FROM. DEFENSE ELECTRONICS SUPPLY CENTER (DESC-EMM)
DAYTON, OH 45444-5283

SUBJECT. INVALID VERSION OF MIL-S-8805D DATED 7 SEPTEMBER 1984

1. An incorrect version of the MIL-S-8805D basic document has worked its way into the distribution system. We have discovered numerous format and technical errors in the version which is currently being distributed. Also, the document has somehow been stretched from the original 38 pages to 50 pages

2. Enclosed is a correct copy of MIL-S-8805D, as originally issued, and request that you use it to replaced your existing copy.

3. For further information or discussion, please contact Mr. Richard Gosciniak, (513) 296-6179 or AV986-6179.

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MILITARY SPECIFICATION

SWITCHES AND SWITCH ASSEMBLIES, SENSITIVE AND PUSH (SNAP ACTION), GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for snap action, sensitive, and push switches, and switch assemblies (switches shall include switch assemblies, see 6.4.1) (see 6.1). For definitions of terms used in this specification, see 6.4.

1.2 Classification.

* 1.2.1 Enclosure design. The enclosure design is identified by a single digit in accordance with table I.

TABLE I. Enclosure design (see 6.4.12).

Symbol	Seal
1	Unsealed
2	Dusttight
3	Watertight
4	Resilient
5	Hermetic
6	Splashproof

1.2.2 Temperature characteristic. The temperature characteristic is identified by a single digit, indicating the temperature range of the switch, in accordance with table II.

TABLE II. Temperature characteristic.

Symbol	Temperature range	
	Minimum	Maximum
1	-55°C	+85°C
2	-65°C	+125°C
3	-65°C	+200°C
4	-65°C	+350°C

1.2.3 Shock type. The shock type is identified by a single letter in accordance with table III.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Electronic Systems Command, ATTN: ELEX 8111, Department of the Navy, Washinton, DC 20363, 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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TABLE III. Shock type.

Symbol	Shock type
M	100g, test condition I, method 213 of MIL-STD-202
H	High-impact

* 1.2.4 Sinusoidal vibration grade. The vibration grade is identified by a single digit in accordance with table IV.

TABLE IV. Sinusoidal vibration grade.

Symbol	Frequency range	Acceleration level
	Hz	
1	10-500 swept sinusoidal	10g peak
2	10-2,000 swept sinusoidal	15g peak
3	10-3,000 swept sinusoidal	30g peak

* 1.2.5 Random vibration category (when specified, see 3.1). The random vibration category is identified by a single digit in accordance with table V.

TABLE V. Random vibration categories.

Symbol	Power spectral density	Overall RMS G	Frequency range (Hz)
A	.02	5.2	50 - 2,000
B	.04	7.3	50 - 2,000
C	.06	9.0	50 - 2,000
D	.1	11.6	50 - 2,000
E	.2	16.4	50 - 2,000
F	.3	20.0	50 - 2,000

1.3 Military part number. The military part number shall consist of the letter "M", the basic number of the specification sheet, and an assigned dash number as shown in the following example (see 3.1, 6.2.1, and 6.2.2):

M 8805/1 - 001

Military designator — Specification sheet number — Dash number

Unless a superseding "M" part number has been assigned (see applicable specification sheet), switches formerly covered by Military Standards (MS) have retained the part number reflected therein.

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* 2. APPLICABLE DOCUMENTS

2.1 Government 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 specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-N-290 - Nickel Plating (Electrodeposited).
QQ-S-571 - Solder, Tin Alloy, Tin Lead Alloy and Lead Alloy.
ZZ-R-765 - Rubber, Silicone.

MILITARY

MIL-I-10 - Insulating Compound, Electrical, Ceramic, Class L.
MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-P-997 - Plastic Material, Laminated, Thermosetting, Electrical Insulation: Sheets, Glass Cloth, Silicone Resin.
MIL-R-5757/10 - Relays, Electrical, Hermetically Sealed, DPDT, Low Level and 2 Amperes.
MIL-C-5809 - Circuit Breakers, Trip-Free, Aircraft, General Specification for.
MIL-T-7928 - Terminal, Lug and Splice, Crimp-Style, Copper.
MIL-S-8516 - Sealing Compound, Polysulfide Rubber, Electric Connectors and Electric Systems, Chemically Cured.
MIL-F-15160 - Fuses: Instrument, Power and Telephone.
MIL-F-15160/2 - Fuse, Instrument, Power, and Telephone, (Nonindicating), Style F02.
MIL-I-16923 - Insulating Compound, Electrical, Embedding.
MIL-P-18177 - Plastic Sheet, Laminated, Thermosetting, Glass Fiber Base, Epoxy-Resin.
MIL-S-23586 - Sealing Compound, Electrical, Silicone Rubber, Accelerator Required.
MIL-M-24041 - Molding and Potting Compound, Chemically Cured, Polyurethane.
MIL-M-24519 - Molding Plastics, Electrical, Thermoplastic.
MIL-R-25988 - Rubber, Fluorosilicone Elastomer, Oil-and-Fuel-Resistant, Sheets, Strips, Molded Parts, and Extruded Shapes.
MIL-S-28786 - Switches, Preparation for Delivery of.
MIL-G-45204 - Gold Plating, Electrodeposited.
MIL-S-55433 - Switches, Reed, General Specification for.
MIL-I-81023 - Inductor, 28 V dc, Laboratory Test, General Specification for.
MIL-I-81550 - Insulating Compound, Electrical, Embedding, Reversion Resistant Silicone.
MIL-P-81728 - Plating, Tin Lead Electrodeposited.

(See Supplement 1 for list of associated specifications.)

STANDARDS

FEDERAL

FED-STD-H28 - Screw-Thread Standards for Federal Services.

MILITARY

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-202 - Test Methods for Electronic and Electrical Component Parts.

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MIL-STD-454	-	Standard General Requirements for Electronic Equipment.
MIL-STD-889	-	Dissimilar Metals.
MIL-STD-1285	-	Marking of Electrical and Electronic Parts.
MIL-STD-1549	-	Common Termination Systems for Electrical and Electronic Parts.
MIL-STD-45662	-	Calibration Systems Requirements.
MS25244	-	Circuit Breaker, Trip Free, Push Pull, 5 Thru 35 Ampere, Type 1.

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers 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. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4066 - Nylon Injection and Extrusion Materials.

(Application for copies of ASTM publications should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

UNDERWRITERS' LABORATORIES, INC. (UL)

UL94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

(Application for copies should be addressed to the Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

(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 other than specification sheets cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Specification sheets. The individual part requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheets, the latter shall govern (see 6.2.1).

3.2 Switch categories. Switches furnished under this specification shall be category I, II, or III, as defined in 3.2.1, 3.2.2, or 3.2.3, respectively.

3.2.1 Category I switches. Switches completely defined by a military specification sheet (see 3.1). Category I switches shall be ordered in accordance with 6.2.1.

3.2.2 Category II switches. Switches the same as category I switches except for minor differences such as termination configuration, operating characteristics, and minor actuator variations, which do not change the basic design or construction of the qualified switch. Category II switches shall be acquired from a source listed on the applicable qualified products list for the particular similar product in category I. Category II switches shall be ordered in accordance with 6 2.2. These switches are nonstandard.

3.2.3 Category III switches. Switches not covered by specification sheets. These switches are nonstandard (see 4.6.2 and 6.2.3).

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3.3 Qualification. Category I 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 4.5 and 6.3).

3.4 Material. Material shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the switches to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

* 3.4.1 Metals. All metal parts, other than current-carrying parts, shall be of corrosion-resistant material, or shall be suitably protected to resist corrosion.

3.4.1.1 Ferrous material. Ferrous material shall not be used for current-carrying parts except for feed-through terminals in headers and for switches having temperature characteristics with a maximum temperature rating of 125°C or higher.

* 3.4.1.2 Dissimilar metals. When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. The use of dissimilar metals in contact, which tend toward active electrolytic corrosion (particularly brass, copper, or steel used in contact with aluminum or aluminum alloy) is not acceptable. However, metal plating or metal spraying of dissimilar base metals to provide similar or suitable abutting surfaces is permitted. The use of dissimilar metals separated by a suitable insulating material is also permitted. Dissimilar metals are defined in MIL-STD-889.

3.4.2 Insulation.

3.4.2.1 Ceramic. Ceramic insulation shall be grade L422 or higher, in accordance with MIL-I-10.

* 3.4.2.2 Plastic. Unless otherwise specified (see 3.1), molded plastic material shall conform to MIL-M-14, thermoplastic material shall conform to ASTM D4066 or MIL-M-24519, and laminated plastic material shall conform to MIL-P-997 or MIL-P-18177. Other types of plastic materials may be used provided the manufacturer submits acceptable evidence of performance to the preparing activity during the qualification test program on the submitted product. The plastic material used shall pass the fungus test specified in MIL-STD-454, requirement 4. The plastic material used in all external switch parts and enclosures shall be tested in accordance with UL94 and classified as 94V-0; this requirement applied to all materials for external parts and enclosures regardless of whether the material used is procured to a Military specification or not.

* 3.4.3 Rubber. All rubber parts shall be in accordance with ZZ-R-765 or MIL-R-25988.

* 3.4.4 Potting compounds. Unless otherwise specified (see 3.1), potting compounds shall meet the hydrolytic stability requirements of MIL-S-8516, MIL-S-23586, MIL-I-81550, MIL-M-24041, or MIL-I-16923, as applicable.

* 3.5 Design and construction. Switches shall be so constructed as to insure proper operation when mounted in any position. The switches shall be of the design, construction, and physical dimensions specified (see 3.1).

3.5.1 Mounting hardware. Each switch shall be provided with mounting hardware as specified (see 3.1 and 6.2). Bushing-mounted switches shall include a nonturn device. For direct Government orders, the hardware shall be assembled in proper order or packaged with the switch as specified in MIL-S-28786.

3.5.2 Terminals. Terminals shall be as specified (see 3.1 and 6.2).

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* 3.5.2.1 Solder terminals. Solder terminals shall be treated to facilitate soldering. Coatings such as hot solder or hot-tin dip are acceptable. Gold plating shall not be used, except when solder lug terminals are integral with gold contacts, gold plating .000030 inch to .000100 inch may be used. Silver plating shall not be used as the external coating.

* 3.5.2.2 Printed circuit board terminals. Printed circuit board terminals shall be tin-lead plated or solder dipped. Tin-lead plating shall be 100 microinches minimum in accordance with MIL-P-81728. Solder dip shall be 60-40 tin-lead in accordance with QQ-S-571, 100 microinches minimum thickness.

3.5.2.3 Screw terminals. Screw terminals shall be provided with hardware as specified (see 3.1 and 6.2). Lockwashers shall be captive to the screw. For direct Government orders, all terminal hardware shall be assembled in proper order or packaged with the switch as specified in MIL-S-28786.

* 3.5.2.4 Plug-in terminations (not applicable to printed circuit boards). Terminals shall be gold-plated in accordance with MIL-G-45204, type II, class 1, over nickel plate .000030 inch to .000150 inch thick. Nickel plate shall be in accordance with QQ-N-290.

* 3.5.2.5 Common termination system. Switches with common termination system shall be designed in accordance with MIL-STD-1549.

3.5.3 Screw threads. Screw threads on removable threaded parts shall be in accordance with unified thread series of FED-STD-H28. Threading of nonmetallic parts shall not be permitted.

3.5.4 Weight. The weight shall be as specified (see 3.1 and 6.2).

3.5.5 Dry reed switch capsules. Dry reed switch capsules used in fabrication of switches and switch assemblies shall be in accordance with MIL-S-55433.

3.6 Solderability (applicable to solderable terminations).

3.6.1 When switches with solid wire terminations of .045 maximum diameter or stranded wire terminations of number 18 AWG or smaller are tested as specified in 4.8.2, the dipped surface of the termination:

a. Shall be at least 95 percent covered by a continuous new solder coating.

b. Shall not have pinholes or voids that are concentrated in one area or that exceed 5 percent of the total area.

3.6.2 When switches with solder terminals, solid wire terminations greater than .045 diameter, and stranded wire terminations larger than number 18 AWG are tested as specified in 4.8.2, the dipped surface of the termination.

a. Shall have 95 percent of the total length of the fillet, which is between the standard wire wrap and the termination, tangent to the surface of the termination being tested and shall be free from pinholes and voids.

b. Shall not have a ragged or interrupted line at the point of tangency between the fillet and the termination under test.

3.7 Seal.

3.7.1 Dusttight (applicable to enclosure design 2). When switches are tested as specified in 4.8.3.1, there shall be no dust inside the switch.

3.7.2 Watertight (applicable to enclosure design 3). When switches are tested as specified in 4.8.3.2, there shall be no leakage as evidenced by a continuous stream of bubbles.

3.7.3 Resilient (applicable to enclosure design 4). When switches are tested as specified in 4.8.3.3, the leakage rate shall not exceed 1×10^{-6} standard atmosphere cubic centimeter per second (atm cm^3/s).

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3.7.4 Hermetic (applicable to enclosure design 5). When switches are tested as specified in 4.8.3.4, the leakage rate shall not exceed 1×10^{-8} standard atmosphere cubic centimeter per second (atm cm^3/s).

* 3.7.5 Splashproof (applicable to enclosure design 6). When switches are tested as specified in 4.8.3.5, there shall be no leakage of water through the panel seal or into the switch as determined by visual inspection.

3.8 Dielectric withstanding voltage. When switches are tested as specified in 4.8.4, there shall be no flashover, arcing, or current flow in excess of 500 microamperes.

3.9 Insulation resistance. When switches are tested as specified in 4.8.5, the insulation resistance shall be not less than 1,000 megohms.

* 3.10 Operating characteristics. When switches are tested as specified in 4.8.6, the operating characteristics shall be as specified (see 3.1 and 6.2). Unless otherwise specified (see 3.1 and 6.2), switch action for each individual pole shall be momentary, break before make.

3.10.1 Coincidence of operating and releasing points (applicable to multipole switches only). When switches are tested as specified in 4.8.6.1, all poles shall have actuated (transfer of contacts) within the limits specified (see 3.1).

* 3.11 Permanency of marking (applicable to switches with printed circuit board mount terminals). Following the test specified in 4.8.7, all required markings (see 3.38) shall be legible.

* 3.12 Fluid resistance (when specified, see 3.1 and 6.2). Following the test specified in 4.8.8, there shall be no electrical, mechanical, or other damage as specified (see 3.1 and 6.2).

3.13 Terminal strength. When switches are tested as specified in 4.8.9, there shall be no short circuiting, breakage, loosening, rotation of terminals, or damage to the switch which will interfere with the electrical or mechanical performance of the switch.

3.14 Strength of actuating means. When switches are tested as specified in 4.8.10, there shall be no electrical or mechanical damage, and the operating characteristics shall be as specified (see 3.1 and 6.2).

3.15 Strength of mounting bushing (when applicable). When switches are tested as specified in 4.8.11, there shall be no damage to the switch or loosening or twisting of the bushing relative to the switch, and operating characteristics shall be as specified (see 3.1 and 6.2).

3.16 Thermal shock. When switches are tested as specified in 4.8.12, there shall be no mechanical or electrical damage, or loosening of rivets or other fastening devices.

3.17 Vibration. When switches are tested as specified in 4.8.13, there shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds, and there shall be no broken, loose, deformed, or displaced parts.

3.18 Shock. When switches are tested as specified in 4.8.14.1, there shall be no opening of closed contacts or closing of open contacts in excess of 10 microseconds. When tested as specified in 4.8.14.2, there shall be no opening of closed contacts or closing of open contacts in excess of 5 milliseconds. At the conclusion of the test, there shall be no broken, loose, deformed, or displaced parts.

3.19 Acceleration (when specified, see 3.1). When switches are tested as specified in 4.8.15, there shall be no opening of closed contacts or closing of open contacts, and there shall be no mechanical or electrical damage.

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3.20 Moisture resistance. When switches are tested in the wet condition as specified in 4.8.16, the insulation resistance shall be not less than 10 megohms. At the end of the drying period, the insulation resistance shall be as specified in 3.9. At the conclusion of the test, there shall be no evidence of destructive corrosion, breaking, cracking, spalling, or loosening of terminals, and mounting hardware shall be readily removable. Destructive corrosion shall be defined as being any type of corrosion which, in any way, interferes with electrical or mechanical performance of the switch or its associated parts.

* 3.21 Marking visibility. When switches are inspected as specified in 4.8.17, all required markings shall be legible (see 3.38).

3.22 Salt spray (corrosion). When switches are tested as specified in 4.8.18, there shall be no evidence of destructive corrosion. Destructive corrosion shall be defined as being any type of corrosion which, in any way, interferes with electrical or mechanical performance of the switch or its associated parts.

3.23 Icing (when specified). When switches are tested as specified in 4.8.19, the period between release of the actuator and closure of the normally closed contacts of the switch when the restraining force is removed shall not exceed 5 seconds. If the switch has no normally closed contacts, the period between release of the actuator and opening of the normally open contacts shall not exceed 5 seconds. After the test, the switches shall be mechanically and electrically operative for 50 cycles of operation.

3.24 Sand and dust (when specified, see 3.1). When switches are tested as specified in 4.8.20.1, the switches shall be mechanically and electrically operative at the conclusion of the test.

3.25 Explosion. When switches are tested as specified in 4.8.21, the explosive mixture in the test chamber surrounding and external to the switch shall not explode whether or not explosion occurs within the switch. Switches shall be electrically operable after the test.

* 3.26 Resistance to soldering heat (applicable to switches with solderable terminals) (not applicable to switches with integral lead wire terminals). When switches are tested as specified in 4.8.22, switches shall meet the contact resistance requirement, and there shall be no deformation or other damage at the conclusion of the test sequence.

* 3.27 Contact resistance. When measured as specified in 4.8.23, the contact resistance shall not exceed 25 milliohms initially and 40 milliohms after the mechanical endurance test. After electrical endurance, the contact resistance shall not exceed 1 percent of the load impedance using the electrical parameters of the electrical endurance test load. For switches with integral lead wires, the contact resistance shall be as specified (see 3.1).

3.28 Contact bounce (when specified, see 3.1 and 6.2). When switches are tested as specified in 4.8.24, the contact bounce shall remain within the limits specified (see 3.1 and 6.2).

3.29 Low temperature operation. When switches are tested as specified in 4.8.25, there shall be no delay between release of the actuating member and closure of the normally closed circuit of the switch as evidenced by a pilot lamp circuit. If the switch has no normally closed circuit, there shall be no delay between release of the actuating member and opening of the normally open circuit as evidenced by a pilot lamp circuit.

3.30 Mechanical endurance. When switches are tested as specified in 4.8.26, there shall be no mechanical or electrical damage

3.31 Short circuit. When switches are tested as specified in 4.8.27, there shall be no welding, sticking or damage of contacts. Switches shall be mechanically and electrically operative at the end of the test.

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* 3.32 Actuator grounding (when specified, see 3.1 and 6.2). When switches are tested as specified in 4.8.28, the actuator to mounting bushing resistance shall not exceed 1.0 ohm initially and 10 ohms after environmental or mechanical tests.

* 3.33 Shielding efficiency (when specified, see 3.1 and 6.2). When switches are tested as specified in 4.8.29, the shielding attentuation shall be not less than 60 dB over the frequency range from 100 to 1,000 MHz.

3.34 Overload cycling. When switches are tested as specified in 4.8.30, there shall be no mechanical or electrical failure.

* 3.35 Electrical endurance. When switches are tested as specified in 4.8.31, no contact shall fail to open or close its individual circuit in proper sequence. The temperature rise shall not exceed 50°C when measured as specified in 4.8.31.3. After the test, the contact resistance shall not exceed 1 percent of the load impedance using the electrical parameters of the electrical endurance test load. After the test, switches shall be electrically and mechanically operative.

* 3.36 Intermediate current (when specified, see 3.1). When switches are tested as specified in 4.8.32, no contact shall fail to close or open its individual circuit in proper sequence as detected by the monitoring device. A failure shall be an individual circuit contact resistance exceeding 1 percent of load impedance on any single contact closure.

3.37 Low level circuit (when specified, see 3.1). When switches are tested as specified in 4.8.33, there shall be no failures. A failure shall be an individual circuit contact resistance exceeding 3.0 ohms on any single contact closure.

* 3.38 Marking.

3.38.1 Identification of product. Switches shall be marked in accordance with MIL-STD-1285 as follows:

a. Military part number (category I only).

b. Manufacturer's part number (when not covered by a military part number).

c. Manufacturer's name or trade mark.

d. Source code (if space is available).

e. Date code.

f. Terminal identification (see 3.1).

3.38.2 Terminal identification. Terminals shall be marked to indicate the contact arrangement of the switch. When specified (see 3.1 and 6.2), terminal markings shall be augmented by a circuit schematic. There shall be no overmarking of the terminal identification.

3.39 Workmanship. Switches shall be processed in such a manner as to be uniform in quality and shall be free from cracked or displaced parts, sharp edges, burrs, and other defects which will affect life, serviceability, or appearance.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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.

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4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662, except that the requirement for out of tolerance evaluators is not applicable.

4.2 Classification of inspections. The inspections specified herein are classified as follows:

a. Materials inspection (see 4.3).

b. Qualification inspection (see 4.5).

c. Inspection for category II and III switches (see 4.6).

d. Quality conformance inspection (see 4.7).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table VI, used in fabricating the switches, are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

* TABLE VI. Materials inspection.

Material	Requirement paragraph	Applicable document
Ceramic	3.4.2.1	MIL-I-10
Plastic	3.4.2.2	MIL-M-14, MIL-P-997, MIL-P-18177, MIL-M-24519, ASTM D4066, MIL-STD-454, UL94
Rubber	3.4.3	ZZ-R-765, MIL-R-25988
Potting compounds	3.4.4	MIL-S-8516, MIL-S-23586, MIL-I-81550, MIL-M-24041, or MIL-I-16923

4.4 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.

* 4.5 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.

4.5.1 Sample size. The number of switches to be subjected to qualification inspection shall be as specified in table VII. The sample submitted shall consist of switches of one basic type as specified on the applicable specification sheet and additional sample units of each of the other types, of the number of varieties specified, and in the quantity specified on the applicable specification sheet.

4.5.2 Inspection routine. Sample units of switches shall be subjected to the qualification inspection in table VII, in the order shown. All sample units shall be subjected to the inspection of group I. The sample units shall then be divided as specified in table VII, and subjected to the inspection for their particular group. Any switch failing any inspection shall not be subjected to further inspection.

4.5.3 Failures. One or more failures shall be cause for refusal to grant qualification approval.

4.5.4 Extent of qualification.

4.5.4.1 Single submission. Qualification shall be restricted to the type submitted.

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* TABLE VII. Qualification inspection.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected
Group I			
Visual and mechanical inspection 1/	3.1,3.4,3.5, 3.38 and 3.39	4.8.1	All units
Solderability (when applicable) 2/	3.6	4.8.2	
Seal (watertight) (enclosure design 3)	3.7.2	4.8.3.2	
Seal (resilient) (enclosure design 4)	3.7.3	4.8.3.3	
Seal (hermetic) (enclosure design 5)	3.7.4	4.8.3.4	
Seal (splashproof) (enclosure design 6)	3.7.5	4.8.3.5	
Dielectric withstanding voltage	3.8	4.8.4	
Insulation resistance	3.9	4.8.5	
Contact resistance	3.27	4.8.23	
Operating characteristics	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable)	3.10.1	4.8.6.1	
Group II			
Terminal strength 3/	3.13	4.8.9	4 6/ 4/
Strength of actuating means 3/	3.14	4.8.10	
Strength of mounting bushing (when applicable) 3/	3.15	4.8.11	
Thermal shock	3.16	4.8.12	
Swept sinusoidal vibration	3.17	4.8.13	
Random vibration (when specified)	3.17	4.8.13	
Shock	3.18	4.8.14	
Acceleration (when specified)	3.19	4.8.15	
Moisture resistance	3.20	4.8.16	
Marking visibility	3.21	4.8.17	
Seal (watertight) (enclosure design 3)	3.7.2	4.8.3.2	
Seal (splashproof) (enclosure design 6)	3.7.5	4.8.3.5	
Dielectric withstanding voltage	3.8	4.8.4	
Operating characteristics	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable)	3.10.1	4.8.6.1	
Seal (resilient) (enclosure design 4)	3.7.3	4.8.3.3	
Seal (hermetic) (enclosure design 5)	3.7.4	4.8.3.4	
Group III			
Salt spray (corrosion) (except enclosure designs 1 and 6)	3.22	4.8.18	2
Icing (when specified)	3.23	4.8.19	
Dielectric withstanding voltage	3.8	4.8.4	
Insulation resistance	3.9	4.8.5	
Sand and dust (when specified)	3.24	4.8.20.1	
Marking visibility	3.21	4.8.17	
Operating characteristic	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable)	3.10.1	4.8.6.1	
Group IV			
Salt spray (corrosion) (enclosure designs 1 and 6)	3.22	4.8.18	2
Marking visibility	3.21	4.8.17	

See footnotes at end of table.

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* TABLE VII. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected
Group V			
Explosion	3.25	4.8.21	2
Operating characteristics	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable)	3.10.1	4.8.6.1	
Group VI			
Permanency of marking (when applicable) 2/	3.11	4.8.7	4 6/
Resistance to soldering heat (when applicable)	3.26	4.8.22	
Contact resistance	3.27	4.8.23	
Contact bounce (when specified)	3.28	4.8.24	
Low temperature operation 3/	3.29	4.8.25	
Mechanical endurance at low temperature 3/ 5/	3.30	4.8.26.2	
Mechanical endurance at high temperature 3/	3.30	4.8.26.2	
Contact resistance	3.27	4.8.23	
Short circuit	3.31	4.8.27	
Dielectric withstanding voltage	3.8	4.8.4	
Operating characteristics	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable)	3.10.1	4.8.6.1	
Actuator grounding (when specified)	3.32	4.8.28	
Shielding efficiency (when specified)	3.33	4.8.29	
Group VII			
Overload cycling (all group VII sample units)	3.34	4.8.30	Number of sample units variable 7/
Electrical endurance 7/	3.35	4.8.31	
Resistive load, dc	3.35	4.8.31.2	
Inductive load, dc	3.35	4.8.31.2	
Motor load, dc	3.35	4.8.31.2	
Lamp load, dc	3.35	4.8.31.2	
Resistive load, ac	3.35	4.8.31.2	
Inductive load, ac	3.35	4.8.31.2	
Lamp load, ac	3.35	4.8.31.2	
Motor load, ac	3.35	4.8.31.2	
Contact resistance	3.27	4.8.23	
Dielectric withstanding voltage 8/	3.8	4.8.4	
Operating characteristics (all group VII sample units)	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable) (all group VII sample units)	3.10.1	4.8.6.1	
Group VIII (enclosure designs 2, 3, 4, 5, and 6 only)			
Fluid resistance (when specified) 3/	3.12	4.8.8	2
Mechanical endurance at room ambient temperature	3.30	4.8.26.1	
Operating characteristics	3.10	4.8.6	
Coincidence of operating and releasing points (when applicable)	3.10.1	4.8.6.1	
Contact resistance	3.27	4.8.23	
Seal (dusttight) (enclosure design 2)	3.7.1	4.8.20.2	
Seal (watertight) (enclosure design 3)	3.7.2	4.8.3.2	

See footnotes at end of table.

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* TABLE VII. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test method paragraph	Number of sample units to be inspected
Group VIII - Continued			
Seal (resilient) (enclosure design 4)	3.7.3	4.8.3.3	2 (Continued)
Seal (hermetic) (enclosure design 5)	3.7.4	4.8.3.4	
Seal (splashproof) (enclosure design 6)	3.7.5	4.8.3.5	
Group IX			
Intermediate current (when specified)	3.36	4.8.32	2
Operating characteristics	3.10	4.8.6	
Group X			
Low level circuit (when specified)	3.37	4.8.33	2
Operating characteristics	3.10	4.8.6	

1/ Only four of the sample units shall be inspected for compliance to physical dimensions.

2/ Four sample units only.

3/ Two sample units only.

4/ Four additional sample units required for additional qualification of identical switches for method II (high impact shock), or higher vibration grades.

5/ Same sample units as for low temperature operation.

6/ Four additional sample units required for additional qualification of identical switches for a higher temperature characteristic.

7/ Two sample units for each electrical load (see 3.1). Two additional sample units for each electrical load required for additional qualification of identical switches for a higher temperature characteristic.

8/ Sea level dielectric withstanding voltage test (4.8.4.1) is to be conducted only on those units which are tested for sea level electrical endurance (4.8.31). Altitude dielectric withstanding voltage test (4.8.4.2) is to be conducted on those units which were tested for altitude electrical endurance tests (4.8.31).

4.5.4.2 Group submission. The extent of qualification shall be in accordance with the applicable specification sheet (see 3.1).

4.5.5 Retention of qualification. To retain qualification, the contractor shall forward the reports listed below to the qualifying activity. The qualifying activity shall establish the initial reporting date. The reports shall consist of:

a. At 12-month intervals, a summary of the results of the tests performed for inspection of product for delivery, group A, indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.

b. At 36-month intervals, a summary of the results of the tests performed for periodic inspection, group B, including the number and mode of failures. If the test results indicate nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

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Failure to submit a report within 30 days after the end of each period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time that the inspection data indicates noncompliance of the product to meet the requirements of this specification.

In the event that no production of category I and II switches occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during two consecutive reporting periods, there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit each type of switch for which qualification is sought to testing in accordance with the qualification inspection requirements.

4.6 Inspection requirements for category II and category III switches (items not covered by specification sheets). Inspection requirements for items not covered by specification sheets shall be performed by the contractor, after award of contract, and prior to production. (See 6.2.2 and 6.2.3).

4.6.1 Category II switches. Additional tests to verify suitability of the variations from the category I switches shall be performed as specified (see 6.2.2).

4.6.2 Category III switches. Unless otherwise specified (see 6.2.3), the inspection requirements shall be as specified in 4.5 through 4.5.2, inclusive.

4.7 Quality conformance inspection.

4.7.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection.

4.7.1.1 Inspection lot. An inspection lot shall consist of all switches of the same specification sheet, of the same enclosure design, temperature characteristic, vibration grade, shock type, and design and construction, produced under essentially the same conditions, and offered for inspection at one time. Similar switches conforming to these requirements but having different circuitry may be combined to form a lot.

4.7.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table VIII. All applicable inspections shall be performed on each sample unit in the order shown.

4.7.1.2.1 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 as specified in table VIII. Major and minor defects shall be as defined in MIL-STD-105.

* 4.7.1.2.2 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. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

* 4.7.2 Periodic inspection. Periodic inspection shall consist of group B. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.7.2.1.4), delivery of products which have passed group A shall not be delayed pending the results of these periodic inspections.

* 4.7.2.1 Group B inspection. Group B inspection shall consist of the inspections specified in table IX, in the order shown. When a manufacturer has similar products qualified under different specification sheets, the qualifying activity may authorize group B tests which do not require redundant testing on the similar features of these products. Group B inspection shall be performed on sample units which have passed group A inspection. A manufacturer's normal quality control tests, production tests, environment tests, and so forth may be used to fulfill all or part of group B inspections; however, all of group B inspections shall be completed as specified.

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* TABLE VIII. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	AQL (percent defective)	
			Major	Minor
Seal (enclosure designs 3, 4, 5, and 6)	3.7.2, 3.7.3, 3.7.4, and 3.7.5	4.8.3.2, 4.8.3.3, 4.8.3.4, and 4.8.3.5	1/	
Visual and mechanical inspection	3.1, 3.4, 3.5, 3.38 and 3.39	4.8.1	1.0 2/	4.0
Operating characteristics	3.10	4.8.6	1.0 3/	
Coincidence of operating and releasing points (when applicable	3.10.1	4.8.6.1	1.0 3/	
Contact bounce (when specified)	3.28	4.8.24	4/	
Dielectric withstanding voltage	3.8	4.8.4.1	.65 1/	
Contact resistance	3.27	4.8.23	.65 5/	
Actuator grounding (When specified)	3.32	4.8.28	4.0 6/	

1/ One-hundred precent inspection required for enclosure designs 3, 4, and 5; in-process inspection may be used to satisfy this requirement.

2/ At the option of the contractor, in-process inspection may be used to meet the materials (see 3.4) and design and construction (see 3.5) requirements provided they meet the acceptable quality level and all of the contractor's in-process control data on these tests are made available to the Government upon request.

3/ One percent AQL applied to each applicable characteristic.

4/ 100 percent inspection required.

5/ 100 percent inspection for switches rated for low level circuit or intermediate current. Documented in-process inspection of completed switches is acceptable.

6/ Special inspection level S-4.

4.7.2.1.1 Sampling plan. Group B inspections shall be completed in accordance with table IX within 36 months after the date of notifiction of qualification and within each subsequent 36-month period. The sample units shall be selected either from stock or a current production lot unless the Government considers it more practical to select a sample from current production. Switches selected from stock shall have been produced after the date of notification of qualification or subsequent to the date code of the previous group B inspection sample units. Group B inspection shall be performed on sample units produced using the same manufacturing facilities and processes as units normally offered for acquisition. When there has been no production of a particular type of switch for 36 months or more, sample units shall be selected from the next production lot presented for acceptance and for each subsequent 36-month period. When the specification sheet covers more than one part number, the part numbers subjected to group B inspection shall be the same part numbers specified for qualification; however, the group B inspection sample units need not be submitted to inspections not specified for qualification.

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* TABLE IX. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph	Sample numbers 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Solderability 1/	3.6	4.8.2	X	X												
Strength of mounting bushing 1/	3.15	4.8.11	X	X												
Thermal shock	3.16	4.8.12	X	X												
Shock	3.18	4.8.14	X	X												
Moisture resistance	3.20	4.8.16	X	X												
Salt spray (corrosion)	3.22	4.8.18			X	X										
Resistance to soldering heat (when applicable)	3.26	4.8.22						X								
Contact resistance	3.27	4.8.23						X								
Low temperature operation	3.29	4.8.25					X									
Mechanical endurance at low temperature	3.30	4.8.26.2					X									
Mechanical endurance at high temperature 2/	3.30	4.8.26.2						X								
Overload cycling	3.34	4.8.30							X	X	X	X				
Electrical endurance	3.35	4.8.31														
Inductive load, dc 3/	3.35	4.8.31.2									X	X				
Resistive load, ac 4/	3.35	4.8.31.2							X	X						
Intermediate current 5/	3.36	4.8.32													X	X
Contact resistance	3.27	4.8.23					X	X	X	X	X	X			X	X
Low level circuit 5/	3.37	4.8.33											X	X		
Dielectric withstanding voltage	3.8	4.8.4							X	X	X	X				
Operating characteristics 6/	3.10	4.8.6	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Coincidence of operating and release points 1/	3.10.1	4.8.6.1	X	X	X	X	X	X	X	X	X	X				
Seal 1/	3.7	4.8.3	X	X	X	X										
Marking visibility	3.21	4.8.17	X	X	X	X										

1/ When applicable.

2/ Mechanical endurance at high temperature is not required when the specified mechanical life is not greater than the specified electrical life.

3/ If rated for use at altitude, test at the rated altitude only.

4/ Test at the maximum temperature rating only. If no resistive ac load is specified, test resistive dc load (see 3.1).

5/ When specified (see 3.1).

6/ Not applicable for enclosure designs 1 and 6, samples 3 and 4.

4.7.2.1.2 Failures. If one or more sample units fail to pass group B inspection, the sample shall be considered to have failed.

4.7.2.1.3 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on the contract or order, but shall be kept on hand until the next inspection period for submittal to the qualifying activity if so requested.

4.7.2.1.4 Noncompliance. If a sample fails to pass group B inspection, the contractor shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, and so forth, and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group B inspection shall be repeated on additional sample units (complete

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inspection, or the inspection which the original sample failed, at the option of the Government.) Group A inspection may be reinstituted; however, final acceptance shall be withheld until the group B reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the contracting officer and the qualifying activity.

4.7.3 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-S-28786.

4.8 Methods of inspection.

* 4.8.1 Visual and mechanical inspection. Switches shall be inspected to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4, 3.5, 3.38 and 3.39). The switching operation of all poles shall be inspected by use of suitable test circuits for compliance with the applicable requirements (see 3.1 and 6.2).

4.8.2 Solderability (see 3.6). Solder type terminations shall be tested in accordance with method 208 of MIL-STD-202. Minimum of two terminals per unit shall be tested.

4.8.3 Seal (see 3.7).

4.8.3.1 Dusttight (applicable to enclosure design 2). See 4.8.20.2 for applicable test.

* 4.8.3.2 Watertight (applicable to enclosure design 3). Switches shall be immersed in a container of water containing approximately 1 percent detergent and shall then be placed in a vacuum chamber. The absolute pressure shall be 1.3 inches of mercury and this pressure shall be maintained for a period of 1 minute, or until air bubbles cease to be given off by the water, whichever is longer. The absolute pressure shall then be increased to 2.5 inches of mercury and this pressure maintained for 2 minutes. During the 2-minute period, the switches shall be observed for evidence of a continuous stream of bubbles. Any bubbles coming from within the switches shall be considered as leakage. Bubbles which are the result of entrapped air on the exterior of the switches shall not be considered as an indication of leakage.

4.8.3.3 Resilient (applicable to enclosure design 4). Switches shall be tested in accordance with method 112 of MIL-STD-202. The following details shall apply:

a. Test condition C.

b. Leakage-rate sensitivity shall be 1×10^{-5} atm cm^3/s.

c. Procedure I, II, III, or IV (as applicable).

During the exposure of helium atmosphere, the differential pressure shall be one atmosphere between the interior and exterior of the switch under test. The vacuum shall be continuously monitored for traces of helium. At the completion of this test, the sample units may be backfilled with an inert gas or air and the bleeder tube pinched off. After pinch off, the pinch off area shall be carefully soldered to assist in obtaining the seal and this shall be tested for gross leaks using the watertight seal test (see 4.8.3.2).

4.8.3.4 Hermetic (applicable to enclosure design 5). Switches shall be tested in accordance with method 112 of MIL-STD-202. The following details shall apply:

a. Test condition C.

b. Leakage-rate sensitivity shall be 1×10^{-8} atm cm^3/s.

c. Procedure I, II, III, or IV (as applicable).

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During the exposure to helium atmosphere (see figure 1), the differential pressure shall be one atmosphere between the interior and exterior of the switch under test. The vacuum shall be continuously monitored for traces of helium. At the completion of this test, the sample units may be backfilled with an inert gas or air and the bleeder tube pinched off. After pinch off, the pinch off area shall be carefully soldered to assist in obtaining the seal and this shall be tested for gross leaks using the watertight seal test (see 4.8.3.2).

* 4.8.3.5 Splashproof (applicable to enclosure design 6). With the switch mounted by its normal means, the switch shall be subjected to the splashproof test of MIL-STD-108. During the test, the switch shall be subjected to 20 cycles of actuation without an electrical load.

4.8.4 Dielectric withstanding voltage (see 3.8). Switches shall be tested in accordance with 4.8.4.1 and, when applicable, in accordance with 4.8.4.2 (see 3.1 and 6.2.2).

* 4.8.4.1 At atmospheric pressure. Switches shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

a. Test potential (RMS): 1,000 volts rms.

b. Duration of applications shall be one minute for qualification and group B tests; five seconds for group A tests.

c. Points of application:

(1) Between all terminals and exposed noncurrent carrying metal or grounded parts.

(2) Between all terminals of mutually insulated circuits, including between poles.

(3) Between all unconnected terminals of the same pole (not applicable after electrical endurance).

d. Inspection after test: Switches shall be inspected for evidence of arcing, flashover, breakdown of insulation, and damage.

These tests shall be performed with the switch in normal position, and shall then be repeated for other operating positions.

4.8.4.2 At reduced barometric pressure. Switches rated for operation above 10,000 feet (see 3.1) shall be tested as specified in 4.8.4.1 and in accordance with method 105 of MIL-STD-202. The following details and exceptions shall apply:

a. Test voltage shall be 500 volts rms unless otherwise specified (see 3.1).

b. Test condition (70,000 feet) unless otherwise specified (see 3.1).

* 4.8.5 Insulation resistance (see 3.9). Switches shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

a. Test condition B (500 volts ±10%).

b. Points of measurement:

(1) Between each terminal and exposed noncurrent carrying metal or grounded parts.

(2) Between all terminals of mutually insulated circuits, including between poles.

(3) Between all unconnected terminals of the same pole.

These tests shall be perfomred with the switch in normal position, and then shall be repeated for other operating positions.

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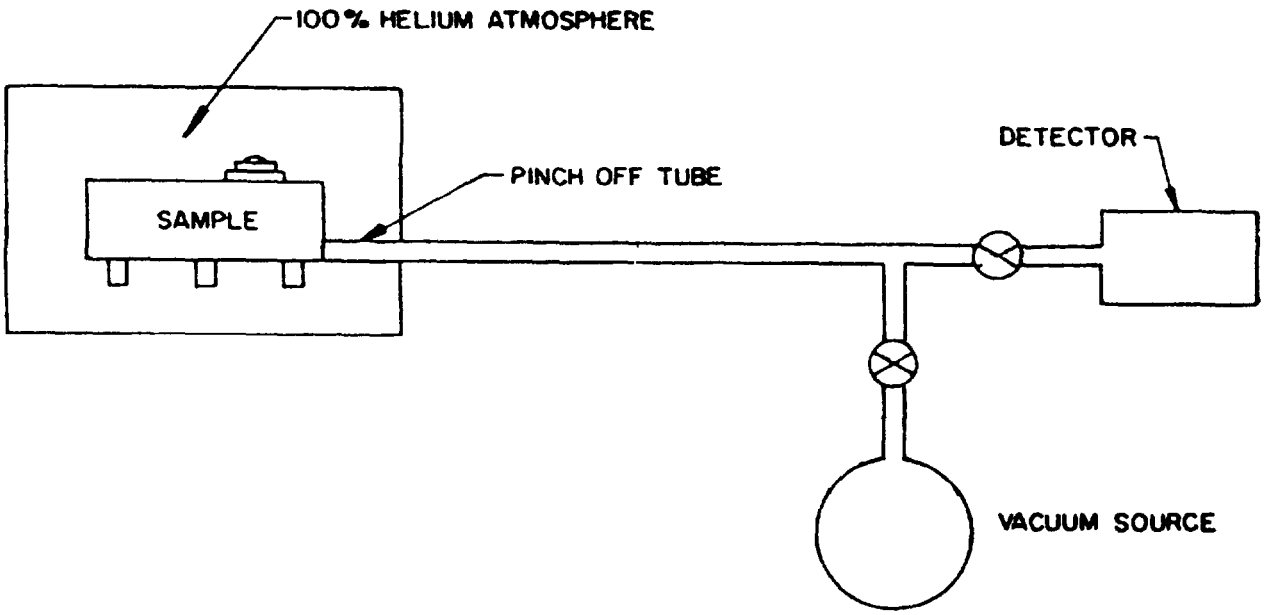

FIGURE 1. Hermetic seal test setup.

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4.8.6 Operating characteristics (see 3.10). Switches shall be measured for operating characteristics as specified (see 3.1 and 6.2).

4.8.6.1 Coincidence of operating and releasing points (see 3.10.1). Coincidence of operating (releasing) points of all poles of a multipole switch shall be determined with suitable indicating circuits. The switch shall be rigidly held in a suitable fixture allowing the actuator to be moved in its intended manner. The actuator shall be advanced and retracted slowly and uniformly with no external vibratory influence while passing through the operating and releasing points, at a rate not exceeding 0.001 inch or 1 degree per second.

* 4.8.7 Permanency of marking (see 3.11) (applicable to switches with printed circuit board mount terminals). Switches shall be tested in accordance with MIL-STD-202, method 215. The following details shall apply:

a. Portion of switch to be brushed: Brush strokes of each solvent solution shall be evenly divided between required identification, terminal, and circuit schematic markings.

b. Mechanical or electrical damage: There shall be no damage at the conclusion of the test sequence.

* 4.8.8 Fluid resistance (see 3.12) (when specified, see 3.1 and 6.2). Switches shall be tested with each fluid as specified (see 3.1 and 6.2).

4.8.9 Terminal strength (see 3.13). Switches shall be mounted by their normal mounting means. The switches shall be inspected for evidence of short-circuiting, breakage, loosening of terminals, or damage to the body of the switch. A circuit, such as a pilot light, shall be used to monitor the test. No terminal shall be tested in more than one direction.

4.8.9.1 Screw terminals. Screw terminals shall be subjected to the tests specified in 4.8.9.1.1 and 4.8.9.1.2.

4.8.9.1.1 Pull. The terminals shall be subjected to a pull of the applicable static force specified in table X. The following details shall apply:

a. Duration shall be one minute.

b. Direction of the pull shall be along the axis of the terminal screw, perpendicular to the axis of the terminal screw, and in the direction most likely to cause failure.

TABLE X. Static values of force.

Thread size	Force in pounds
4-40	5
6-32	30
8-32	35
10-32	40
10-24	40
1/4-28	50

4.8.9.1.2 Torque. Terminals of the switches shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition E, except that for thread size 10-24 the torque shall be 24.0 pound-inches.

b. Direction of torque shall be in the direction which will tighten the screws.

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* 4.8.9.2 Solder terminals. Switches shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition A.

b. Applied force shall be 9 pounds.

c. Directions of force shall be parallel to the long axis of the terminal, perpendicular to the long axis of the terminals, and in the direction most likely to cause failure.

* 4.8.9.3 Wire-lead terminals. Switches shall be tested in accordance with method 211 of MIL-STD-202. The following details and exceptions shall apply:

a. Test condition A.

b. Applied force shall be 15 pounds.

4.8.10 Strength of actuating means (see 3.14). With the switches mounted by their normal mounting means, a static load of 10 pounds shall be gradually applied to the actuator and maintained for a period of 1 minute. The force resulting from application of the static load shall be in a direction to cause actuation of the switch. A circuit, such as a pilot light, shall be used to monitor the test.

4.8.11 Strength of mounting bushing (see 3.15). Bushing-mounted switches shall be mounted on a metal panel by their normal mounting means with the hardware specified (see 3.1 and 6.2). A torque of 15 pound-inches shall be applied to the mounting nut. If the unit incorporates a nonturn device, the mounted switch bracket shall be subjected to a torque of 5 pound-inches.

4.8.12 Thermal shock (see 3.16). Switches shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

a. Test condition:

A, for temperature characteristic 1;
B, for temperature characteristic 2;
C, for temperature characteristic 3;
D, for temperature characteristic 4.

b. Measurements before and after cycling: Not applicable.

c. Inspections after test: Switches shall be inspected for mechanical and electrical damage and loosening of rivets or other fastening devices.

* 4.8.13 Vibration (see 3.17). Switches shall be tested as specified in 4.8.13.1, and in addition, when specified (see 3.1 and 6.2), as specified in 4.8.13.2. The following details and exceptions shall apply to swept sinusoidal and random vibration:

a. Tests and measurements prior to vibration: Not applicable.

b. Mounting: Switches shall be rigidly mounted by their normal mounting means on a rigid metal panel. The mounting fixture shall be free from resonances over the test frequency range. Where connectors are part of the switch, the complete connector shall be tested with the switch.

c. Monitoring of open and closed circuits: All open and closed circuits shall be monitored. Unless otherwise specified (see 3.1), half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position. Open circuits may be connected in parallel and monitored for closing, and closed circuits may be connected in series and monitored for opening. With the circuits so wired, in the event of indication of failure, the test shall be modified by successive testing with the contacts monitored, switch by switch, to determine which, if any, contacts are defective. If one or more contacts fail singularly, the switches shall be considered to have failed.

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d. Test and measurements during vibration - Switch-contact stability shall be continuously monitored during vibration, using method 310 of MIL-STD-202, test condition A, test circuit B.

e. Tests and measurements after vibration - Not applicable.

f. Inspections after test - Switches shall be inspected for evidence of broken, deformed, displaced, or loose parts.

4.8.13.1 Swept sinusoidal. Switches shall be tested in accordance with method 204 of MIL-STD-202. The following details and exceptions shall apply:

Test condition:
A, for vibration grade 1;
B, for vibration grade 2;
D, for vibration grade 3, except that acceleration level shall be 30 G and the upper level of the frequency range shall be 3,000 hertz.

* 4.8.13.2 Random vibration (when specified, see 3.1 and 6.2). Switches shall be tested in accordance with method 214 of MIL-STD-202, test condition I. Duration of test shall be 90 minutes in each of three mutually perpendicular directions, one of which shall be in the direction of actuator movement. The test condition letter is identified as follows:

A through F, for random vibration categories A through F respectively.

4.8.14 Shock (see 3.18). Unless otherwise specified (see 3.1), switches shall be tested as specified in 4.8.14.1, method I, and in addition, when specified (see 3.1), as specified in 4.8.14.2, method II. The following details and exceptions shall apply to method I and method II:

a. Special mounting means: Switches shall be mounted on a rigid metal panel by their normal mounting means.

b. Electrical load conditions: The electrical load shall consist of the monitor circuit only.

c. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position. Open circuits may be connected in parallel and monitored for closing and closed circuits may be connected in series and monitored for opening. In the event of indication of opening or closing of contacts greater than that allowed, the test shall be modified by applying successive identical blows in the same plane to monitor contacts, switch by switch, to determine if a switch is defective.

d. Measurements during shock: Switch-contact stability shall be continuously monitored during shock using method 310 of MIL-STD-202, test circuit B.

e. Measurement after shock: Not applicable.

f. Measurement after test: There shall be no evidence of broken, deformed, displaced, or loose parts.

4.8.14.1 Method I (applicable to shock type M). Switches shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply

a. Test condition I.

b. Monitoring: Method 310 of MIL-STD-202, test condition A.

4.8.14.2 Method II (applicable to shock type H). Switches shall be tested in accordance with method 207 of MIL-STD-202. Switch contacts shall be monitored in accordance with method 310 of MIL-STD-202, test condition D.

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4.8.15 Acceleration (see 3.19). When specified (see 3.1), switches shall be subjected to an acceleration force of 20 G attained within 2 minutes. The force shall be maintained for 1 minute in each direction along each of its three mutually perpendicular axis. The switches shall be monitored for opening of closed contacts and closing of open contacts with a circuit such as a pilot lamp. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position.

4.8.16 Moisture resistance (see 3.20). Switches shall be tested in accordance with method 106 of MIL-STD-202. The following details and exceptions shall apply:

a. Mounting: By normal mounting means on a corrosion-resistant metal panel extending beyond the switch, positioned 15 degrees from vertical and uninsulated. Half of the units shall be tested with the actuating means in one position and the other half of the units shall be tested with the actuating means in an alternate position.

b. Polarization: During steps 1 to 6 inclusive, a polarizing voltage of 100 volts dc shall be applied between all terminals tied together and the metal panel. The negative polarity shall be applied to the metal panel. Steps 7a and 7b are not applicable.

c. Load voltage: Not applicable.

d. Final measurements: Within 5 minutes after conclusion of the test and while the switches are still wet, insulation resistance shall be measured as specified in 4.8.5. At the end of the 24-hour drying period, insulation resistance shall again be measured as specified in 4.8.5.

e. Inspections during final measurement and after test: Switches shall be inspected for evidence of corrosion, breaking, cracking, or spalling. Mounting hardware shall be removed at the end of the test.

f. Water, steam, distilled or deionized water shall be used for this test.

* 4.8.17 Marking visibility (see 3.21). Subsequent to the inspections of group II of table VII and the applicable inspections of table VIII, switches shall be inspected for legibility of required marking (see 3.38). 5X maximum magnification may be used.

4.8.18 Salt spray (corrosion) (see 3.22). Switches shall be tested in accordance with method 101 of MIL-STD-202 with associated mounting and terminal hardware assembled. The following details and exceptions shall apply:

a. Test condition A.

b. Switches, of enclosure design 2, shall be subjected to 10 cycles of operation of making and breaking the rated resistive current at the lowest dc voltage specified (see 3.1 and 6.2), immediately after the gentle wash or dip and light brushing. Sealed switches (designs 3, 4, and 5) shall be subjected to these 10 cycles of operation after a 6-hour drying period in a forced-draft oven at a temperature of approximately 57°C.

c. Five percent salt solution unless otherwise specified.

4.8.19 Icing (when specified, see 3.1) (see 3.23). Switches shall be carefully cleaned to remove grease or other foreign material from surfaces that will be in contact with the ice. Switches with test leads attached shall be mounted by their normal mounting means within individual fixtures so designed that the actuator of the switch can be individually and suddenly released from its full overtravel position. The fixture shall not impede or assist the fracture of the ice or the subsequent release of the actuator. The fixture shall be so designed that releasing the switch actuator does not exert any stress upon the ice coating except the stress applied by the test switch itself. The fixture shall be designed to support and continuously maintain the test switch in an attitude such that the actuating member moves upward when released by the fixture. The fixture shall be designed to provide a minimum of heat transfer between the fixture and the test switch. (See figure 2 for suggested

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icing test fixtures.) During the test, no part of the ice coating shall come into physical contact with any surface other than that of the fixture or test switch or the water during immersion. It shall not be exposed to warm drafts, and shall not be brought into close proximity to any heated object or surface. The fixture, with switch installed, shall be conditioned at -8°C for at least 10 hours immediately prior to the first water immersion. Clear glaze-ice coatings shall be formed over the switch by alternately dipping it in distilled water at 0°C to +1°C for 5 seconds and placing it in a cold chamber at -8°C for at least 30 minutes. The switch shall not be removed from the temperature chamber for a longer period than 16 seconds to perform the immersion cycle. Ice cubes made from distilled water may be placed in the water bath to aid in maintaining its temperature, but the ice coating shall not be allowed to touch floating ice. During the 5-second immersion, the switch shall be completely submerged and shall remain stationary; the water shall not be stirred while the switch is immersed. The ice coating shall be not less than 1/16-inch thick. The ice coating shall not be mechanically disturbed before the fixture releases the switch actuating member for evaluation. At the conclusion of the final low temperature exposure, the fixture containing the switch shall be removed from the low temperature chamber and, within 20 seconds, a pilot lamp circuit shall be connected to the test leads attached to the switch terminals and the fixture shall suddenly and completely release the switch actuator and operate for 50 cycles of operation at room ambient temperature.

* 4.8.20 Sand and dust (when specified, see 3.1) (see 3.24 and 3.7.1).

4.8.20.1 Method I (see 3.24). Switches shall be tested in accordance with method 110 of MIL-STD-202. During step 3, the switches shall be mechanically operated for 2,500 cycles. The cycling rate shall not exceed 60 cycles of operation per minute. The second 6-hour test at 63°C (145°F) shall be performed immediately after reaching stabilization in step 2.

4.8.20.2 Method II (applicable only to enclosure design 2) (see 3.7.1). Switches shall be tested as specified in 4.8.20.1, except that subsequent to all applicable tests of group VIII of table VII, the switches shall be opened and inspected internally for dust. The inspection shall be made using 10-power magnification.

4.8.21 Explosion (see 3.25). Switches shall be tested in accordance with method 109 of MIL-STD-202. Switches shall be operated at their maximum rated dc inductive current and open-circuit voltage (see 3.1 and 6.2).

* 4.8.22 Resistance to soldering heat (see 3.26) (applicable to switches with solderable terminals) (not applicable to switches with integral lead wire terminals). Switches shall be tested in accordance with method 210 of MIL-STD-202. The following details shall apply:

a. Depth of immersion. Terminals shall be immersed to within 0.05 inch of the switch body.

b. Test condition B.

c. Cooling time: Not applicable.

d. Inspections and measurements:

(1) Before: None.

(2) After: Subsequent to all applicable tests of group VI of table VII, the switches shall be opened and inspected for deformation or other damage.

* 4.8.23 Contact resistance (see 3.27). Switch contacts shall be tested in accordance with method 307 of MIL-STD-202. The following details shall apply

a. Measurements shall be made between the terminals of the contacts of the same pole forming a switching circuit. Measurements shall be made for all poles in a switch at each of the actuators extreme positions.

b. Test current: 0.1 ampere. After electrical endurance, use the electrical parameters of the electrical endurance test load (this also applies to 4.8.23c).

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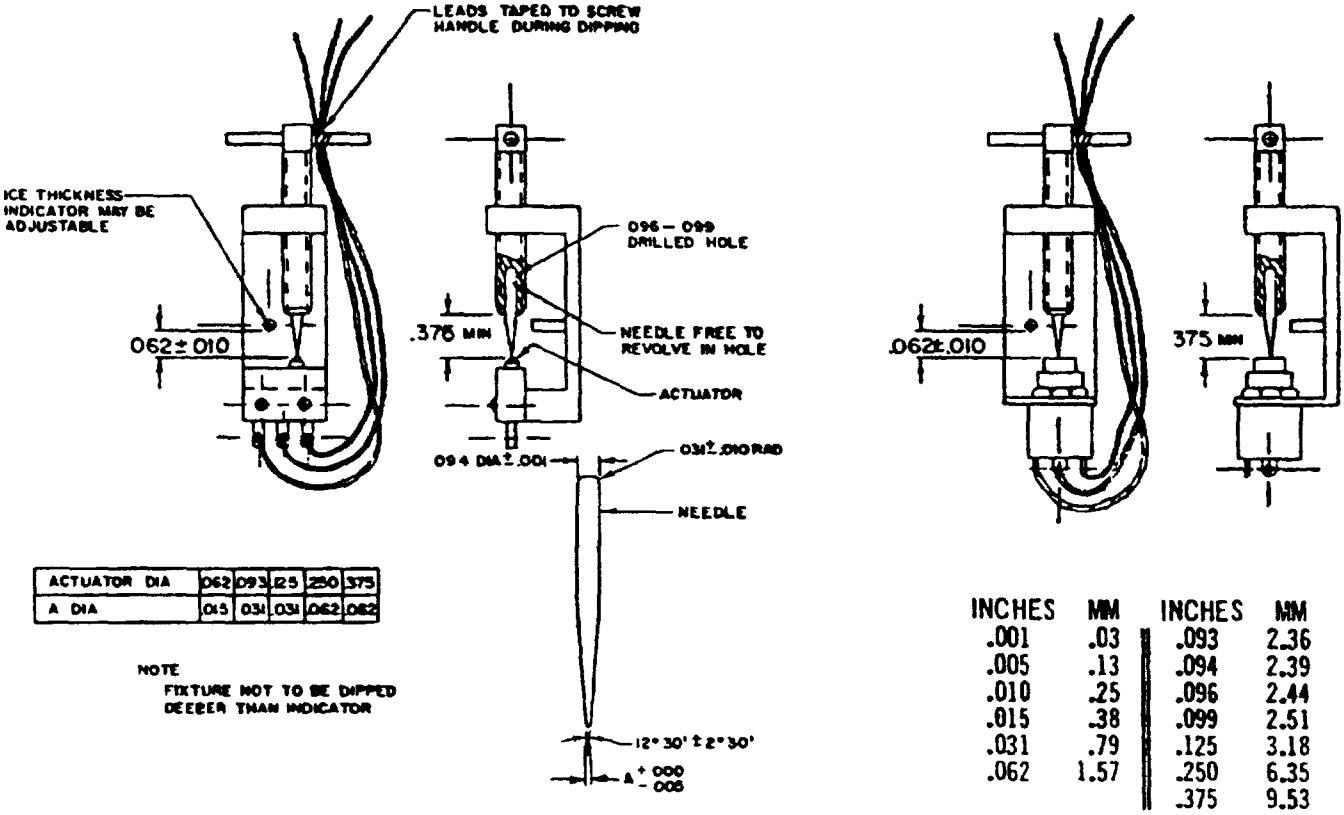

ACTUATOR DIA	.062	.093	.125	.250	.375
A DIA	.015	.031	.031	.062	.062

NOTE
FIXTURE NOT TO BE DIPPED DEEPER THAN INDICATOR

INCHES	MM	INCHES	MM
.001	.03	.093	2.36
.005	.13	.094	2.39
.010	.25	.096	2.44
.015	.38	.099	2.51
.031	.79	.125	3.18
.062	1.57	.250	6.35
		.375	9.53

FIGURE 2. Suggested icing test fixtures.

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c. Open-circuit test voltage: 6 ±1 V dc.

d. Number of actuations prior to measurement: Three.

e. Number of test actuations: Three.

f. Number of measurements per actuation: One.

* 4.8.24 Contact bounce (when specified, see 3.1 and 6.2) (see 3.28). The contact bounce occurring under the initial conditions of closing contacts shall be measured by mechanically actuating the plunger in a direction parallel to the allowable plunger travel by means of a mechanical cycler. The method of observing shall be by means of an oscilloscope trace or equivalent test method. The oscilloscope band width shall be not less than 50,000 Hz. The mechanical cycling means shall include a triggering circuit such that the quiescent contact state shall be viewed prior to the initial closing of the contacts. An example of a typical recording of contact bounce is shown on figure 3. The electrical circuit shown on figure 4, or an equivalent, shall be utilized. The contact bounce readings shall be the maximum occurring in ten consecutive readings.

4.8.24.1 Sensitive and limit switches. Sensitive and limit type switches shall be tested with a plunger actuation rate of .001 ±.0005 inch per second.

4.8.24.2 Manual switches. Manual switches shall be tested with an actuator rate of 6 ±2 inches per second.

4.8.25 Low temperature operation (see 3.29). Half of the sample units shall be mounted in a fixture which depresses the actuating member to its full overtravel position, and half of the sample units shall be similarly mounted with actuating members depressed with the normally open contacts closed, the actuator shall be held in the differential travel range. The fixtures shall be designed to afford a minimum of heat transfer between the fixture and switch. The fixtures shall permit free circulation of air around the test switch, and shall be designed to provide sudden and complete release of the switch actuating member. The fixtures containing the sample units shall be placed in a low temperature chamber provided with forced circulation, and the chamber shall be brought to the minimum temperature specified (see 3.1 and 6.2). The temperature shall then be maintained at this level for 24 hours. With the test chamber maintained at the specified low temperature, the fixtures shall be removed from the chamber individually, and within 5 seconds, the test switch actuating member shall be suddenly and fully released by the fixture. A pilot lamp circuit shall be used to observe switch behavior.

4.8.26 Mechanical endurance (see 3.30). Switches shall be subjected to mechanical operation cycling at a rate of 60 ±5 cycles per minute. Switch contacts shall be monitored for circuit continuity a minimum of one minute per hour for the duration of the test. Two switches shall be tested at each ambient temperature condition.

4.8.26.1 Mechanical endurance (room temperature). Switches shall be subjected to the number of mechanical cycles specified (see 3.1 and 6.2).

4.8.26.2 Mechanical endurance (high and low temperature).

a. Two sample units at rated high temperature for the number of cycles specified (see 3.1 and 6.2).

b. Two sample units at rated low temperature for the number of cycles specified (see 3.1 and 6.2).

* 4.8.27 Short circuit (see 3.31 and 3.1). Switches shall be tested as specified in 4.8.27.1, method I, or when specified (see 3.1), switches shall be tested as specified in 4.8.27.2, method II.

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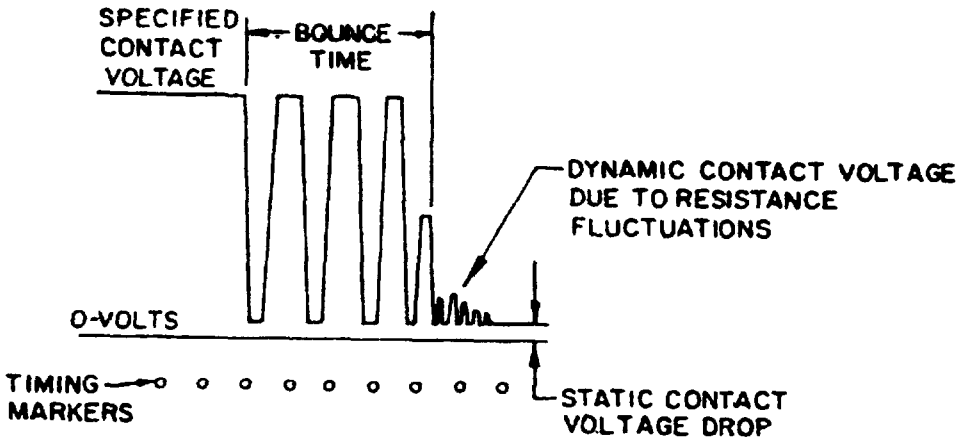

FIGURE 3. Typical recording of contact bounce.

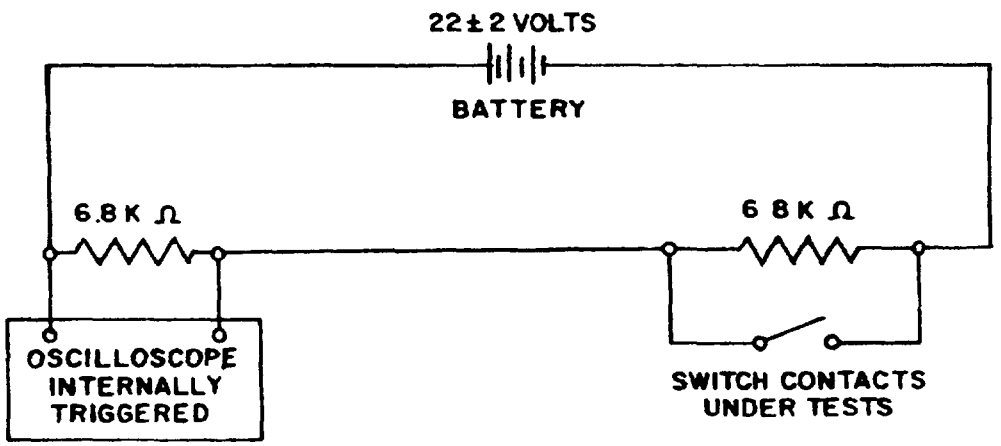

FIGURE 4. Test circuit for contact bounce.

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* 4.8.27.1 Method I. The switch shall be inserted in a circuit calibrated to supply current equal to 60 times the rated resistive load at the lowest rated dc voltage specified (see 3.1). The switch shall be connected in series to a thermal-type circuit breaker or a fuse in accordance with figure 5. A circuit breaker shall be used for switches having a rated resistive load of 10 amperes or greater, and a fuse for switches having a rated resistive load less than 10 amperes. The wire shall be of a size for single use in free air as specified in table XI as determined by the rated resistive load of the switch (see 3.1). If the rated load of the switch does not coincide with a wire size, the next larger wire size shall be used. The terminals shall be in accordance with MIL-T-7928. The circuit breaker shall be in accordance with MIL-T-7928. The circuit breaker shall be in accordance with MIL-C-5809 and cable and fuses shall be in accordance with MIL-F-15160 and table XI. If the rated load of the switch does not coincide with a circuit breaker or fuse current rating, the next larger breaker or fuse shall be employed. Calibration shall be made with a substitute circuit breaker (or equivalent fuse), less the test switch and with the switch leads in the circuit. With both the switch under test and the circuit breaker in a closed position as shown as shown on figure 5, the circuit shall be closed manually by switch S_1. A minimum of 2 minutes shall elapse between the successive closing of the switch. The test shall be conducted five times. For double-throw switches, half the switches shall be tested in one position, and the remaining half shall be tested in the other position.

4.8.27.2 Method II. Method II is similar to method I except as follows:

The calibrated circuit shall be closed by the switch under test, and after the circuit breaker or fuse interrupts the circuit, the test switch shall be manually opened. This procedure shall be repeated 10 times. After each closure, the test switch shall be returned to the "off" position, and the switch contacts shall be checked for proper opening by any suitable continuity test method. The circuit breaker shall be reset or the fuse replaced after each closure. The switch contacts under test must open after each closure operation, and there shall be no mechanical failure or damage to the switch case.

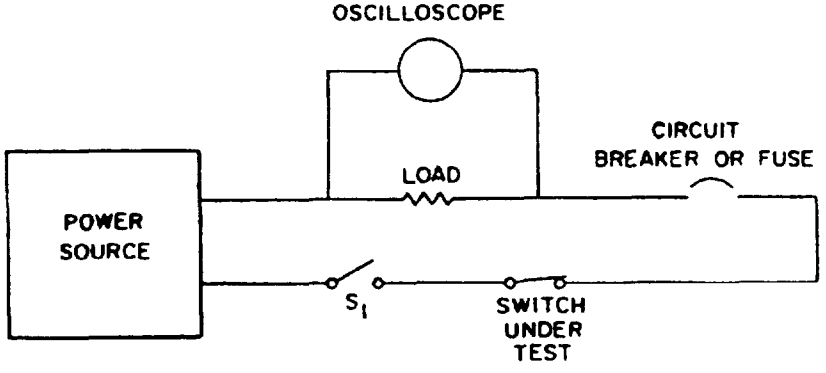

FIGURE 5. Circuit diagram for short circuit test.

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* TABLE XI. Short circuit and electrical endurance wire size, and circuit breaker or fuse designations.

Resistive rating at lowest voltage, amperes	Wire size	Circuit breaker or fuse
Less than 10 - - - - - - - -	AN-20	MIL-F-15160/2, characteristics A rating, as applicable
10 - - - - - - - - -	AN-18	MS25244-10
15 - - - - - - - - -	AN-18	MS25244-15
18 - - - - - - - - -	AN-16	MS25244-20
20 - - - - - - - - -	AN-16	MS25244-20
25 - - - - - - - - -	AN-14	MS25244-25
30 - - - - - - - - -	AN-14	MS25244-30
40 - - - - - - - - -	AN-12	MS25244-50

* 4.8.28 Actuator grounding (when specified, see 3.1 and 6.2) (see 3.32). Resistance between the mounting bushing and the actuator shall be measured in accordance with method 307 of MIL-STD-202. The following details and exceptions shall apply:

a. Method of connection: Between a suitable exterior point on the mounting bushing and the switch actuator (or shield when applicable).

b. Test current: 100 ±10 milliamperes.

c. Maximum open-circuit test voltage: 6 V dc.

d. Number of actuations prior to measurement: Three.

e. Number of test actuations. Three.

f. Number of measurements per actuation: One.

g. Measurement shall be made in each actuator position including all momentary positions. There shall be no exterior force applied to actuator during measurement in maintained positions.

4.8.29 Shielding efficiency (when specified, see 3.1 and 6.2) (see 3.33). Switches shall be tested utilizing a test setup (or equivalent) as shown on figure 6. Measurements shall be made as follows:

a. With the door open and the antennas in the "initial setup" position, establish a test level over the 200 MHz to 1 GHz range such that the received signal level is at least as many dB above the RF ambient level as that of the shielded enclosure attentuation.

b. Record the received signal level and the signal generator output level. Repeat measurements at 100, 200, 400, 600, 800, and 1,000 MHz.

c. Move the antennas to the final test positions, close the door and with a RF-tight blank panel between the antennas, measure the integrity of the enclosure by setting the signal generator to the same output and record the received signal level for each frequency used in step b. The shielded enclosure attentuation is then calculated using the following equation:

$$\text{Attenuation (dB)} = 20 \log \frac{E1}{E2}$$

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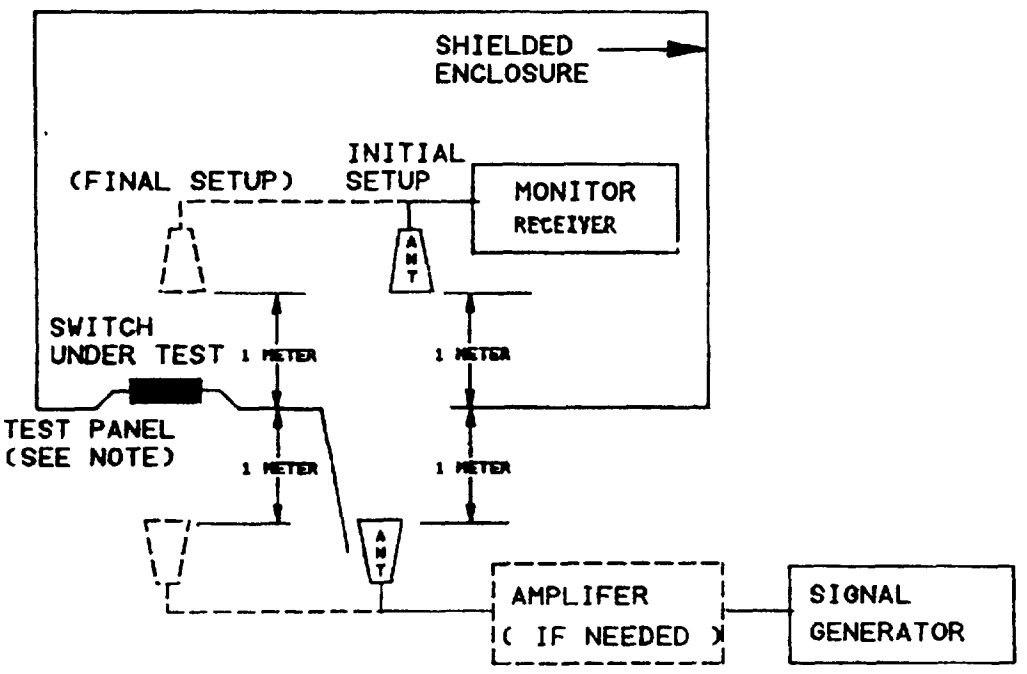
Where E1 is the receiver reading in step b and E2 is the receiver reading in step c.

d. Mount the test switch in the blank panel with the rear of the switch outside of the shielded enclosure (toward the signal generator antenna). The switch shall be mounted as it would be for normal installation using the mounting hardware supplied or recommended. Repeat the measurements of step c above and calculate the shielding attentuation of the switch using the new receiver readings.

4.8.30 Overload cycling (see 3.34). Each switch to be tested for electrical endurance shall first be tested for overload cycling at room ambient conditions using the same voltage, electrical frequency, and the same pairs of contacts that will subsequently be used for the electrical endurance test. The switches shall close and open the overload current of a resistive circuit equal to 150 percent of the resistive load rating at the particular voltage and electrical frequency. The cycling rate shall be 5 to 6 cycles of operation per minute. Fifty cycles of operation shall be performed. The duty cycle shall be approximately 50 percent on, 50 percent off.



NOTE: Test panel shall be located in the chamber wall at least 1 meter from any corner and at least 1 meter from floor and ceiling.

FIGURE 6. Block diagram of switch shielding efficiency test.

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4.8.31 Electrical endurance (see 3.35).

* 4.8.31.1 Conditions.

a. Test loads shall be arranged so that an independent load shall be provided for each pole.

b. Switches shall be continuously monitored and recorded to determine whether any contact has failed to open or close its individual circuit in the proper sequence. The monitoring circuit shall not shunt inductive components of inductive loads or switch contacts.

c. Temperature rise shall be measured (see 4.8.31.3).

d. The duty cycle shall be approximately 50 percent on and 50 percent off for resistive, inductive, and motor loads. The duty cycle shall be approximately 30 percent on and 70 percent off for lamp loads.

e. The cycling rate shall be 10 to 12 cycles per minute at a maximum actuator velocity of 5 inches per second.

f. When applicable, half of the switches shall be tested in the normally open position and the other half shall be tested in the normally closed position.

g. In any of the specified load tests, each conductor shall be of an applicable size for single use in free air as listed in table X. If the switch rating under test does not coincide with a wire size, the next larger diameter wire shall be used.

h. One side of the power supply, one side of the test load, the switch mounting plate, metal case (if applicable), and the actuating member, if metal, shall be connected to a common ground.

i. Altitude tests and motor load tests shall be conducted at room temperature conditions only. All switches tested to all other loads shall be subjected to the number of cycles specified (see 3.1 and 6.2) at the maximum temperature specified (see 3.1 and 6.2).

4.8.31.2 Loads. Voltage, current, frequency, altitude, and operating cycles shall be as specified (see 3.1 and 6.2). Unless otherwise specified, ac tests are to be 60 Hz. Where different current ratings for 60 and 400 Hz are shown, both 60 and 400 Hz tests are to be performed. The loads are as follows:

a. Resistive load, dc.

b. Inductive load, dc: Inductors in accordance with MIL-I-81023 shall be used.

c. Lamp load, dc: Controlling a tungsten lamp which provides the rated, steady state lamp current. The circuit shall be arranged so as to provide a minimum of 15 seconds cooling time preceding each time a lamp is energized. Only tungsten lamps having a nominal wattage not to exceed 50 watts, at the voltage specified, shall be used to make up the load.

d. Motor load, dc: The duration of the inrush current shall be not less than .05 second. Only resistive components shall be used. Switches shall make 6 times the rated load, and break the rated load.

e. Resistive load, ac.

f. Inductive load, ac: Inductive ac load test circuits shall consist of inductive and resistive load element connected in series. The circuit parameters shall be rated inductive load current at 0.7 ±0.05 lagging power factor at 115 volts.

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g. Lamp load, ac: Similar to 4.8.31.2c above, except that the rated ac voltage shall be used. Only tungsten lamps having a nominal wattage not to exceed 200 watts, at the voltage specified, shall be used to make up the load.

h. Motor load, ac: The duration of the inrush shall be not less than .05 second. Only resistive components shall be used. Switches shall make 6 times the rated load, and break the rated load.

* 4.8.31.3 Temperature-rise measurement. The switches tested for electrical endurance at the highest rated current, shall be tested immediately thereafter for temperature rise. The concluding segment of the electrical endurance test shall have been continuous for a minimum of 4 hours. The switch terminal temperature shall be measured using a suitable thermocouple (28-32 AWG), while the switch is continuously carrying its maximum rated current. The test shall be performed with the switch in still air which has a temperature of 25°C ±5°C. The temperature measuring thermocouple shall be attached to the normally-open or normally-closed terminal, using the terminal which was carrying current during the overload and endurance test. If wire leads are provided, the measurement shall be made on the copper conductor at the point of the entrance of the leads to the switch. If wire leads are not provided, the connections to the switch shall be made with not less than 1-foot length copper wire of the size used during the endurance test. The test current shall be passed through the switch without interruption. The terminal temperature shall be recorded at not less than 5-minute intervals, until the temperature has stabilized or until a minimum period of 2 hours has elasped. The temperature shall be considered stable when three successive readings taken at 5-minute intervals indicate no change in temperature. The ambient temperature shall be measured during the same period at a point sufficiently far from any heat source (including the test switch) to obtain a representative temperature value for the air reaching the switch by convection. The temperature rise shall then be calculated by subtracting the lowest recorded ambient temperature from the highest recorded switch terminal temperature.

* 4.8.32 Intermediate current (when specified, see 3.1) (see 3.36). One throw of each pole of the switches under test shall be connected into a circuit having a 27 +3, -0 volt dc source and a load consisting of the coil of relay M5757/10-033 of MIL-R-5757/10, or equivalent. Switch performance during the test shall be continuously monitored. The monitoring equipment shall provide a record of the number of cycles and shall record failures or discontinue the test if a failure occurs. During each closure, the contact potential shall be monitored for at least 40 percent of the time the contacts are closed. The number of operations shall be 50,000 cycles unless otherwise specified (see 3.1). THe switch shall be cycled by a mechanical actuating device. During each cycle of operation, the actuating member of the switch shall be moved once to each extreme of its travel. Double-throw switches shall be tested with half of the sample lot controlling the load with the normally open contacts and half controlling the load with the normally closed contacts. Each multipole switch shall be connected with all normally open circuits loaded simultaneously or all normally closed circuits loaded simultaneously. The frequency of actuation shall be compatible with the time response characteristics of the switch and monitoring device. Prior to testing, each switch shall be subjected to a 24-hour minimum conditioning in air at the maximum rated temperature. The test shall then be performed at the following operating temperatures:

a. Twenty-five percent of the test cycles at the minimum temperature specified.

b. Fifty percent of the test cycles at room ambient temperature.

c. Twenty-five percent of the cycles at the maximum temperature specified.

4.8.33 Low level circuit (when specified, see 3.1 and 6.2) (see 3.37). Switches shall be tested for the number of cycles specified (see 3.1) as follows.

a. Contact load. Each switch contact shall make, carry, and break a resistive load of 10 milliamperes maximum at an open circuit voltage of 30 millivolts maximum dc or peak ac. Both normally open and normally closed contacts shall be loaded. Contacts shall be connected to individual loads.

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b. Operate cycles: Rate not to exceed 60 cycles per minute with nominally equal "on" and "off" times.

c. Monitoring circuit: The monitoring equipment shall provide a record of the number of cycles and shall record failures or discontinue the test if a failure occurs. During each closure, the contact potential shall be monitored for at least 50 percent of the time the contacts are closed.

d. Operating temperatures:

(1) Twenty-five percent of the test cycles at the minimum temperature specified.

(2) Twenty-five percent of the test cycles at room ambient temperature.

(3) Fifty percent of the cycles at the maximum temperature specified.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-28786.

6. NOTES

6.1 Intended use and application. Switches covered by this specification are intended for use in ac and dc applications. Switches are for single phase use only and are not to be used to transfer from phase-to-phase, unless otherwise specified.

6.2 Ordering data. Switches (see 3.2) shall be described as follows:

6.2.1 Category I switches (items covered by specification sheets, see 3.2.1). The acquisition document shall specify the following:

a. Title, number, and date of this specification.

b. Title, number, and date of the applicable specification sheet and the part number.

6.2.2 Category II switches (qualified switches with modification, see 3.2.2). The acquisition document should specify the following:

a. Title, number, and date of this specification.

b. Title, number, and date of applicable specification sheet.

c. Switch is category II.

d. Military part number of qualified switch.

e. Manufacturer's part number of modified switch (see 3.38.1b).

f. Details of the variations from the specification sheet. A copy of the drawing furnished under f, including the description of the variations from the specification sheet, should be sent to the preparing activity as listed in the individual specification sheet.

g. Inspection requirements: To verify suitability of variations from category I switches. Available manufacturing test data showing compliance may be substituted as meeting these requirements at option of contracting activity.

(1) Tests to be performed (if any).

(2) The laboratory at which inspection is to be performed.

(3) Samples and submission of data if other than that specified.

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* 6.2.3 Category III switches (items not covered by specification sheets) (see 3.2.3). For switches not covered by specification sheets, the acquisition document should specify the following:

a. Title, number, and date of this specification.

b. Classification (see 1.2.1 to 1.2.4, inclusive).

c. Part number (see 3.38.1).

d. Details of design, construction, physical dimensions, and weight (see 3.5).

e. Other plastic insulation, if required (see 3.4.2.2).

f. Operating characteristics (see 3.10).

g. Inspection requirements, if other than that specified in 3.3 and 4.6 and

(1) The laboratory at which the inspection is to be performed (see 4.1).

(2) Samples and submission of data if other than that specified (see 4.6).

NOTE: Available manufacturing test data showing compliance may be substituted as meeting these requirements, at option of the acquiring activity.

h. Mounting hardware (see 3.5.1).

i. Terminal design and construction (see 3.5.2).

j. Screw-terminal hardware (see 3.5.2.2).

k. Marking (see 3.38).

l. Permanency of marking (see 3.11).

m. Fluid resistance (see 3.12).

n. Acceleration testing (see 3.19).

o. Sand and dust testing (see 3.24).

p. Actuator grounding (see 3.32).

q. Shielding efficiency test (see 3.33).

r. Altitude rating, when applicable (see 4.8.4.2 and 4.8.31.2).

s. Icing test, when applicable (see 4.8.19).

t. Electrical load conditions for explosion and electrical endurance tests, as applicable (see 4.8.21 and 4.8.31). Number of cycles for electrical endurance tests.

u. Intermediate current test, if required, and number of cycles (see 4.8.32).

v. Test voltage for dielectric withstanding voltage test at reduced barometric pressure, if necessary (see 4.8.4.2).

w. Number of cycles for mechanical endurance at full overtravel (see 4.8.26.1 and 4.8.26.2).

x. Shock-contact opening or closing other than as specified (see 3.18).

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y. Contact resistance, if other than as specified (see 3.27).

z. Low level circuit, if required, (see 4.8.33).

aa. Contact bounce, when applicable (see 4.8.24).

6.2.4 Indirect shipments. The preservation, packing and marking specified in section 5 apply only to direct purchase by or direct shipments to the Government and are not intended to apply to contracts or orders between the manufacturer and prime contractor.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, 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. The activity responsible for the qualified products list is the Naval Electronic Systems Command, Department of the Navy, Washington, D.C. 20363. Information pertaining to qualification of products may be obtained from either the Naval Electronic Systems Command or the Defense Electronic Supply Center (DESC), Dayton, Ohio 45444, Agent for Administration of the Qualified Products List. Application for qualification tests should be made in accordance with "Provisions Governing Qualification (see 6.3.1).

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

6.4 Definitions.

6.4.1 Switch assembly. Switch assembly is one or more switches that are permanently fixed to a bracket having a common actuating means, that is, lever, button, or plunger.

6.4.1.1 Sensitive/limit switch assembly. A sensitive/limit-switch assembly is one or more individual switch modules adapted to or intended for use in a nonhand-operated mode.

6.4.1.2 Manual switch assembly. A manual switch assembly is one or more switches adapted to or intended for hand operation; i.e., to be depressed or operated manually and subject to operator variations.

6.4.2 Actuator. The normal switch actuator is the mechanism of the switch or housing which, when moved as intended, will operate the contacts.

6.4.3 Actuator free position. Actuator free position is the initial actuator position when there is no external force (other than gravity) applied on the actuator.

6.4.4 Contact separation. The contact separation distance of a switch is the minimum open gap distance between the stationary and movable contacts or live parts connected thereto, with moving contact member in the open position.

6.4.5 Movement differential. Movement differential is the distance or angle through which the actuator travels from the operating position to the releasing position.

6.4.6 Actuating force or torque. Actuating force or torque is the force or torque applied to the actuator to operate the contacts.

6.4.7 Releasing force or torque. The releasing force or torque is the value to which the force or torque on the actuator must be reduced to permit the contacts to return to the unoperated position after operation.

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6.4.8 Pretravel. Pretravel is the distance or angle through which the actuator moves from free position to operating position.

6.4.9 Overtravel. Overtravel is the distance in inches or degrees between the operating position and the extreme position to which the actuator may be moved.

6.4.10 Overtravel force or torque. Overtravel force or torque is the force or torque applied to actuating mechanism to move the actuator to the overtravel limit position.

6.4.11 Contact bounce time. The contact bounce time is the total time between the initial contact and the cessation of contact openings due to transfer mechanism disturbance. Dynamic contact voltages due to resistance fluctuations or "white noise" shall not be included in contact bounce time.

6.4.12 Enclosure. An enclosure is an auxiliary housing providing protection and means for mounting and actuating of the basic switch.

6.4.12.1 Unsealed switch. Unsealed switches are switches with contact areas open to the atmosphere.

6.4.12.2 Dusttight switch. Dusttight switches are switches with contact areas sealed to meet the requirements of 3.7.1.

6.4.12.3 Watertight switch. Watertight switches are switches with contact areas sealed to meet the requirements of 3.7.2.

6.4.12.4 Resilient switch. Resilient switches are switches with contact areas sealed to meet the requirements of 3.7.3.

6.4.12.5 Hermetic switch. Hermetic switches are switches with an enclosure so constructed as to be gas tight by complete sealing of glass or ceramic to metal or bonding metal to metal by fusion. They shall meet the requirements of 3.7.4.

* 6.4.12.6 Splashproof switch. Splashproof switches are switches designed to seal the panel and contact areas to meet the requirements of 3.7.5.

6.4.13 Snap action. Snap action is that type of action in which speed of the moving contacts is relatively independent of the speed of the actuating mechanism.

6.4.14 Sensitive switch. A sensitive switch is a switch having a snap action, microgap mechanism which is operated directly by a defined force through a definite travel.

6.4.15 Cycle of operation. A cycle of operation is the movement of the actuating means through the entire range of its travel, causing the switch contacts to change from one position to another position and then return to their original position. Each stroke of the actuating means includes a full range of travel from free position to full overtravel position and return to the fully released position.

6.5 Panel seal boots. Boots, when used to provide a panel seal, should be in accordance with MIL-B-5423, "Boots, Dust and Water Seal (For Toggle and Push-Button Switches, Circuit Breakers, and Rotary-Actuated Parts), General Specificatin for".

* 6.6 Intermetallic contact. The finishing of metallic areas to be placed in intimate contact by assembly presents a special problem, since intermetallic contact of dissimilar metals results in electrolytic couples which promote corrosion through galvanic action. To provide the required corrosion protection, intermetallic couples are restricted to those permitted by MIL-STD-889.

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6.7 Application information

* 6.7.1 Electrical load handling capability. Switches have electrical load ratings specified by the specification sheet. The electrical load ratings normally reflect the maximum electrical load that the switch can properly control for a specified minimum cycles of operation. In selecting a switch for a particular application electrical load, the electrical ratings of the switch should be compatible with the application load. For application loads with sufficient voltage and current to cause arcing (approximately 8 volts and 0.5 ampere), any switch with higher electrical ratings will properly control the application load. For application loads with insufficient voltage to cause arcing but with sufficient voltage to melt the contact material, (approximately .5 to 8 volts), a switch with logic load ratings should be selected. For application loads with lower voltages (below .5 volt), a switch with low level ratings should be selected.

* 6.7.2 Control of electronic logic circuits. Contact bounce and transfer time of most sensitive, snap action basic switches is of concern when used to control devices having very fast response time. In the case of a double throw, break-before-make, snap action switch, there is no circuit through either contact during the transfer (snap over) time. Thus, there will be a definite interval between the time one circuit opens and the other closes. Associated with circuit closure is contact bounce. When the moving contact strikes the stationary contact, the kinetic energy is converted to heat and potential energy in the form of deformation of the contacts. As a result of elastic deformation the moving contact rebounds from the stationary contact, the contact pair being reclosed by the contact force. This can occur one or more times until bouncing ceases and the contact system reaches static equilibrium.

In general, the combined transfer time and bounce time will usually not exceed five milliseconds and cause no problems on slow responding devices. On fast responding electronic logic circuits, each contact bounce may be erroneously interpreted by the circuit as a separate signal causing a false output. To compensate for the contact bounce of the switch, a ten millisecond buffering circuit is usually adequate to prevent false outputs of the logic circuit.

The environmental conditions in which a switch must control a logic load level or low level electrical load may directly affect its performance in the application. Under these electrical load conditions, there is no arc present to remove contamination from the contact interfaces which prevent proper contact closure. The probability of proper contact closure under nonarcing conditions is inversely proportional to the contamination in the environment.

The detrimental effects of environmental contamination can be significantly reduced by the use of one or more of the following:

a. Sealed enclosure.

b. Contact material.

c. Contact configuration.

By enclosing the contacts in a sealed enclosure, the contacts are protected from the environment. The use of gold at the contact interface will prevent the formation of sulphides and oxides. There are two basic contact concepts specifically suited for nonarcing electrical loads:

a. Multiple-point contact designs to provide redundancy such as bifuricated contacts.

b. Point-to-plane or point-to-point contact designs such as wedge-shaped contacts, crossed-cylinder contacts, or crossed-prism contacts

6.7.3 Intermediate current capability. The intermediate current test is used to test the low energy capability of a power switch (see 4.8.32).

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* 6.7.4 Low level capability. Where a switch is intended to "make" and "break" a low level circuit, the low level test requirement should be used (see 4.8.33), and if possible, a switch with sealed contact areas should be utilized.

6.7.5 Submarine application. Switches using phenolic plastics are not to be used for submarine applications.

6.7.6 Intended usage (paralleling contacts). Contacts may be paralleled for reasons of redundancy or to reduce the total contact resistance, but they must not be paralleled with the idea of switching currents greater than the published ratings of a single contact. Another switch with suitable contact rating must be used.

6.8 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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