator independent of the automatic transfer circuits. For battery started sets, the counterclockwise position shall be for start and the clockwise position for lock-out. Air start sets may use a pushbutton.

3.5.2.11.8.1 Control switches for emergency switchboards. In addition to the above switches, the operation selector switch shall contain a position adjacent to the manual position for feedback operation.

3.5.2.11.8.2 Control switches for ship's service auxiliary switchboards. A synchronizing switch shall be provided to operate in the manual position of the operation selector switch. This switch may be combined with the operation selector switch.

3.5.2.11.8.3 Control circuits. Control voltage shall be as specified in MIL-S-16036.

3.5.2.11.9 Indicator lamps. Indicator lamp and cap styles shall be as specified in MIL-S-16036 and as follows:

- (a) Power available. White indicator lamps shall be installed on or adjacent to each ship's service circuit breaker (device 4) and above each circuit breaker or contactor control switch (device 1) to show power available from the corresponding ship's service supply.
- (b) Contactor closed. Blue indicator lamps shall be installed on or adjacent to each circuit breaker or contactor (device 4) which does not have a mechanical indicator and above each associated control switch (device 1) to show the contactor closed.

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- (c) Auto set-up. A green indicator lamp shall be installed to indicate that all devices required to start and maintain the operation of the automatic system are in the proper position. (See MIL-S-16036 for a typical list of devices.)
- (d) Generator up to voltage lamp. A green lamp shall be provided to show generator up to voltage operated through a voltage sensing relay (device 27) to show generator up to voltage. This lamp is only required when the voltmeter can be turned off and generators exceeding 1 megawatt.

3.5.2.11.10 Remote set-up panel provisions. The switches provided by 3.5.2.5 shall be utilized for this purpose.

3.5.2.11.11 Terminal blocks. Terminal blocks shall be installed and numbered in accordance with MIL-S-16036.

3.5.2.12 Detail requirements for manual bus transfer switches.

3.5.2.12.1 Manual bus transfer switch power available (power-on). Manual bus transfer switches shall be provided with a white color indicating lamp for each supply line which will indicate the availability of power in each supply line. The indicator lights shall be positioned on the front of the transfer switch enclosure so that the operator can tell at a glance by looking at the switching device and the indicator lamp which power supply is being utilized and which is available.

3.5.2.12.2 Off position. Manual bus transfer switches shall have an off position between the two on positions which must be actuated during transfer.

3.5.2.12.3 Detail requirements for special service bus transfer switches. Detail requirements for special service bus transfer switches (type ABT-S or MBT-S), shall be as specified (see 6.2.1).

3.6 Information plates, identification plates and marking. Information and identification plates for bus transfer switches shall conform to type A, B or C of MIL-P-15024 and MIL-P-15024/5 as supplemented by MIL-E-917. Inscriptions or markings for all type plates shall be black on neutral background or white on black background except danger, warning and caution plates, which shall be red inscriptions or markings on white or neutral background or white; inscriptions or markings on a solid red background. The marking format, information and location shall be as specified in 3.6.1 through 3.6.3.

3.6.1 Manufacturer's identification plate. The manufacturer's identification plate for bus transfer switches shall be metallic only, and shall contain, as a minimum, the following information:

- (a) Manufacturer's name
- (b) Name of the unit ("Bus Transfer Switch")
- (c) Type (see 1.2.1.1), rating, voltage, frequency and phases
- (d) Manufacturer's identification number
- (e) Contract number

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- (f) National stock number
- (g) Technical manual number or unit drawing number
- (h) "US" marking to indicate Government ownership
- (i) Place for Government inspector's stamp

3.6.2 Information plates. Each bus transfer switch's external power circuits, selector switches, and visual indicators shall be identified by means of an information plate. The plate shall be located adjacent to the switch handle or lamp, as applicable. Plates containing safety notices shall be in full view and as near the area identified as practical. The transfer switch manual operating mechanism shall be provided with information plates that indicate the function of each operating position, as specified (see 6.2.1). Where necessary, pointers shall be provided to indicate the operating positions of the mechanism.

3.6.3 Markings for parts and small components. Markings for parts and small components for bus transfer switches shall be a minimum of 2.4 mm (3/32 inch) high (10 point type) upper case plain block letters. Parts shall be labeled.

3.7 Technical data. The contractor shall prepare drawings, certification data sheets and technical manuals in accordance with the data ordering document included in the contract or order (see 6.2.2).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection system. The contractor shall maintain an inspection system in accordance with the data ordering document included in the contract or order (see 6.2.2).

4.2 Classification of inspection. Inspections herein are classified as follows:

- (a) Qualification inspection (see 4.4).
- (b) First article inspection (see 4.5).
- (c) Quality conformance inspection (see 4.6).
- (d) Periodic tests (see 4.7).

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

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory satisfactory to NAVSEA, on sample units produced with equipment and procedures normally used in production.

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4.4.1 Sample size. One bus transfer switch of each type shall be subjected to qualification inspection.

4.4.2 Inspection and tests. The sample bus transfer switch shall be subjected to the inspections specified in table VI.

TABLE VI. Qualification inspection of automatic bus transfer switches.

Inspection and tests	Requirement paragraph	Test method paragraph
General examination	3.4.7	4.8.1
Inclined operation	3.4.8	4.8.2
Shock	3.4.9	4.8.3
Vibration	3.4.10	4.8.4
Temperature rise	3.4.11	4.8.5
Endurance and overload	3.4.12	4.8.6
Short-circuit withstandability	3.4.13	4.8.7
Insulation resistance	3.4.14	4.8.8
Dielectric withstanding voltage	3.4.15	4.8.9
Auxiliary switches	3.5.2.5	4.8.10
Degree of enclosure	3.5.2.9	4.8.11
Operational - Automatic bus transfer switches	3.5.2.10	4.8.12

4.4.3 Failures. Any failure shall be cause for refusal to grant qualification approval.

4.5 First article inspection. First article inspection shall consist of the tests specified in table VII (see 6.4).

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TABLE VII. First article inspection of manual bus transfer switches.

Inspection and tests	Requirement paragraph	Test method paragraph
General examination	3.4.7	4.8.1
Shock	3.4.9	4.8.3
Vibration	3.4.10	4.8.4
Temperature rise	3.4.11	4.8.5
Short-circuit withstandability	3.4.13	4.8.7
Insulation resistance	3.4.14	4.8.8
Dielectric withstanding voltage	3.4.15	4.8.9
Auxiliary switches	3.5.2.5	4.8.10
Degree of enclosure	3.5.2.9	4.8.11
Operational - Manual bus transfer switches	3.5.2.12	4.8.12.2.1 and 4.8.12.2.2

4.5.1 First article inspection report. A first article inspection report shall be prepared in accordance with the data ordering document (see 6.2.2).

4.5.2 Sample size. The contractor shall submit one sample from normal production line manual bus transfer switch of each type for which the first article acceptance is required.

4.5.3 Failure. One or more failures of first article inspection tests shall be cause for rejection.

4.6 Quality conformance inspection.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of inspection specified in table VIII.

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TABLE VIII. Quality conformance inspection.

Inspection	Requirement paragraph	Test method paragraph
General examination	3.4.7	4.8.1
Insulation resistance	3.4.14	4.8.8
Dielectric withstanding voltage	3.4.15	4.8.9
Operational - Automatic bus transfer switches	3.5.2.10.1 through 3.5.2.10.8	4.8.12.1.1 through 4.8.12.1.7
Operational - Manual bus transfer switches	3.5.2.12.1 through 3.5.2.12.2	4.8.12.2.1 through 4.8.12.2.2

4.6.1.1 Inspection lot. An inspection lot shall consist of all bus transfer switches of the same type designation produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality level (AQL) shall be 1.5 percent defective.

4.6.1.2.1 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.7 Periodic tests. At intervals of not more than 3 years during which equipment has been bought under this specification on Government contracts or orders, automatic bus transfer switches of a given design shall be subjected to periodic tests. The tests shall be conducted on completely assembled production units. A periodic test shall be required after any change in design which affects the performance characteristics. If production sampling tests reveal variations beyond a normal manufacturing tolerance, the Government inspector may require that any or all of the periodic tests be conducted on a particular bus transfer design to demonstrate that it is in accordance with this specification. Periodic tests shall be performed under the supervision of the Government inspector. Periodic tests shall be in accordance with table IX and shall be conducted in the order listed.

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TABLE IX. Periodic test.

Tests	Requirement paragraph	Test paragraph
General examination	3.4.7	4.8.1
Effectiveness of enclosure	3.5.2.9	4.8.11
General operation	3.5.2.10	4.8.12
Endurance and overload	3.4.12	4.8.6
Shock	3.4.9	4.8.3
Insulation resistance	3.4.14	4.8.8
Dielectric withstanding voltage	3.4.15	4.8.9

4.7.1 Failure. Failure of any sample bus transfer to conform to this specification for periodic tests shall be cause for rejection of the equipment and no further deliveries shall be authorized by the Government inspector until directed by NAVSEA.

4.8 Test procedures.

4.8.1 General examination. Bus transfer switches shall be subjected to a thorough examination to determine that the material, workmanship, safety to operating personnel, design and construction are in conformance with this specification and the applicable drawings. The examination shall be conducted using the classifications of defects as specified in table X as applicable.

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TABLE X. Classification of defects.

Categories	Defects
Major	
101	Prohibited materials are used (see 3.3.5).
102	Transfer positions are not two-way or three-way, as specified (see 3.4.2 and 3.5.2.11.1).
103	Switching mechanisms are not circuit breakers or transfer or relay contactors, as specified (see 3.4.4).
104	Number of line phases not as specified for a.c. bus transfer switches (see 3.4.6).
105	Parts not in conformance with applicable specifications (see 3.5.1.1).
106	Contactors not as specified (see 3.5.1.1.1).
107	Circuit breakers not as specified (see 3.5.1.1.2).
108	Relays not as specified (see 3.5.1.1.3).
109	Removable magnetic coil not readily removable or rigidly held (see 3.5.1.1.4).
110	Indicator lights, lamps or lenses not as specified (see 3.5.1.1.5).
111	Painting not as specified (see 3.1.5.4).
112	Creepage and clearance distances not as specified (see 3.5.1.5).
113	Contactors are not mechanically held (see 3.5.2.1.1).
114	Interlocks not provided as required (see 3.5.2.2).
115	Fusing of control circuits and indicator light circuits not as specified (see 3.5.2.3).
116	Manual operating mechanism not external to the enclosure or located in a readily accessible position (see 3.5.2.4).
117	Auxiliary switches not as specified (see 3.5.2.5).
118	Terminal boards not provided or wire connection points not accessible and identifiable (see 3.5.2.6).
119	Wire, wiring methods and marking not as specified (see 3.5.2.7).

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TABLE X. Classification of defects. - Continued

Categories	Defects
Major	
120	Supply line and load terminal markings not as specified (see 3.5.2.7.1).
121	Diagrams and descriptions of operation not provided as specified (see 3.5.2.8).
122	Degree of enclosure not as specified (see 3.5.2.9).
123	Insulating material not as specified or not provided as required (see 3.5.2.9.1).
124	Cable entrances not as specified (see 3.5.2.9.2).
125	Manual operation for automatic bus transfer switch - not provided as required (see 3.5.2.10.1).
126	Manual operating mechanism does not have mechanical position indicator for supply line indication (see 3.5.2.10.1.1).
127	Manual-automatic selector switch not provided for automatic bus transfer switches (see 3.5.2.10.2).
128	Preferred source selector switch not provided as specified (see 3.5.2.10.3).
129	Time delay circuits not provided as specified or instantaneous is not within maximum time limit specified (see 3.5.2.10.5).
130	Test switch not provided for automatic bus transfer switches (see 3.5.2.10.7).
131	Full phase protection not provided as specified (see 3.5.2.10.8).
132	Power available indicator lamp not provided for manual bus transfers (see 3.5.2.12.1).
133	Information plates, identification plates and marking not as specified (see 3.6).

4.8.2 Inclined operation. Bus transfer switches shall be operated at rated voltage and frequency when inclined 45 degrees forward, backward, right and left from its normal vertical orientation. Control circuits for automatic bus transfer switches shall be operated in each of the four inclined positions to ensure proper operation. Bus transfer switches shall be switched to all

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operating positions in each of the four inclined positions. Open main line contacts and auxiliary switch contacts shall not close and closed main line contacts and auxiliary switch contacts shall not open in any of the four inclined positions unless the opened and closed positions are normal for the selected operating position.

4.8.3 Shock. Bus transfer switches shall be subjected to the requirements as specified in MIL-S-901 for grade A, class I, type A equipment with weight classification as required by the weight of the equipment. The tests shall be conducted with the transfer switches carrying current, at rated voltage and frequency. Control circuits shall be energized as in actual service. An oscillograph shall be used to check the closed contacts for excessive contact bounce and to check the open contacts for momentary closures. Transfer switch mounting shall be as specified for standard mounting for bulkhead mounted equipment in accordance with MIL-S-901. 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 transfer switches being tested shall not be reconditioned or adjusted during the testing. Transfer switches shall fail the test if it can not 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 due to the force of shock blow
- (f) Main line contacts have contact bounce in excess of 0.02 second per bounce
- (g) Closed auxiliary contacts momentarily open or open auxiliary contacts momentarily close

The transfer switches 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.

4.8.4 Vibration. Bus transfer switches shall be subjected to type I vibration tests in accordance with MIL-STD-167-1. The tests shall be conducted with the transfer switch in each operating position with the transfer switch carrying rated current at rated frequency. Control circuits shall be energized as in actual service. An oscillograph or other suitable instrument shall be used to check for opening and closing of main line contacts and 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. Transfer switches shall fail the test if it can not 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

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- (f) Main line contacts exhibit contact chatter
- (g) Closed auxiliary contacts momentarily open or open auxiliary contacts momentarily close

The transfer switches shall be thoroughly examined after the tests to determine whether there is evidence of items (c) and (d) above. The transfer switches shall be subjected to and pass the dielectric withstanding voltage test of 4.8.9 after the vibration tests.

4.8.5 Temperature rise. Bus transfer switches shall be subjected to a temperature rise test. The test shall be conducted with the transfer switches carrying rated current, with control circuit energized. Coil 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-E-917 and shall be continuous until the measured temperature rises have not increased by more than 1°C in each of and for three consecutive 20 minute test periods or until a constant temperature is reached as specified in UL 1008. Temperature rises shall not exceed the values specified in 3.4.11. The ambient temperature of the equipment shall not be allowed to vary by more than 5°C for 2 hours preceeding the test.

4.8.6 Endurance and overload. Bus transfer switches shall be tested for overload and endurance in accordance with table XI. Switches shall be energized for a minimum of 1/6 of a second before and after transfer. Unless otherwise specified (see 6.2.1), method II is applicable to a.c. automatic bus transfer switches without time delay and not for switchboard service, and method I is applicable to all other bus transfer switches. These tests may be conducted on one set of contacts. However, in no case shall the specified operating cycles cause damage to windings from excessive heating. Transfer switches shall fail the overload and endurance tests if they fail to perform their intended operating functions during or after the tests without adjustment or replacement of parts.

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TABLE XI. Endurance and overload test conditions.

Line contacting mechanism	Overload test conditions				
	Number of cycles of operations	Test current (percent rated)	Test voltage (percent rated)	Load power factor	Time limit
A.c. contactors (method I)	50	600	100	0.40-0.50	1 hour
A.c. contactors (method II)	50	150	100	0.70-0.80	1 hour 40 minutes
D.c. contactors	50	400	100	-	1 hour
	Endurance test conditions				
	Number of cycles of operations	Test current (percent rated)	Test voltage (percent rated)	Load power factor	Minimum make and break operating cycles
A.c. contactors (method I)	6000	100	100	0.80	6 per minute
A.c. contactors (method II)	6000	100	100	0.80	6 per minute
D.c. contactors	6000	100	100	-	6 per minute

4.8.7 Short-circuit withstandability. Unless otherwise specified (see 6.2.1), bus transfer switches shall be tested for short-circuit withstandability for conformance with 3.4.13. The transfer switches shall be subjected to and pass the dielectric withstanding voltage test as specified in 4.8.9 after the short-circuit withstandability tests without adjustment or replacement of parts.

4.8.7.1 A.c. short-circuit withstandability test. The test circuit current shall be measured, instrumented and calibrated in accordance with UL 1008.

4.8.7.2 D.c. short-circuit withstandability test. For short-circuit d.c. withstandability 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 A per second.

4.8.7.3 Failure of tests. Bus transfer switches shall fail the short-circuit withstandability tests if one or more of the following occurs during the test:

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- (a) Contacts weld tight enough to prevent one transfer and retransfer action by manual means.
- (b) Contacts weld tight enough to prevent the transfer and retransfer at rated conditions.
- (c) Component damage other than contact erosion which can be corrected by replacing contacts or by cleaning and adjustments.

4.8.8 Insulation resistance. Insulation resistance tests shall be conducted in accordance with MIL-E-917. Failure to meet the requirements as specified in 3.4.14 shall be cause for rejection.

4.8.9 Dielectric withstanding voltage. Dielectric withstanding voltage tests shall be conducted in accordance with MIL-E-917.

4.8.10 Auxiliary switches. Contacts of auxiliary switches for bus transfer switches shall be tested for endurance in accordance with table XI method II.

4.8.11 Degree of enclosure. Bus transfers shall be tested in accordance with MIL-E-2036, as supplemented by MIL-STD-108, to determine the effectiveness of the enclosure as specified in 3.5.2.9.

4.8.12 Operational tests.

4.8.12.1 Automatic bus transfer switches.

4.8.12.1.1 Manual operation. When alternate manual operation has been specified (see 3.5.2.10.1), the bus transfer switches' automatic control circuit devices shall be operated while the manual-automatic selector switch is in the manual position; the transfer switches shall not automatically transfer. If manual operation is accomplished by a protruding operating handle or lever, the manual-automatic selector switch shall be placed in the automatic position and the automatic control circuit devices shall be operated to cause the transfer switch to automatically transfer; the protruding manual operating handle or lever shall remain stationary in a neutral position during the automatic transfer.

4.8.12.1.2 Automatic operation. Bus transfer switches shall be operated to determine that the operating voltages are as specified in 3.5.2.10.4. Not less than five transfers and five retransfers shall be made under conditions of constant temperature, frequency and rate of change of voltage.

4.8.12.1.3 Preferred source selection. When specified (see 3.5.2.10.3), preferred source selector switch shall be switched to each position and the transfer switches shall be operated to determine that the actual preferred source is as selected.

4.8.12.1.4 Timing. Timing and time delay as specified by the bus transfer switch type designation (see 1.2.1), shall be measured five times to determine conformance with the required time periods as specified in 3.5.2.10.5. Adjustable time delay devices shall be operated over their adjustable range to determine that the specified time range can be achieved. When instantaneous is specified, the voltage shall be reduced quickly to five approximate equal intervals from 20 percent rated voltage to specified drop-out voltage including

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maximum and minimum drop-out point. The transfer switch shall pick up the non-preferred source within 0.50 seconds after initial time delay is completed. The switch shall not transfer at the maximum drop-out setting.

4.8.12.1.4.1 Restoration of power during time delay transfer. Transfer switches provided with line circuit time delay shall be tested for retransfer and shall have full voltage restored from reduced and zero voltage, at the start, mid, and end of the off position with voltage maintained on emergency or alternate supply. The switch may complete the transfer cycle before returning to the normal supply. No additional delay in time shall occur.

4.8.12.1.5 Test switch. The bus transfer switches' test switch shall be operated to determine that it simulates a voltage failure and a transfer action occurs.

4.8.12.1.6 Full phase protection. When specified (see 3.5.2.10.8), the bus transfer switches shall be operated to determine that the operating voltages of each phase are as specified in 3.5.2.10.4. Not less than five transfers and five retransfers per phase voltage test shall be made under conditions of constant temperature, frequency and rate of change of voltage.

4.8.12.1.7 Inphase monitor. When specified (see 3.5.2.10.9), the bus transfer switches shall be operated to determine that automatic transfer can be made to a power source which is within 60 electrical degrees of the connected source. Load shall include a motor whose rating is a minimum of 67 percent of the ABT rating. The remaining load may be a resistive load bank.

4.8.12.1.8 Frequency sensing. The frequency when specified shall be tested five times at the high and low frequency pickup points to determine compliance with the frequency requirements as specified (see 3.5.2.10.6).

4.8.12.2 Manual bus transfer switches.

4.8.12.2.1 Power available indicator lights. Bus transfer switches shall be operated to determine that each power available indicator light operates properly when power is supplied and removed from each supply line.

4.8.12.2.2 Off position. Interlock mechanisms for circuit breaker type transfer switches shall be disassembled and reassembled noting tolerances, to ensure that the switch must be set in off position during transfer.

4.9 Inspection of packaging. The packaging, packing and marking shall be inspected for compliance with section 5 of this document.

5. PACKAGING

(The preparation for delivery requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.6.)

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5.1 Preservation-packaging, packing and marking. Bus transfer switches, repair parts and manuals shall be preserved-packaged level A or C, packed level A, B or C as specified (see 6.2.1) and marked in accordance with MIL-E-17555. Special marking shall be as specified (see 6.2.1).

5.2 Use of loose-fill material.

5.2.1 For domestic shipment and early equipment installation and level C packaging and packing. Unless otherwise approved by the contracting activity (see 6.2.1), use of loose-fill material for domestic shipment and early equipment installation and level C packaging and packing applications such as cushioning, filler and dunnage is prohibited. When approved, unit packages and containers (interior and exterior) shall be marked and labeled as follows:

"CAUTION

Contents cushioned etc., with loose-fill material.
Not to be taken onboard ship.
Remove and discard loose-fill material before shipboard storage.
If required, recushion with cellulosic material bound fiber,
fiberboard or transparent flexible cellular material."

5.2.2 For level A packaging and level A and B packing. Use of loose-fill material is prohibited for level A packaging and level A and B packing applications such as cushioning, filler and dunnage.

5.3 Semi-conductors or solid-state devices. Semi-conductors such as diodes, transistors, integrated circuits as well as circuit boards or chassis in which they are incorporated, shall be individually packaged in a barrier bag conforming to class E, style 1, type I or II, or class F, style 1, type 1 of MIL-B-117. Bag material conforming to MIL-B-117 shall employ aluminum foil as a laminate of the bag barrier material. Bag closure shall be affected by heat sealing. Leads and terminals shall be protected from damage by means of the container (carrier) design, die cut inserts, or by the use of non-corrosive cushioning material. Leads and other projecting parts may be used for positioning, but shall not be subjected to loads or other stresses such as bending or twisting that can damage the entry seals. For level C preservation-packaging, semiconductors or solid-state devices subject to electromagnetic degradation shall be protected with a wrap of aluminum foil or barrier bag employing aluminum foil as a laminate of the bag material. Leads and terminals shall be protected as specified herein.

6. NOTES

6.1 Intended use. Bus transfer switches are intended for use in Naval shipboard applications as devices which automatically or manually transfer power supply lines via its main line contacts to a connected load. When accomplished automatically, control circuits determine when and in what manner the transfer will occur.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

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- (a) Title, number and date of this specification.
- (b) Classification required (see 1.2).
- (c) Whether or not first article is required (see 3.2).
- (d) Three-way transfer positions, if required (see 3.4.2 and 3.5.2.11.1).
- (e) Rated line voltage (see 3.4.3.1).
- (f) Rated control circuit voltage, for automatic bus transfer switches (see 3.4.3.2).
- (g) Other than three-phase line circuits for a.c. bus transfer switches, if required (see 3.4.6).
- (h) Special endurance and overload requirements, if required (see 3.4.12).
- (i) Special short-circuit withstandability requirements, if required (see 3.4.13 and table III).
- (j) Contactor requirements, (see 3.5.1.1.1).
- (k) Overload trip devices for circuit breakers, if required (see 3.5.1.1.2).
- (l) Additional relay requirements, if necessary (see 3.5.1.1.3).
- (m) When contactors are not mechanically held (see 3.5.2.1.1).
- (n) Special auxiliary switch requirements, if necessary (see 3.5.2.5).
- (o) Degree of enclosure (see 3.5.2.9).
- (p) Cable entrance for dripproof protected, watertight or spraytight enclosures (see 3.5.2.9.2).
- (q) Manual operation of automatic bus transfer switches required (see 3.5.2.10.1, 3.5.2.10.3).
- (r) Special operating voltages for automatic bus transfer switches, if required (see 3.5.2.10.4).
- (s) Timing or time delay, other than as specified (see 3.5.2.10.5).
- (t) Time delay requirements for frequency sensing automatic bus transfer switches (see 3.5.2.10.6).
- (u) Full phase protection for a.c. automatic bus transfer switches, if not allowed (see 3.5.2.10.8).
- (v) Inphase monitor control circuit for a.c. automatic bus transfer switches, if required or prohibited (see 3.5.2.10.9).
- (w) Additional detail requirements for special service (type ABT-S and MBT-S bus transfer switches, if required (see 3.5.2.12.3).
- (x) Information plate markings for manual operating mechanism (see 3.6.2).
- (y) Special endurance and overload tests, if required (see 4.8.6).
- (z) Special short-circuit withstandability test, if required (see 4.8.7).
- (aa) Preservation-packaging, packing and marking requirements (see 5.1 and 5.2.1).

6.2.2 Data requirements. When this specification is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of DAR 7-104.9 (n)(2) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraphs.

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<u>Paragraph no.</u>	<u>Data requirement title</u>	<u>Applicable DID no.</u>	<u>Option</u>
3.7	Drawings, engineering and associated lists	DI-E-7031	Level 3 Design activity designation - contractor Drawing No.- contractor Parts lists required Certification data sheets required
3.7	Manual, technical, preliminary	DI-M-2043	MIL-M-15071, type I
3.7	Manual technical, final	DI-M-2044	MIL-M-15071, type I
4.1.1	Inspection system program plan	DI-R-4803	--
4.5.1	First article inspection report	DI-T-4902	--

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DoD 5000.19L., Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4 or 5 of this specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.2.2.2 Condition of omission of drawings. Unless otherwise specified (see 3.7), when a bus transfer switch is a part of an assembly, such as a switchgear unit, individual transfer switch drawings need not be furnished. The applicable drawings shall, however, be indicated on the switchgear or assembly drawings together with complete descriptive data for the transfer switch.

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6.2.2.3 Manuals. A separate technical manual shall be prepared for each automatic bus transfer switch type or group of similar types. The manual shall be suitable for binding as a separate book or for including as a part of a technical manual for an assembly such as a switchgear unit. Technical manuals may be forwarded with commercial protective paper or plastic covers and shall contain illustrations of the bus transfer switch, wiring diagrams and assembly drawings including mounting data. Data shall include:

- (a) Identification plate ratings, classification data and weights
- (b) Safety precautions
- (c) Inspection, maintenance and installation of repair parts
- (d) List of repair parts with ordering data.

6.3 With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List QPL-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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is Naval Sea Systems Command SEA 5523, Department of the Navy, Washington, DC 20362 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

6.4 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples of bus transfer switches with special type designation for first article inspection as to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.5 Definitions. Definitions in 6.5.1 through 6.5.22 shall apply when the terms are used in this specification.

6.5.1 Automatic bus transfer switch. An automatic bus transfer switch is self-acting equipment for transferring one or more load cable connections from one power source to another.

6.5.2 Bus transfer switch. A bus transfer switch (transfer switch) is a device for transferring load from one power source to another.

6.5.3 Bus transfer switch positions. Transfer switch positions indicate the number of power supply lines involved. Two-way transfers indicate that the connected load is capable of being transferred between two power supply lines. The two supply lines or sources are identified as Normal (ship's service) and Emergency (service) or Normal (ship's service) and Alternate

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(ship's service). Three-way transfers indicate that the connected load is capable of being transferred between three supply lines. These three supply lines or sources are identified as Normal (ship's service), Alternate (ship's service) and Emergency (service). Either the Normal or Alternate source may be selected as the preferred source for a given application. The preferred source is usually the Normal supply line or source.

6.5.4 Continuous duty. Operation at substantially constant load for an unlimited period of time is considered continuous duty.

6.5.5 Control circuits. Control circuits are electromechanical or solid-state (semiconductor) or both, automatic bus transfer circuits which sense and control the transfer from normal to alternate power sources and retransfer or otherwise control operation of the transfer switch.

6.5.6 Dropout time. Dropout time is the time required to open a set of contacts after the solenoid is de-energized.

6.5.7 Dropout voltage. Dropout voltage is the maximum voltage at which a device will release to its de-energized position.

6.5.8 Full phase protection. Full phase protection occurs when an automatic bus transfer switch which includes solid-state or electromechanical devices monitors all phase voltages of one power source and initiate transfer of the connected load from the monitored power source to another when any phase voltage of the monitored power source drops below a predetermined value of voltage; the devices initiate transfer of the connected load back to the monitored power source when all phase voltages of the monitored source return to within specified limits.

6.5.9 Inphase monitor. An inphase monitor is a device used to sense the phase angle between the normal and alternate sources prior to load transfer. It is used with a two way instantaneous type bus transfer switch to initiate transfer only when the two sources are nearly synchronized thereby limiting the motor inrush current to below normal starting current levels and avoiding inadvertent circuit breaker tripping.

6.5.10 Instantaneous. A qualifying term indicating that no delay is purposely introduced in the action of the bus transfer switch. An unintentional delay of up to 50 ms is normally experienced due to magnetic field collapse and physical movement needed to break arc before closing on an energized source.

6.5.11 Interlock. Interlock is a device actuated by the operation of some other device with which it is directly associated, to govern succeeding operations of the same or allied devices. An interlock system is a series of interlocks applied to associated equipment in such a manner as to prevent or allow operation of the equipment only in a prearranged sequence. Interlocks are classified into three main divisions: mechanical interlocks, electrical interlocks, and key interlocks, based on the type of interconnection between the associated devices.

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6.5.12 Manual (nonautomatic) bus transfer switch. A manual (nonautomatic) bus transfer switch is a device by which a human operator manually transfers the connected load from one power source to another by opening and closing the contacts connecting the load to the power sources by a direct mechanical system.

6.5.13 Off time. Time between opening at one set of main contacts and closing on the other set of main contacts.

6.5.14 Operation. Transfer switch operation is the transfer or the retransfer of the connected load from one power source to another.

6.5.15 Pickup voltage. The pickup voltage of a device is the minimum voltage at which the device starts to operate.

6.5.16 Power on (power available) indication. Electrical or electro-mechanical indication that a bus transfer switch power supply circuit is energized is defined as power on indication.

6.5.17 Preferred power source. The preferred power source is a selectable power source for three-way bus transfer switches to which the switching mechanism returns when nominal voltage is available from the selected preferred power source.

6.5.18 Short-circuit withstandability. Short-circuit withstandability is the ability of the bus transfer switch 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.

6.5.19 Special service bus transfer switch. A special service bus transfer switch (type ABT-S or MBT-S) is a device which has most of the requirements specified for another type of transfer switch and one or more special features.

6.5.20 Three-way bus transfer switch. See bus transfer switch positions.

6.5.21 Time delay. Time delay is an intentionally introduced delay in the operation of a bus transfer switch.

6.5.22 Two-way bus transfer switch. See bus transfer switch positions.

6.6 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Provisioning. Provisioning Technical Documentation (PTD), spare parts and repair parts should be furnished as specified in the contract.

6.7.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment.

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6.8 Cross reference of classifications. The following is a comparison of the classification between MIL-S-17773A(SHIPS) and DOD-S-17773B(SH).

MIL-S-17773ADOD-S-17773B

ABT-A1

ABT-1A1-25	ABT-1F1-25
ABT-4A1-25	ABT-2F1-25
ABT-1A1-50	ABT-4F1-25
ABT-4A1-50	ABT-1F1-50
ABT-1A1-100	ABT-2F1-50
ABT-4A1-100	ABT-4F1-50
*ABT-1A1-150	ABT-1F1-100
*ABT-4A1-150	ABT-2F1-100
ABT-1A1-250	ABT-4F1-100
ABT-4A1-250	ABT-1F1-150
*ABT-1A1-300	ABT-2F1-150
*ABT-4A1-300	ABT-4F1-150
ABT-1A1-400	ABT-1F1-250
ABT-4A1-400	ABT-2F1-250
ABT-1A1-600	ABT-4F1-250
ABT-4A1-600	ABT-1F1-300
	ABT-2F1-300
	ABT-4F1-300

ABT-A2

ABT-1A2-**	ABT-1F2-***
ABT-4A2-**	ABT-2F2-***
	ABT-4F2-***

ABT-A3

ABT-1A3-**

ABT-4A3-**

ABT-A3(ES)

ABT-1A6-**

ABT-4A6-**

ABT-1A9-**

ABT-4A9-**

ABT-S

ABT-1A1S**

ABT-4A1S**

ABT-1A2S**

ABT-4A2S**

ABT-1A3S**

ABT-4A3S**

ABT-1A4-***

ABT-4A4-***

ABT-1A4S***

ABT-4A4S***

ABT-1A5***

ABT-4A5***

ABT-1F4-***

ABT-2F4-***

ABT-4F4-***

ABT-1F4S***

ABT-2F4S***

ABT-4F4S***

ABT-1F5-***

ABT-2F5-***

ABT-4F5-***

ABT-D

ABT-1D***

ABT-2D***

ABT-D(ES)

ABT-2D6**

ABT-2D9**

DOD-S-17773B(SH)

MIL-S-17773A

NBT-M

DOD-S-17773B

MBT-10
MBT-30
MBT-60
MBT-100
MBT-250
MBT-400
MBT-800

- * Not recommended for new construction.
- ** Current rating - same as for A1 above.
- *** Current rating - same as for F1 above.

6.9 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 6110-N246)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)*

1. DOCUMENT NUMBER DOD-S-17773B(SH)		2. DOCUMENT TITLE SWITCHES, BUS TRANSFER, ELECTRIC POWER, AUTOMATIC AND MANUAL		(METRIC)
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)		
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR		
		<input type="checkbox"/> USER		
		<input type="checkbox"/> MANUFACTURER		
		<input type="checkbox"/> OTHER (Specify): _____		
5. PROBLEM AREAS				
a. Paragraph Number and Wording:				
b. Recommended Wording:				
c. Reason/Rationale for Recommendation:				
6. REMARKS				
7a. NAME OF SUBMITTER (Last, First, MI) - Optional			b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional			8. DATE OF SUBMISSION (YYMMDD)	