

MIL-S-4040D
 23 January 1969
~~SUPERSEDING~~
 MIL-S-4040C
 23 January 1958

MILITARY SPECIFICATION
SOLENOID, ELECTRICAL,
GENERAL SPECIFICATION FOR

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

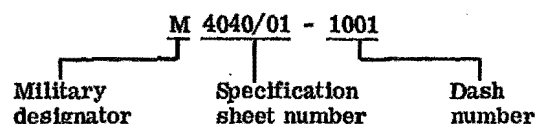
1. SCOPE

1.1 Scope. This specification covers the general requirements for electrical solenoids used to actuate various devices through the conversion of electrical signals into mechanical motion. These solenoids are of the axial stroke type in which the mechanical force is direct movement in a plane parallel to the longitudinal axis of the coil, and the rotary stroke type.

1.2 Classification. Solenoids are classified as follows:

<u>SYMBOL</u>	<u>TYPE</u>	<u>DUTY</u>	<u>ROTATION</u>
I	Pull	Continuous	-
II	Pull	Intermittent	-
III	Push	Continuous	-
IV	Push	Intermittent	-
V	Rotary	Continuous	Clockwise
VI	Rotary	Intermittent	Clockwise
VII	Rotary	Continuous	Counterclockwise
VIII	Rotary	Intermittent	Counterclockwise

1.2.1 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 (see 3.1) as shown in the following:



2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-C-320 - Chromium Plating, Electrodeposited.
 QQ-N-290 - Nickel Plating (Electrodeposited).
 QQ-P-416 - Plating Cadmium (Electrodeposited).
 QQ-S-365 - Silver Plating, Electrodeposited, General Requirements for.
 QQ-Z-325 - Zinc Coating, Electrodeposited, Requirements for.
 PPP-B-566 - Boxes, Folding, Paperboard.
 PPP-B-636 - Box, Fiberboard.
 PPP-B-676 - Boxes, Setup.
 PPP-T-60 - Tape: Pressure - Sensitive Adhesive, Waterproof for Packaging.
 PPP-T-76 - Tape: Pressure - Sensitive Adhesive, Paper (for Carton Sealing).

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MIL-M-14	- Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-W-76	- Wire and Cable, Hookup, Electrical, Insulated.
MIL-P-116	- Preservation, Methods of.
MIL-W-583	- Wire, Magnet, Electrical.
MIL-I-631	- Insulation, Electrical, Synthetic - Resin Composition, Nonrigid.
MIL-P-997	- Plastic - Material, Laminated, Thermosetting, Electrical Insulating: Sheets, Glass Cloth, Silicone Resin.
MIL-C-5015	- Connector, Electric, AN Type.
MIL-C-8384	- Connector, Plug and Receptacle, Electrical (Molded Body) and Accessories, General Specification for.
MIL-S-8805	- Switches and Switch Assemblies, Sensitive and Push.
MIL-S-12883	- Socket, for Plug-In Electric Components, and Accessories, General Specification for.
MIL-P-15037	- Plastic-Sheet, Laminated, Thermosetting, Paper-Base, Phenolic-Resin.
MIL-I-15126	- Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive.
MIL-W-16878	- Wire, Electrical, Insulated, High Temperature.
MIL-C-26074	- Coating, Nickel-Phosphorus, Electroless Nickel, Requirements for.
MIL-C-45662	- Calibration System Requirements.

STANDARDS

FEDERAL

FED-STD-406	- Plastics, Methods of Testing.
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MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-202	- Test Methods for Electronic and Electrical Component Parts.
MIL-STD-456	- Electronic Parts, Date and Source Coding for.
MIL-STD-704	- Electric Power, Aircraft, Characteristics and Utilization of.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS.

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of conflict between requirements of this specification and the specification sheets, the latter shall govern (see 6.1).

3.2 Qualification. Solenoids 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 6.2).

3.3 Preproduction inspection for solenoids not covered by specification sheets. Unless otherwise specified (see 6.1.2), solenoids furnished under this specification, not covered by specification sheets, shall be products which have been tested and have passed the inspection specified in 4.6.

3.3.1 Information to be furnished with sample. The applicable information outlined in 6.1.2 shall be furnished with the sample together with any other pertinent information as required by the Government.

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3.4 Materials. The materials shall be as specified herein. When a definite material is not specified, a suitable material shall be used which will enable the solenoids to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of acceptance of the finished product.

3.4.1 Fungus-resistant materials. Nonmetallic parts of the solenoid shall be inherently non-fungus-nutrient or treated to resist fungus growth.

3.4.2 Metals. Metals shall be of a corrosion-resistant type, or shall be plated or treated to resist corrosion.

3.4.2.1 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. A listing of materials is included in 6.3.

3.4.2.2 Plating and coating. Plating and coating shall be in accordance with QQ-N-290, QQ-C-320, QQ-S-365, QQ-P-416, QQ-Z-325, or MIL-C-26074.

3.4.3 Plastic. Unless otherwise specified herein, plastic material shall conform to MIL-M-14 for molded material and MIL-P-997 or MIL-P-15037 for laminated material. Other types of plastic materials possessing superior characteristics may be used, provided the manufacturer submits acceptable evidence to the activity responsible for qualification that such materials meet the performance requirements of MIL-M-14, MIL-P-997, or MIL-P-15037, whichever is applicable. In addition to these requirements, the plastic material shall not support combustion and shall meet the requirements of a self-extinguishing material when tested in accordance with method 2021 of FED-STD-406. Cotton or wood flour-filled thermosetting materials shall not be used.

3.4.4 Wire.

3.4.4.1 Magnet wire. Unless otherwise specified (see 3.1 or 6.1.2), magnet wire shall conform to MIL-W-583. If because of size or temperature range, magnet wire conforming to MIL-W-583 cannot be used, other suitable wire shall be used.

3.4.4.2 Lead wire. Lead wire (when applicable) shall conform to MIL-W-76 or MIL-W-16878 (see 3.1 or 6.1.2).

3.4.5 Insulating tape. Unless otherwise specified, insulating tape shall be in accordance with MIL-I-631 or MIL-I-15126 (see 3.1 or 6.1.2).

3.5 Design and construction. Solenoids shall be of the design, construction, and physical dimensions specified (see 3.1 or 6.1.2).

3.5.1 Coils. The coils shall be evenly wound and insulated to meet the performance requirements specified herein. The coils shall be completely insulated from the frame and other grounded parts, and the coil leads shall not be internally grounded. Coils shall be suitably taped and impregnated as required, to prevent damage under prolonged exposure to humidity and salt-fog environmental conditions. Coils shall be securely anchored to the frame or other stationary parts in a manner to prevent coil movement or strain on the coil leads.

3.5.2 Terminals. Terminals, including connectors, solder-type, pig-tail or lead-in wires shall be as specified (see 3.1 or 6.1.2). Terminals shall be constructed of corrosion-resistant material or shall be suitably plated to resist corrosion during service.

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3.5.2.1 Plug-in terminations. Plug-in terminations shall conform to the arrangements of dimensions necessary for proper mating with the applicable connectors or sockets covered by MIL-C-5015, MIL-C-8384 and MIL-S-12883. The mounting arrangement of the solenoid shall be so designed that the weight of the solenoid will be supported and the stability of its mounting will be provided by mounting means other than the electrical terminals of the socket. Solenoids with plug-in termination shall have the electrical and environmental tests, specified in 4., performed with the appropriate or specified socket or connector assembled to the solenoid.

3.5.2.2 Terminal marking. When specified (see 3.1 or 6.1.2), terminals shall be permanently and legibly marked.

3.5.3 Electrical contacts. When snap action switches are used, they shall conform to MIL-S-8805.

3.5.4 Case. Unless otherwise specified (see 3.1 or 6.1.2), the coil housing shall be enclosed and shall be electrically isolated from any electrical circuit and shall be magnetically shielded.

3.5.5 Mounting. The mounting means shall be an integral part of the solenoid housing or shall be securely attached thereto in a manner which will prevent any movement between the solenoid and the mounting means in service use.

3.5.6 Armature or plunger travel. The armature or plunger shall be provided with sufficient travel to completely activate the load equipment as required. Unless otherwise specified (see 3.1 or 6.1.2), positive stops shall be provided at both extremes of travel and shall be sufficiently spring-loaded to force the armature and load to the normal or deenergized position with coil deenergized and under maximum load conditions and temperature extremes.

3.5.7 Installation provisions. Clearances shall be provided for installation of power cables and mounting hardware. Unless otherwise specified (see 3.1 or 6.1.2), special installation tools shall not be required by virtue of solenoid design.

3.5.8 Solid state components. Diodes and other solid state devices shall be of sufficient ratings to withstand peak reverse voltage transients of the utilizing electrical power system. The minimum and maximum peak inverse volts (PIV) shall be as specified (see 3.1 or 6.1.2).

3.5.9 Weight (when specified, see 3.1 or 6.1.2). Solenoids shall not exceed the specified weight.

3.6 Electrical requirements.

3.6.1 Electrical characteristics.

3.6.1.1 Operating force (or torque). When solenoids are tested as specified in 4.8.2.1, the operating force (torque) shall be as specified (see 3.1 or 6.1.2). The term "force" is applicable to solenoids having linear output motion, and the term "torque" is applicable to solenoids having rotary output motion.

3.6.1.2 Compensated actuating voltage. When tested as specified in 4.8.2.2, the solenoid shall be in the energized position.

3.6.1.3 Deactuating voltage (when specified, see 3.1 or 6.1.2). When tested as specified in 4.8.2.3, the solenoid shall be in the energized position with more than maximum deactuating voltage (or current) applied, and shall be in the deenergized position with less than minimum deactuating voltage (or current) applied.

3.6.1.4 Operate and release time (when specified, see 3.1 or 6.1.2). When solenoids are tested as specified in 4.8.2.4, the time required for the solenoid to complete the energized function or to revert to the deenergized position shall not exceed the values specified (see 3.1 or 6.1.2).

3.6.1.5 Coil current. When solenoids are tested as specified in 4.8.2.5, the coil current shall not exceed specified requirements (see 3.1 or 6.1.2).

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3.6.1.6 Characteristics for airborne equipment. Electrical characteristics for airborne equipment (solenoids) shall be in accordance with MIL-STD-704.

3.6.2 Insulation resistance. When relays are tested as specified in 4.8.3, the insulation resistance (unless otherwise specified (see 3.1)), shall be 1,000 megohms or greater, except that the insulation resistance between coil and case at the maximum specified ambient temperature shall be 500 megohms or greater.

3.6.3 Dielectric withstanding voltage. When relays are tested as specified in 4.8.4, there shall be no evidence of damage, arcing, breakdown, or leakage current in excess of .5 milliamperes.

3.6.4 Mounting stud and terminal strength. When solenoids are tested as specified in 4.8.5, the mounting studs and terminals shall not loosen nor shall there be any other damage when subjected to the static values of tension and torque specified in table I. Wire lead terminals shall meet specified pull requirements.

TABLE I.

Tension and torque leads for solenoid wire leads, solder lug or hook, stud or screw, and mounting studs.

WIRE TERMINALS		THREADED TERMINALS OR MOUNTING STUDS				
Diameter inches	Pull tension (lbs)	Size	Pull tension (lbs)		Torque in pound-inches	
			Terminals	Mounting studs	Terminals	Mounting studs
.035 - .047 less than .035	4.5 2 ±0.2	4	5	7	4.4	5
		6	30	25	10.0	12
		8	35	35	20.0	20
		10	40	50	32.0	40
		1/4	50	60	75.0	80
		5/16	70	80	100.0	160
		3/8	100	115	150.0	275

3.6.5 Static spring return force (when specified, see 3.1 or 6.1.2). When solenoids are tested as specified in 4.8.6, the static spring return force shall fall within specified limits (see 3.1 or 6.1.2).

3.6.6 Magnetic effect (when specified). When solenoids are tested as specified in 4.8.7, the intensity of the magnetic field surrounding the solenoid shall not exceed the value specified (see 3.1 or 6.1.2).

3.7 Environmental requirements.

3.7.1 Thermal shock. When solenoids are tested as specified in 4.8.8, there shall be no mechanical, electrical, or operational failure, and no cracking, peeling, or flaking of the finish. During this test, operating force (torque) and deactuating voltage shall be as specified in 3.6.1.1 and 3.6.1.3, respectively. Following the test, the compensated actuating voltage shall be as specified in 3.6.1.2.

3.7.2 Solderability. When solenoids are tested as specified in 4.8.9, 95 percent of the total length of fillet, which is between the standard wrap wire and the terminal, shall be tangent to the surface of the terminal being tested. There shall be no pinholes, voids, etc. A ragged or interrupted line at the point of tangency between the fillet and the terminal under test shall be considered a defect. After the test there shall be no evidence of fracture, loosening of parts, or any other mechanical failure of solenoids.

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3.7.3 Vibration. When solenoids are tested as specified in 4.8.10, there shall be no evidence of loosening of parts or mechanical damage to the solenoid. Following this test, operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.6.1.1, 3.6.1.2, and 3.6.1.3, respectively.

3.7.4 Shock. When solenoids are tested as specified in 4.8.11, there shall be no evidence of mechanical or electrical damage, nor shall the test impair the normal operation of the solenoid. Following this test, operating force (torque), deactuating voltage (or current) (see 3.1 or 6.1.2) and compensated actuating voltage shall be as specified in 3.6.1.1, 3.6.1.3, and 3.6.1.2, respectively.

3.7.5 Acceleration (when specified, see 3.1 or 6.1.2). When tested as specified in 4.8.12, the solenoids shall meet specified requirements. During this test, the compensated actuated voltage and deactuating voltage (or current) shall be as specified in 3.6.1.2 and 3.6.1.3.

3.7.6 Moisture resistance. Unless otherwise specified (see 3.1 or 6.1.2), solenoids shall be tested in accordance with 4.8.13. There shall be no evidence of breaking, cracking, or spalling of the solenoids. Immediately after step 6 of the final cycle, the insulation resistance shall be at least 1 megohm, and the compensated actuated voltage shall be as specified in 3.6.1.2. After the 24-hour drying period, the insulation resistance shall be at least 50 megohms. The operating force (torque), deactuating voltage (or current), and compensated actuating voltage shall be as specified in 3.6.1.1, 3.6.1.3, and 3.6.1.2, respectively.

3.7.7 Altitude (when specified, see 3.1 or 6.1.2). Solenoids shall be tested as specified in 4.8.14. Following this test the insulation resistance, operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be as specified in 3.6.2, 3.6.1.1, 3.6.1.2, and 3.6.1.3, respectively.

3.7.8 High temperature. When tested as specified in 4.8.15, the solenoids shall meet the operating force (torque) requirements specified in 3.6.1.1.

3.7.9 Low temperature. When tested as specified in 4.8.16, the solenoids shall meet the operating force (torque) requirements specified in 3.6.1.1.

3.7.10 Salt spray. When solenoids are tested as specified in 4.8.17, there shall be no evidence of corrosion, or peeling, chipping, or blistering of the finish, nor exposure of base metal when inspected by the unaided eye. Following this test, the insulation resistance, operating force (torque), deactuating voltage, and compensated actuating voltage shall be as specified in 3.6.2, 3.6.1.1, 3.6.1.3, and 3.6.1.2, respectively. For sealed or encapsulated solenoids, dielectric withstanding voltage (at sea level) (see 3.6.3) shall be applicable.

3.7.11 Sand and dust (when specified, see 3.1 or 6.1.2). Solenoids shall be tested as specified in 4.8.18. Following this test, the operating force (torque), deactuating voltage (or current), and compensated actuating voltage shall be as specified in 3.6.1.1, 3.6.1.3, and 3.6.1.2, respectively.

3.7.12 Explosion (when specified, see 3.1 or 6.1.2). When tested as specified in 4.8.19, solenoids shall not ignite an ambient explosive atmosphere.

3.8 Life. When solenoids are tested as specified in 4.8.20, solenoids shall remain mechanically and electrically operative. There shall be no indication of mechanical resonance due to the frequency of the energizing voltage. Following this test, the coil resistance shall be within ± 2 percent of the pre-life value, and the insulation resistance and dielectric withstanding voltage (at sea level), shall be as specified in 3.6.2 and 3.6.3, respectively.

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3.9 Marking. Unless otherwise specified (see 3.1), solenoids shall be permanently and legibly marked with the military part number, date code, and either the manufacturer's name, trademark, symbol, or source code as shown in the following example; and, wherever space permits, the manufacturer's part number, and the rated voltage (or current), and operating frequency. Paper labels shall not be used. Other markings which in any way interfere with, obscure, or confuse those specified herein, are prohibited. The marking shall remain legible after all tests.

Example:	M4040/ }	- Military part number
	01-1001 }	- Manufacturer's source code
	12345	- Date code
	6824	

3.9.1 Military part number. The military part number shall be in accordance with 1.2.1.

3.9.2 Date code and manufacturer's source code. The date code and manufacturer's source code shall be in accordance with MIL-STD-456.

3.10 Workmanship. Solenoids shall be processed so that they are uniform in quality and shall be free from cracked or deformed parts, sharp edges, burrs or other defects which will affect life, serviceability, or appearance.

4. QUALITY ASSURANCE PROVISIONS.

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

4.1.1 Test equipment and inspection facilities. The supplier shall establish and maintain a calibration system in accordance with MIL-C-45682.

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) Preproduction inspection (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 II, used in fabricating the solenoids, are in accordance with the applicable referenced specifications or requirements prior to such fabrication.

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TABLE II. Materials inspection.

Material	Requirement paragraph	Applicable specification
Plating and coating	3.4.2.2	QQ-N-290 QQ-C-320 QQ-S-365 QQ-P-416 QQ-Z-325 MIL-C-26074
Plastic	3.4.3	MIL-M-14 MIL-P-997 MIL-P-15037
Magnet wire	3.4.4.1	MIL-W-583
Lead wire	3.4.4.2	MIL-W-76 MIL-W-16878
Insulating tape	3.4.5	MIL-I-631 MIL-I-15126

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 6.2) on sample units produced with equipment and procedures normally used in production.

4.5.1 Sample size. Twelve solenoids shall be subjected to qualification inspection.

4.5.2 Inspection routine. The sample shall be subjected to the inspections specified in table III, in the order shown, except that groups II and III may be conducted concurrently. All sample units shall be subjected to the inspection of group I. The sample shall then be divided equally into two groups of six units each and subjected to the inspection for their particular group.

TABLE III. Qualification inspection.

Examination or test	Requirement paragraph	Method paragraph	No. of sample units to be inspected	No. of failures
<u>Group I</u>				
Visual and mechanical	3.1, 3.4, 3.5, 3.8, and 3.10	4.8.1	} 12	} 0
Electrical characteristics	3.6.1	4.8.2		
Insulation resistance	3.6.2	4.8.3		
Dielectric withstanding voltage (at sea level)	3.6.3	4.8.4.1		

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TABLE III. Qualification inspection. - Continued

Examination or test	Requirement paragraph	Method paragraph	No. of sample units to be inspected	No. of failures
<u>Group II</u>				
Thermal shock	3.7.1	4.8.8	6	0
Solderability	3.7.2	4.8.9		
Vibration	3.7.3	4.8.10		
Shock	3.7.4	4.8.11		
Mounting stud and terminal strength	3.6.4	4.8.5		
Acceleration (when specified)	3.7.5	4.8.12		
Moisture resistance	3.7.6	4.8.13		
Static spring return force (when specified)	3.6.5	4.8.6		
Life ^{1/}	3.8	4.8.20		
<u>Group III</u>				
Magnetic effect (when specified)	3.6.6	4.8.7	6	0
Altitude (when specified)	3.7.7	4.8.14		
High temperature	3.7.8	4.8.15		
Low temperature	3.7.9	4.8.16		
Salt spray	3.7.10	4.8.17		
Sand and dust (when specified)	3.7.11	4.8.18		
Static spring return force (when specified)	3.6.5	4.8.6		
Explosion (when specified)	3.7.12	4.8.19		
Life ^{1/}	3.8	4.8.20		

^{1/} 3 samples only

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

4.5.4 Retention of qualification. To retain qualification, the supplier shall forward, at 12-month intervals, to the qualifying activity, a summary of the results of group A tests, indicating as a minimum the number of lots which passed and the number which failed, and a summary of the results of group B tests, including the number and type of any part failures. The summary shall include those tests performed during that 12-month period. If the summary of the test results indicates nonconformance with specification requirements, action shall be taken to remove the failing product from the qualified products list. Failure to submit the summary shall result in loss of qualification for that product. In addition to the periodic submission of inspection data, the supplier shall immediately notify the qualifying activity at any time during the 12-month period that the inspection data indicates failure of the qualified product to meet the requirements of the specification. In the event that no production occurred during the reporting period, a negative report shall be submitted.

4.6 Preproduction inspection. Preproduction inspection shall be performed by the supplier, after award of contract and prior to production, at a location acceptable to the Government. Preproduction inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. Preproduction approval is valid only on the contract or purchase order under which it is granted, unless extended by the Government to other contracts or purchase orders.

4.6.1 Inspection routine. Unless otherwise specified (see 6.1.2), the samples and test routine shall be identical to those required for qualification.

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4.6.2 Failures. One or more failures shall be cause for refusal to grant preproduction approval.

4.7 Quality conformance inspection.

4.7.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection. Except as specified in 4.7.4.1.4, delivery of products which have passed the group A inspection shall not be delayed pending the results of the group B inspection.

4.7.2 Inspection lot. An inspection lot, shall consist of one week's production of solenoids of the same design, materials, and production processes, produced under essentially the same conditions and offered for inspection at one time. Where production is less than 200 solenoids per week, a lot shall consist of two consecutive weeks production and the date code shall indicate that the solenoids were produced during the first week.

4.7.3 Group A inspection. Group A inspection shall consist of the examinations and tests specified in table IV, in the order shown.

TABLE IV. Group A inspection.

Examination or test	Requirement paragraph	Method paragraph	AQL (percent defective)	
			Major	Minor
<u>Subgroup 1</u>				
Dielectric withstanding voltage	3. 6. 3	4. 8. 4	100% inspection	
<u>Subgroup 2</u>				
Coil current	3. 6. 1. 5	4. 8. 2. 5	0. 65	4. 0
Compensated actuating voltage	3. 6. 1. 2	4. 8. 2. 2	0. 65	
Insulation resistance	3. 6. 2	4. 8. 3	0. 65	
Visual and mechanical examination	3. 4, 3. 5, 3. 9 and 3. 10	4. 8. 1	1. 0	
Deactuating voltage (when specified)	3. 6. 1. 3	4. 8. 2. 3	1. 0	
Operate and release time (when specified)	3. 6. 1. 4	4. 8. 2. 4	1. 0	

4.7.3.1 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 IV. Major and minor defects shall be as defined in MIL-STD-105.

4.7.3.2 Rejected lots. If an inspection lot is rejected, the supplier 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.

4.7.4 Periodic inspection. Periodic inspection shall consist of group B inspection.

4.7.4.1 Group B inspection. Group B inspection shall consist of the examinations and tests specified in table V, in the order shown. Group B inspection shall be made on sample units selected from inspection lots which have passed the group A inspection.

4.7.4.1.1 Sampling plan. Eight sample units shall be selected from those covered by a single specification sheet, 12 months after the date of notification of qualification, and after each subsequent 12-month period.

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4.7.4.1.2 **Defectives.** If the number of defectives exceed the number allowed in table V, the sample shall be considered to have failed.

TABLE V. Group B inspection.

Examination or test	Requirement paragraph	Test method paragraph	Number of sample units to be inspected	Number of defectives permitted
<u>Subgroup 1</u>				
Thermal shock	3.7.1	4.8.8	4	1
Vibration	3.7.3	4.8.10		
Shock	3.7.4	4.8.11		
Mounting stud and terminal strength	3.6.4	4.8.5		
Acceleration (when specified)	3.7.5	4.8.12		
Moisture resistance	3.7.6	4.8.13		
Life	3.8	4.8.20		
<u>Subgroup 2</u>				
Magnetic effect (when specified)	3.6.6	4.8.7	4	1
Altitude (when specified)	3.7.7	4.8.14		
Salt spray	3.7.10	4.8.17		
Sand and Dust (when specified)	3.7.11	4.8.18		
Explosion (when specified)	3.7.12	4.8.19		
High temperature	3.7.8	4.8.15		
Dielectric withstanding voltage (high altitude)	3.6.3	4.8.4.2		

4.7.4.1.3 **Disposition of sample units.** Sample units which have been subjected to group B inspection shall not be delivered on the contract or purchase order.

4.7.4.1.4 **Noncompliance.** If a sample fails to pass group B inspection, the supplier 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, etc, 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 (all 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 corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7.5 **Inspection of preparation for delivery.** Sample packages or packs and the inspection of the preservation, packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 or the documents specified herein.

4.8 Methods of examination and test.

4.8.1 **Visual and mechanical examination.** Solenoids shall be examined to verify that the materials, design, construction, physical dimensions, marking, and workmanship are in accordance with the specified requirements (see 3.1, 3.4, 3.5, 3.9 and 3.10).

4.8.2 Electrical characteristics.

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4.8.2.1 Operating force (torque) (see 3.6.1.1). Unless otherwise specified (see 3.1), the operating force (torque) of the solenoids shall be tested in accordance with the following details:

4.8.2.1.1 For qualification inspection,

- (a) Points of measurement.
 - (1) At the beginning of the solenoid's stroke (0-5 percent).
 - (2) Full stroke force or torque (95-100 percent of stroke (when specified, see 3.1 or 6.1.2)).
 - (3) Holding force (when specified, see 3.1 or 6.1.2).
- (b) Magnitude of test voltage and temperature. The test shall be conducted at the value values of the upper and lower, and lower and upper limits of the voltage and temperature ranges, respectively.
- (c) Nature of potential. With specified load (see 3.1 or 6.1.2) applied to the solenoid.
- (d) Duration of applied voltage. The duty cycle of intermittent duty solenoids shall not be exceeded.
- (e) Attitude(s) during testing: See 3.1 or 6.1.2.
- (f) Applied load. A static load equal to the specified force (torque) (see 3.1 or 6.1.2) shall be applied to the armature or plunger.
- (g) Force (torque) measurement. With the solenoid mounted in the specified attitude(s) and ambient temperature, and with a load in accordance with (f) above, the output force (torque) shall equal or exceed the static output force (torque) with the specified voltage applied to the coil.

4.8.2.1.2 For quality conformance inspection.

- (a) Points of measurement.
 - (1) At the beginning of the solenoid's stroke (0-5 percent).
- (b) Magnitude of test voltage and temperature. The test voltage shall be equivalent to that of minimum voltage at maximum rated temperature (see 4.8.2.2).

In addition, 4.8.2.1.1 (c) thru (g) are applicable.

4.8.2.2 Compensated actuating voltage (see 3.6.1.2). Unless otherwise specified (see 3.1 or 6.1.2), the compensated actuating voltage of the solenoids shall be tested in accordance with the following details.

- (a) Magnitude of test voltage and temperature. The test shall be conducted at the voltage equivalent to minimum voltage at maximum temperature.
- (b) Nature of potential - See 3.1 or 6.1.2.
- (c) Duration of applied voltage. The duty cycle of the intermittent duty solenoids shall not be exceeded (see 3.1 or 6.1.2).
- (d) Mounting the solenoid for test. The solenoid shall be mounted by its normal mounting means and in its normal mounting attitude.

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- (e) Temperature and load. With the solenoid at stabilized temperature of $25 \pm 2^\circ \text{C}$, the solenoids shall generate sufficient mechanical force (or torque) at the specified compensated actuating voltage (or current) (see 3.1 or 6.1.2) to cause full plunger (or armature) travel in the energized position against the specified (see 3.1 or 6.1.2) value of load (force or torque).

- (f) Observe position of armature.

4.8.2.3 Deactuating voltage (or current) (see 3.6.1.3). With rated mechanical load attached to the armature or plunger as specified (see 3.1 or 6.1.2), the solenoid shall be energized with rated load applied. Reduce the voltage (or current) to a value equal to the maximum deactuating voltage specified. Observe position of armature. Further reduce the voltage (or current) to a value equal to the minimum deactuating voltage specified (see 3.1 or 6.1.2). Observe position of armature. For qualification inspection, unless otherwise specified (see 3.1 or 6.1.2), the deactuating voltage (or current) shall fall within the required limits when the solenoid is mounted in each of three mutually perpendicular planes, one of which shall be that where the plunger gravity force opposes the return spring force.

4.8.2.4 Operate and release time (see 3.6.1.4). Nominal rated voltage (or current) (see 3.1 or 6.1.2) shall be applied to the solenoid. The test shall be performed with the solenoid at stabilized $25^\circ \pm 2^\circ \text{C}$ and at rated high and low temperatures. Time interval between (a) application of voltage (or current) and full travel of the solenoid and (b) time interval between removal of voltage (or current) and full return travel of the plunger or armature to the deenergized position shall be measured.

4.8.2.5 Coil current (see 3.6.1.5). Coil current shall be measured with (a) the coil at stabilized ambient temperature of $25^\circ \pm 2^\circ \text{C}$ and rated voltage, and (b) coil at stabilized low temperature rating and maximum rated voltage (see 3.1). The current shall be measured within 10 seconds of application of coil voltage.

4.8.3 Insulation resistance (see 3.6.2). Solenoids shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

- (a) Test condition letter - A, for solenoids having a voltage rating of less than 60; B, for solenoids having a voltage rating of 60 or greater.
- (b) Point of measurement - Between the coil and case.

4.8.4 Dielectric withstanding voltage (see 3.6.3).

4.8.4.1 At sea level. Solenoids shall be tested in accordance with method 301 of MIL-STD-202. The following details shall apply:

- (a) Magnitude of test voltage - The magnitude of the test potential shall be based on the coil voltage rating. (See table VI).
- (b) Nature of potential - alternating current (ac).
- (c) Duration of test voltage - 5 to 15 seconds for quality conformance inspection.
- (d) Point of application of test voltage - Between the coil and case.

After the test, solenoids shall be examined for any evidence of damage, arcing, and breakdown, and leakage current shall be measured.

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TABLE VI. Dielectric withstanding voltage (at sea level) potential.

Voltage rating	RMS test voltage
< 60 - - - - -	1,000
60 to 250, incl - - - - -	1,500 + rated voltage
Over 250 to 500, incl - - - - -	2 X voltage rating + 1,000

4.8.4.2 At reduced barometric pressure (high altitude). Solenoids shall be tested in accordance with method 106 of MIL-STD-202. The following details shall apply:

- (a) Test condition letter - See 3.1 or 6.1.2.
- (b) Magnitude of test voltage - The magnitude of the test potential shall be 350 ± 10 volts.
- (c) Nature of potential - alternating current (ac).
- (d) Duration of test voltage - 5 to 15 seconds for quality conformance inspection.
- (e) Point of application of test voltage - Between the coil terminals and the case.

After the test, solenoids shall be examined for any evidence of damage, arcing, and breakdown, and leakage current shall be measured.

4.8.5 Mounting stud and terminal strength (see 3.6.4). The solenoid studs, as applicable, shall be subjected to the tensile and torque loads specified in 3.6.4 and applied parallel to the axis of the studs for a period of 1 minute. There shall be no mechanical failure resulting from these tests. Lead wire terminals No. 22 AWG or larger shall be subjected to 4.5 pounds pull for a minimum of 30 seconds. There shall be no mechanical or electrical impairment resulting from the test. Lead wires smaller than No. 22 AWG shall be tested as specified (see 3.1 or 6.1.2).

4.8.6 Static spring return force (see 3.6.5). The static spring return force (torque) shall be measured in pounds or pound-inches at the following percentages of plunger travel (with coil deenergized): (0-5) (95-100). The attitude of the solenoid during test shall be such that the plunger gravity force does not oppose the spring force (torque).

4.8.7 Magnetic effect (see 3.6.6). The solenoid shall not produce a magnetic field greater than the field produced by a straight bus bar carrying a direct current of 15 times the coil current of the solenoid. The coil current shall be that produced when the temperature of the coils is $25^\circ \pm 2^\circ$ C and maximum operating voltage is impressed thereon. The field shall be measured by a suitable fluxmeter with the search coil adjacent to the coil housing or bus bar in the position causing greatest deflection of the meter.

4.8.8 Thermal shock (see 3.7.1). Solenoids shall be tested in accordance with method 107 of MIL-STD-202. The following details shall apply:

- (a) Test condition - See 3.1 or 6.1.2. Exposure time shall be 1 hour at each temperature extreme.
- (b) Measurement during cycling. During the last 10 minutes of the fifth temperature cycle at both high and low temperatures, the solenoid shall meet requirements of operating force (torque) (see 3.6.1.1) and deactuating voltage (or current) (see 3.6.1.3) and return to room temperature.
- (c) Measurements after cycling. Compensated actuating voltage shall be tested as specified in 4.8.2.2. The solenoids shall then be examined for cracking, peeling and flaking of the case and finish.

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4.8.9 Solderability (see 3.7.2). Solenoids having solderable terminals shall be tested in accordance with method 208 of MIL-STD-202 except the dipping device need not be used.

- (a) Number of terminations of each part to be tested - 2.
- (b) Solder dip - Not applicable.
- (c) Examination of terminations - fillet area.

4.8.10 Vibration (see 3.7.3). The solenoids shall be tested in accordance with method 204 of MIL-STD-202. The following details shall apply:

- (a) Mounting - Solenoids shall be rigidly mounted by a normal mounting means in a suitable test jig. The vibration shall be monitored on top of the test jig as near as practicable to the solenoids support points.
- (b) Electrical-load conditions - The solenoids shall be energized with rated coil voltage (or current) for half the required test time and deenergized for half the required test time in each of the three mutually perpendicular directions.
- (c) Test condition letter - See 3.1 or 6.1.2.
- (d) Tests and measurements after vibration - After vibration, operating force (torque), compensated actuating voltage, and deactuating voltage (or current) shall be tested as specified in 4.8.2.1, 4.8.2.2, and 4.8.2.3, respectively. Solenoids shall be examined externally for evidence of damage such as cracks or loosening of parts.

4.8.11 Shock (see 3.7.4). Solenoids shall be tested in accordance with 4.8.11.1, 4.8.11.2, or 4.8.11.3, as applicable (see 3.1).

4.8.11.1 Shock 1. Solenoids shall be tested in accordance with method 205 of MIL-STD-202. The following details shall apply:

- (a) Test condition letter - C.
- (b) Electrical operating conditions - In each direction of shock the coil shall be deenergized during two shocks and energized with rated voltage (or current) during one shock.
- (c) Measurements after shock - Following this test, the operating force (torque), compensated actuating voltage and deactuating voltage (or current) shall be tested as specified in 4.8.2.1, 4.8.2.2, and 4.8.2.3, respectively.

4.8.11.2 Shock 2. Solenoids shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

- (a) Mounting method and accessories - Normal mounting means.
- (b) Test condition letter - A.
- (c) Electrical operating conditions - As specified in 4.8.11.1 (b).
- (d) Measurements after shock - As specified in 4.8.11.1 (c).

Following the shock test there shall be no evidence of mechanical or electrical damage, nor shall the test impair the normal operation of the solenoid.

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4.8.11.3 Shock 3. Solenoids shall be tested in accordance with method 207 of MIL-STD-202. The following details shall apply:

- (a) Mounting fixtures - Normal.
- (b) Height of hammer drop - See 3.1 or 6.1.2.
- (c) Electrical operating conditions - As specified in 4.8.11.1 (b).
- (d) Measurements after shock - Following this test, operating force (torque), compensated actuating voltage, and deactuating voltage shall be tested as specified in 4.8.2.1, 4.8.2.2, and 4.8.2.3, respectively. There shall be no evidence of mechanical or electrical damage or impairment of the operation of the solenoid.

4.8.12 Acceleration (see 3.7.5). The solenoids shall be rigidly mounted on the centrifuge and then subjected to an acceleration force of 10g in both directions in three mutually perpendicular axes one of which is parallel to the longitudinal axis of the solenoid coil. During the test the solenoids shall deliver the specified actuating force within the specified voltage limits (see 3.1 or 6.1.2).

4.8.13 Moisture resistance (see 3.7.6). Solenoids shall be tested in accordance with method 106 of MIL-STD-202. The following details shall apply:

- (a) Mounting - On a corrosion-resistant metal panel, by normal mounting means.
- (b) Initial measurement. Insulation resistance as specified in 4.8.3.
- (c) Polarization - During steps 1 to 6 inclusive, 100 volts dc shall be applied between the coil (positive) and the mounting frame (negative) of one-half of the solenoids. Within 5 minutes after the end of the conditioning, the operating force (torque) shall be tested as specified in 4.8.2.1.
- (d) Final measurements - After a 24-hour drying period at a relative humidity of 50 \pm 5 percent, solenoids shall be examined for evidence of breaking, cracking, spalling, and loosening of the terminals; and the insulation resistance, operating force (torque), deactuating voltage (or current), and compensated actuating voltage shall be tested as specified in 4.8.3, 4.8.2.1, 4.8.2.3, and 4.8.2.2, respectively.

4.8.14 Altitude (see 3.7.7). Solenoids shall be tested in accordance with method 105 of MIL-STD-202. The following details shall apply:

- (a) Mounting. Solenoids shall be rigidly mounted by their normal mounting means.
- (b) Test condition letter - See 3.1 or 6.1.2.
- (c) Tests during subjection to reduced pressure - With the complete solenoid at stabilized ambient temperature of 25 \pm 2° C, measure coil resistance with \pm 0.5 percent accuracy. Then with pressure reduced to the specified altitude and the ambient temperature specified for altitude conditions (see 3.1 or 6.1.2), the solenoid with the coil energized with maximum rated voltage, shall be subjected to the specified conditions for a minimum of two hours. The duty cycle of intermittent duty solenoids shall be as specified (see 3.1 or 6.1.2). Within the last 5 to 10 minutes of the exposure to reduced pressure, coil resistance shall be measured in order to enable calculation of the coil temperature. The calculated coil temperature shall be within the temperature limits of the coil magnet wire. Immediately following coil resistance measurement, compensated actuating voltage shall be tested as specified in 4.8.2.2 with the solenoid in its normal attitude. Immediately following the compensated actuating voltage test, dielectric withstanding voltage shall be tested as specified in 4.8.4.2 at maximum rated altitude. After return to room temperature and sea level pressure, insulation resistance, operating force (torque), deactuating voltage, and compensated actuating voltage shall be tested as specified in 4.8.3, 4.8.2.1, 4.8.2.3, and 4.8.2.2,

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4.8.15 High temperature (see 3.7.8). The solenoid shall be energized with rated voltage and 98-102 percent of rated load and shall be subjected to maximum rated ambient temperature and maximum rated altitude for a period of 2 hours. Immediately at the end of the conditioning and while in the specified ambient temperature, operating force test specified in 4.8.2.1 shall be performed.

4.8.16 Low temperature (see 3.7.9). The solenoid deenergized shall be subjected to the specified minimum temperature condition (see 3.1) for at least 4 hours. At the end of the conditioning and while still subjected to the low temperature, with minimum rated voltage applied, operating force test specified in 4.8.2.1 shall be performed.

4.8.17 Salt spray. Solenoids shall be tested in accordance with method 101 of MIL-STD-202. The following details shall apply:

- (a) Applicable salt solution - 5 percent.
- (b) Test-condition letter - B.
- (c) Measurements after exposure - After exposure, solenoids shall be washed, shaken, and air blasted, and then permitted to dry for 24 hours at room temperature. Solenoids shall then be examined for evidence of corrosion, peeling, chipping, and blistering of the finish, and exposure of base metal. The insulation resistance, dielectric withstanding voltage (sea level), operating force (torque), deactuating voltage (or current), and compensated actuating voltage shall be tested as specified in 4.8.3, 4.8.4, 4.8.2.1, 4.8.2.3, and 4.8.2.2, respectively.

4.8.18 Sand and dust. Solenoids shall be tested in accordance with method 110 of MIL-STD-202. The following details shall apply:

- (a) Test-condition letter - A.
- (b) Measurements - At the end of the test period, operating force (torque), deactuating voltage (or current), and compensated actuating voltage shall be tested as specified in 4.8.2.1, 4.8.2.3, and 4.8.2.2, respectively.

4.8.19 Explosion. Solenoids shall be tested in accordance with method 109 of MIL-STD-202. The following details shall apply:

- (a) Mechanical and electrical load - rated voltage and no mechanical load.
- (b) Chamber temperature condition - See 3.1 or 6.1.2.

4.8.20 Life (see 3.8). Measure coil resistance. Solenoids shall then be tested for life cycle with specified load (see 3.1 or 6.1.2). Each solenoid shall be connected to a load in the range of 95 to 100 percent of that specified for the maximum operating force. Continuous duty rating solenoids shall be subjected to an ambient temperature of $25^{\circ} \pm 2^{\circ}$ C for a period of 168 hours with the coil energized with rated voltage (or current). Intermittent duty solenoids shall be energized for 168 hours at $25^{\circ} \pm 2^{\circ}$ C ambient temperature and with a continuous voltage (or current) such that the watts input shall be equal to the product of rated input watts times duty cycle. The solenoid shall then be operated for a minimum of 25,000 operations; 12,500 at the maximum rated temperature, and 12,500 at the minimum rated temperature. The rate of cycling shall be 10 cycles per minute minimum with coil energized approximately 66 percent of the cycle and deenergized approximately 33 percent of the cycle. For intermittent duty solenoids, the duty cycle shall be as specified (see 3.1 or 6.1.2). Following the test, the coil resistance shall be measured, and insulation resistance and dielectric withstanding voltage (at sea level) shall be tested as specified in 4.8.3 and 4.8.4, respectively.

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5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be level A or C, as specified (see 6.1).

5.1.1 Level A.

5.1.1.1 Cleaning. Solenoids shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Solenoids shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. None required.

5.1.1.4 Unit packaging. Unless otherwise specified, each solenoid shall be individually packaged in accordance with MIL-P-116, method 1A8, insuring compliance with the general requirements paragraph under methods of preservation (unit protection) and the physical protection requirements paragraph therein. Unit packages which exceed 20 cubic inches shall be placed in a supplementary container conforming to PPP-B-566 or PPP-B-676.

5.1.1.5 Intermediate packaging. Solenoids, packaged as described in 5.1.1.4, and when the unit container is not already a carton, shall be placed in intermediate containers conforming to PPP-B-566 or PPP-B-676. Intermediate containers shall be uniform in size, shape, and quantities, shall be of minimum tare and cube, and shall contain multiples of five unit packages, not to exceed 100 packages or ten pounds. No intermediate packaging is required when the total quantity shipped to a single destination is less than 50 units.

5.1.2 Level C. Each cleaned and dried solenoid shall be individually packaged in a manner that will afford adequate protection against corrosion, deterioration, and physical damage during shipment from supply source to the first receiving activity.

5.2 Packing. Packing shall be level A, B, or C, as specified (see 6.1).

5.2.1 Level A. The packaged solenoids shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirement. In lieu of the closure and waterproofing requirements in the appendix of PPP-B-636, closures and waterproofing shall be accomplished by sealing all seams, corners, and manufacturer's joints with tape, 2 inches minimum width, conforming to PPP-T-60, class 1, or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636, using nonmetallic or tape banding only.

5.2.2 Level B. The packaged solenoids shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirement. Closures shall be in accordance with the appendix thereto. For Army, fiberboard container shall be class weather-resistant, as specified in level A.

5.2.3 Level C. The packaged solenoids shall be packed in shipping containers in a manner that will afford adequate protection against damage during direct shipment from the supply source to the first receiving activity. This pack shall conform to the applicable carrier rules and regulations.

5.3 Marking. In addition to any special marking required by the contract or order, each unit package, intermediate, and exterior container shall be marked in accordance with MIL-STD-129.

5.4 General. Exterior containers shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent possible.

5.5 Inspection. Inspection of military packaging shall be in accordance with 4.7.5.

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6. NOTES

6.1 Ordering data.

6.1.1 Solenoids for which specification sheets (see 3.1) have been established. For solenoids covered by specification sheets, the procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Title, number, and date of the applicable specification sheet.
- (c) Military part number.
- (d) Levels of preservation, packaging, packing, and marking (see section 5).

6.1.2 Solenoids for which specification sheets have not been established. For solenoids not covered by specification sheets, the procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) The specific type and style solenoid required.
- (c) Electrical requirements.
- (d) Design and construction.
- (e) Environmental requirements.
- (f) Levels of preservation, packaging, and packing and applicable container marking (see 5.1).
- (g) Requirements for test plan and details regarding submission (see 4.6).
- (h) Requirements for test reports and details regarding submission. (See 4.6).
- (i) Manufacturer's part number.

6.2 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 listed by that date. The attention of the suppliers 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 Air Force Logistics Command, Department of the Air Force, Attn: SGEB, Wright-Patterson Air Force Base, Dayton, Ohio 45433; however, information pertaining to qualification of products may be obtained from the Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45401. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification" (see 6.2.1).

6.2.1 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

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6.3 Grouping of metals. The grouping specified below is intended to serve as a guide in selecting materials to be used in electronic equipment, and should not be construed to waive requirements herein or in the applicable specification sheet to corrosion resistance of components and assemblies.

I	II	III	IV
Magnesium alloys (most anodic)	Aluminum Aluminum alloys Zinc Cadmium Tin Corrosion resistant steel	Zinc Cadmium Steel Lead Tin Corrosion resistant steel	Copper and copper alloys Nickel and nickel alloys Chromium Corrosion resistant steel Gold Silver (most cathodic)

6.3.1 Application. Unless specifically approved by the Government, all metals not listed in 6.3 should be considered dissimilar with respect to one another and with respect to any of the materials listed. Except for zinc, cadmium, and tin as listed in groups II and III, and for corrosion resistant steel as listed in groups II, III, and IV, contact between a member of one group and a member of any other group should be considered dissimilar. Such contact should not be made unless necessary, in which case it should be demonstrated that the contact is not detrimental. When reference is made to a metal in a particular group, the reference applies to the metal on the surface of the part; that is, zinc means zinc coating as well as zinc electroplate, zinc hotdip, or zinc metal spray. Different metals in contact, even though similar, should be employed in assemblies in such a manner that the smaller part is cathodic (or protected) and the larger part is anodic (or corroded) if any corrosion takes place. Care should be exercised in using different aluminum alloys against each other or against differing material.

6.4 Definitions.

6.4.1 Deactuating voltage. The coil voltage at which the coil releases the plunger or armature to its deenergized position with rated mechanical load.

6.4.2 Maximum operating voltage. The maximum anticipated voltage at which a solenoid will be required to operate.

6.4.3 Minimum operating voltage. The minimum anticipated voltage at which a solenoid will be required to operate.

6.4.4 Rated stroke. The linear or angular (as applicable) travel of the armature from the deenergized position to the energized position.

6.4.5 Compensated actuating voltage. The voltage that will provide at $25^{\circ} \pm 2^{\circ} \text{ C}$ stabilized solenoid temperature a force equivalent to that produced at maximum rated temperature and minimum rated voltage.

6.4.6 Rated force. The force in pounds a solenoid will produce at rated stroke and minimum in voltage and over specified temperature range in accordance with the characteristic curve submitted by the manufacturer.

6.4.7 Rated torque. The torque in pound-inches a solenoid will produce at rated stroke and minimum voltage over specified temperature range in accordance with the characteristic curve submitted by the manufacturer.

6.4.8 Return force. The spring force in pounds available to move the solenoid armature and load to their deenergized position.

6.4.9 Return torque. The torque in pound-inches available to return the armature from its energized position.

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6.4.10 Net starting torque. The static torque produced by the solenoid within 0 to 5 percent of rated stroke when rated voltage is applied.

6.4.11 Duty cycle. The duty cycle is the ratio of the "on" time to the total time.

Example:

$$\text{Duty cycle} = \frac{\text{time on} \times 100}{\text{time on} + \text{time off}} \%$$

6.4.12 Continuous duty solenoid. A solenoid that is capable of operating for periods of 1 hour or more without damage or malfunction.

6.4.13 Intermittent duty solenoid. A solenoid that is capable of operating at the specified duty cycle without damage or malfunction with energized periods less than 1/2 hour.

6.4.14 Rotation. Rotation is defined as clockwise when the shaft moves clockwise with respect to the frame, and counterclockwise conversely. For double shaft extension solenoids, the shaft opposite the mounting means shall be the referent.

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

Custodians:
Army - EL
Navy - EC
Air Force - 85

Preparing activity:
Air Force - 85

(Project 5945-0063)

Review activities:
Army - EL
Navy - EC
Air Force - 11
DSA - ES

User activities:
Army -
Navy -
Air Force -