



Global Battery Performance and Test Specification for Cars and Light-Duty Trucks

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This specification applies to rechargeable global common batteries for original equipment use in all GM global common passenger car and light-duty truck applications worldwide, and it describes their operating requirements. The mission of this document is to list the requirements for automotive Starting, Lighting, and Ignition (SLI) batteries. The battery is part of the vehicle Charging and Energy Storage System.

Note: The term "GM" includes all GM vehicle manufacturers.

1.2 Applicability. This specification is applicable to all future global common batteries used in GM passenger car and light-duty truck vehicles and is intended to promote uniformity of application across all future GM passenger car and light-duty truck vehicles.

1.3 Remarks. In the event of a conflict between the text of this document and the documents cited herein, the text of this document takes precedence.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

EN 50342	IEC 60095-2	SAE J240	SAE J1495
IATF 16949	ISO 17025	SAE J537	SAE J2801

2.2 GM Standards/Specifications.

GMW3059	GMW14093	GMW14573	GMW16449
GMW3172	GMW14555		

2.3 Additional References.

- Battery part drawing
- General Procedure No. 11 (GP11)
- Statement of Requirements (SOR)

3 Requirements

3.1 System/Subsystem/Component/Part Definition. Component Overview. The battery is part of the vehicle Charging and Energy Storage System and is capable of the following:

- Chemically storing electrical energy from the generator
- Delivering energy to vehicle components for SLI
- Providing energy for parasitic (key-off) loads
- Providing energy when electrical loads exceeds what can be supplied by the generator

3.1.1 Appearance. The battery shall have an appearance specified in the SOR.

3.1.2 Content. The required physical and functional content for the battery is identified 3.1.2.1.

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3.1.2.1 Physical Content.

3.1.2.1.1 The battery shall have a positive terminal and a negative terminal. See Figure 1.

3.1.2.1.2 The battery shall have a mounting provision.

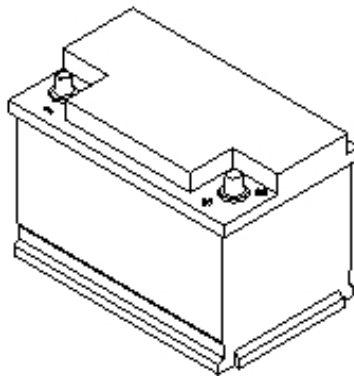
3.1.2.1.3 The battery shall provide a means with a sealed flame arrester to vent internal gases.

3.1.2.1.4 The battery shall have an identification/caution label, according to legal requirements and GMW14573, Global Performance Requirements for Labels. See Appendix B, Table B1 of this standard for further details.

3.1.2.1.5 The battery shall have a permanent assembly and production date code, as specified in the SOR.

3.1.2.1.6 The battery may have a built-in, easy to interpret, service diagnostic indicator for troubleshooting if specified in the SOR.

Figure 1: Battery with Terminals

**3.1.2.2 Functional Content.**

3.1.2.2.1 The battery shall chemically store electrical energy from the automotive generator or external charging device.

3.1.2.2.2 The battery shall deliver energy to the vehicle for starting (cranking and ignition).

3.1.2.2.3 The battery shall deliver energy to the vehicle for key-off or parasitic loads.

3.1.2.2.4 The battery shall deliver energy to vehicle electrical components when electrical demands exceed what can be supplied by the generator.

3.1.2.2.5 The battery shall be a nominal 12 V, and the terminal open circuit voltage at 100% capacity shall be nominally 12.8 V, after recharging and 24 h of standing.

3.1.3 Ambient Environment.

3.1.3.1 Except for temperature, all of the environmental conditions associated with Section 3 and Section 4 are a set which is expected to be representative for battery environmental load conditions in all GM vehicles.

3.1.3.2 The battery shall be capable of operating with electrolyte temperatures from -40 °C to 105 °C (-40 °F to 221 °F) with no reduction of material strength and no acid leaks. The battery shall continue to function at the high temperature excursions, but may experience degraded life performance. The battery shall operate in the environment and durability conditions defined in GMW3172, General Specification for Electrical/Electronic Component to Vehicle Environmental, Reliability, and Performance Requirements.

3.1.3.3 The battery shall be capable of meeting all performance, quality, reliability, and durability requirements with a maximum continuous electrolyte temperature of 65 °C (149 °F) and peak temperatures of 75 °C (167 °F) as measured per GMW14555. The battery shall be able to survive electrolyte temperature excursions to 105 °C (221 °F) with no physical damage. The battery shall be able to survive case temperature excursions to 125 °C (257 °F) with no physical damage.

3.1.4 Interfaces.

3.1.4.1 External-to-Vehicle to Component. Not applicable.

3.1.4.2 Component to Component.

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3.1.4.2.1 Electrical Connection Interface. Electrical connections shall comply with the requirements specified by IEC 60095-2 and free of all manufacturing residuals (i.e., flux).

3.1.4.2.2 Mechanical Mounting Interface. Battery mounting shall comply with the requirements specified by IEC 60095-2.

3.1.5 Usage Definition. The battery is expected to provide the functions specified in 3.1.2.2.

3.2 Product Characteristics. The verifiable technical requirements for the battery are identified in this section. Refer to Table 4 for verification of product characteristics.

3.2.1 Performance Requirements. The functional performance requirements for the battery are specified in 3.2.1.1 through 3.2.1.8. All requirements apply for the conditions specified in 3.1.3 and 3.1.5.

3.2.1.1 Cold Cranking Discharge.

3.2.1.1.1 A fully charged battery shall meet or exceed the Cold Cranking Amperes (CCA) rating at -18 °C (-0.4 °F) as specified in the SOR.

3.2.1.1.2 If EN 50342 CCA is specified in the SOR, the battery shall also be tested to determine the SAE J537 CCA. If the SAE J537 CCA is specified in the SOR, the battery shall also be tested to determine the EN 50342 CCA.

3.2.1.2 Low Capacity/Low Temperature Cold Cranking Discharge. A battery at 80% state of charge (SOC) and at -30 °C (-22 °F) shall meet or exceed 70% of the required EN 50342 or SAE J537 CCA rating as specified in the SOR.

3.2.1.3 Reserve Capacity Discharge. The battery supplier shall provide a battery Reserve Capacity (RC) rating at 25 °C (77 °F) for each battery part drawing.

3.2.1.4 Twenty-Hour (20 h) Capacity (Discharge). A fully charged battery shall meet or exceed the 20 h capacity rating at 25 °C (77 °F) as specified in the SOR.

3.2.1.5 Self-Discharge. A fully charged battery shall retain at least 90% of its 20 h capacity after being stored open circuit for 60 days at room temperature.

3.2.1.6 Charge Rate Acceptance. A battery at 40% of its measured capacity and at 0 °C (32 °F) shall, after 10 minutes of charging at 14.4 V, accept a minimum charge current of $0.26 \times (\text{measured } C_{20})$ A.

3.2.1.7 Field Rechargeability. A battery shall be rechargeable from 20% to 75% rated capacity with an applied constant 16 V flooded/15 V Absorbent Glass Mat (AGM), with charge time, $t_c = 1 \text{ minute} \times (\text{rated } C_{20})$ A (i.e., 60 Ah battery equals 60 minutes), and current limited to 50 A.

3.2.1.8 Total Discharge Rechargeability. A completely discharged battery shall be rechargeable to 95% of its rated capacity in 24 h, after 672 h (28 days) stand at room temperature.

3.2.1.9 Water Consumption.

3.2.1.9.1 The battery shall not lose electrolyte mass $> 1.0 \text{ g/Ah}$ of rated C_{20} battery capacity when charged for 504 h (21 days) at $14.4 \text{ V} \pm 0.05 \text{ V}$ at $50 \text{ °C} \pm 1 \text{ °C}$ ($122 \text{ °F} \pm 1.8 \text{ °F}$).

3.2.1.9.2 The battery shall not lose electrolyte mass $> 2.0 \text{ g/Ah}$ of rated C_{20} battery capacity when charged for 1008 h (42 days) at $14.4 \text{ V} \pm 0.05 \text{ V}$ at $50 \text{ °C} \pm 1 \text{ °C}$ ($122 \text{ °F} \pm 1.8 \text{ °F}$).

3.2.2 Physical Characteristics. The required physical characteristics for the battery are specified in 3.2.2.1 through 3.2.2.1.5.2.

3.2.2.1 Dimensions and Capacity. The dimensional and physical characteristics for the battery are specified as follows.

3.2.2.1.1 Outline Dimensions. The battery dimensions shall be within the tolerances shown on the part drawing.

3.2.2.1.2 Structural Integrity. A battery pressurized to 20 kPa (2.9 psi) shall leak lower than 1 kPa (0.1 psi) in 60 s.

3.2.2.1.3 Lifting Capacities. The anticipated type of lifting will be specified in the SOR, although the battery shall be capable of being lifted by any of the means listed.

3.2.2.1.3.1 Side Lifting. The battery shall be capable of being lifted by two (2) side lift tools, centered at opposite long sides of the battery, exerting 100 N/cm^2 pressure for 30 minutes without leaking acid or sustaining any damage.

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3.2.2.1.3.2 Handle Lifting. If a battery has a handle, it shall be capable of lifting the battery for the life of the battery. The handle must be contained after installation as specified on the part drawing.

3.2.2.1.3.3 Top Post Lifting. The requirement shall not be requested for batteries equipped with handles. The battery shall be capable of being lifted by a positive and negative top post strap without leaking acid or sustaining any damage.

3.2.2.1.4 Terminal Strength. The battery terminals shall mate with connectors a minimum number of times at specified torque and maintain the integrity of the electrical connection. The battery shall not sustain damage or leakage due to the applied torque. The type of terminals used will be specified on the part drawing or in the SOR.

3.2.2.1.4.1 Top (Unsealed) Terminal Posts. Unsealed terminals (posts) shall withstand, without damage, one (1) torque of 15 Nm applied directly to the post for 30 s.

3.2.2.1.5 Mounting Provisions. The type of mounting provision used will be specified in IEC 60095-2 for the Large (standard height configuration) New (LN) and Large (low height configuration) New (LBN) sizes.

3.2.2.1.5.1 Case Hold-Down. The battery shall be able to be mounted in the vehicle by the hold-down surfaces, as shown in the battery drawing, and remain in place without case damage during vehicle operation.

3.2.2.1.5.2 Strap. The battery shall be able to be mounted in the vehicle by a strap, as shown in the battery drawing, and remain in place without case damage during vehicle operation.

3.2.2.1.6 Case Impact. The battery case material shall be impact resistant.

3.2.2.1.7 Thermal Shock. Stresses produced by high-to-low-to-high temperature cycling shall cause no case deformation, cracks, or leaks, especially where the terminals pass through. The battery and vent system shall be fully functional during and after the stresses.

3.2.2.1.8 Bump. The battery shall remain operational and shall not leak during the vertical axes bump stress shown in 4.3.15.

3.2.2.1.9 Vibration. The battery shall remain operational and shall not leak during and after the vertical vibration test shown in 4.3.16.

Note: A measured C₂₀ capacity loss of 10% shall be accepted.

3.2.2.1.10 Chemical Resistance of Case. Per GMW16449.

3.2.2.2 Mass Properties. The battery mass shall be within the range of the mass tolerances specified in the SOR and recorded in the outline drawing.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. Not applicable.

3.2.3.2 Reliability Requirements. Using accepted statistical sample size determination techniques, the battery test samples shall demonstrate that the battery population conforms to the reliability requirements with 89% reliability and 50% confidence at the target life described in 3.2.5.1.

3.2.3.2.1 Cycle Life Requirements.

3.2.3.2.1.1 Deep Cycle Life. The battery shall survive a minimum of seven (7) complete sets of the 24 charge/discharge (7 × 24 total) cycles as defined in 4.3.18.1 Deep Cycle Life Test.

3.2.3.2.1.2 SAE J2801. Batteries with a 20 h capacity shall survive a minimum of charge/discharge cycles to failure shown in Table 1 as defined in the SAE J2801 Cycle High Temperature Application Accelerated Cycle Life Test, at 75 °C (167 °F). Reference 4.3.18.2 of this document.

Table 1: SAE J2801 Cycle Life Requirement

Technology (Flooded/AGM)	Battery 20 h Capacity Ampere-Hours (Ah)	Cycles to Failure (Weeks)
Flooded	> 39	6
Flooded	< 60	7
Flooded	≥ 60	11
AGM	< 60	11
AGM	≥ 60	15

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3.2.3.2.1.3 Battery Life with Capacity ≥ 51 Ah. As a demonstration of battery life, the GM approved High Temperature Combined Environmental Reliability Test (CERT) Accelerated Tests shall be used. The number of required minimum life cycles and characteristic life cycles for batteries with 20 h capacity ≥ 51 Ah are shown in Table 2 using Weibull failure analysis. One (1) life cycle is completion of one (1) 4 h discharge/charge cycle test as defined in 4.3.19.4.

Table 2: Capacity (≥ 51 Ah) CERT Life Cycle Requirements ^{Note 1}

Battery Technology	High Temperature CERT	
	Minimum Life (Cycles)	Characteristic Life (Cycles)
Flooded	180	211
AGM	383	450

Note 1: Minimum slope (β) is equal to three (3) in all cases.

3.2.3.2.1.4 Battery Life with Capacity < 51 Ah. As a demonstration of battery life, the GM approved High Temperature CERT accelerated tests shall be used. The number of required minimum life cycles and characteristic life cycles for batteries with 20 h capacity < 51 Ah are shown in Table 3 using Weibull failure analysis. One (1) life cycle is the completion of one (1) 4 h discharge/charge cycle test as defined in 4.3.19.4.

Table 3: < 51 Ah Capacity CERT Life Cycle Requirements

Battery Technology	High Temperature CERT	
	Minimum Life (cycles)	Characteristic Life (cycles)
Flooded	93	162
AGM	197	350

3.2.4 Serviceability. The battery design characteristics for serviceability have been addressed in other requirement sections. Some of the key characteristics are in 3.2.2.1.4 Terminal Strength, 3.2.2.1.5 Mounting Provisions, and 3.2.6.1 Hydrometer, as requested in the part drawing.

3.2.5 Dependability. Dependability is the ability of the battery to function during its target life within the performance levels specified in this specification.

3.2.5.1 Target Life. Target life is the point where reliability is determined. The reliability target life is 3 years or 4 years of customer usage and environmental exposure and compliance will be evaluated at severe levels of customer usage (99.8%). The warranty period of the battery in vehicle use is either a minimum of 3 years or 4 years. The requirement is specified in the SOR.

3.2.5.2 Short Circuit. A fully charged battery shall withstand a short circuit between the positive and negative terminals for 5 s without exhibiting any internal open circuits, explosions, fires, acid spewing, or ejection of hydrometer or vent plugs.

3.2.5.3 Reverse Jump Start. The battery shall tolerate inadvertent reverse jump start voltage hookups. The battery shall withstand a 24 V reverse jump start hookup for 5 s without exhibiting any internal open circuits, explosions, fires, acid spewing, or ejection of hydrometer or vent plugs.

3.2.5.4 Hazardous Liquids/Solids Emissions. The battery shall not emit any hazardous liquids or solids under normal operating conditions.

3.2.5.4.1 Hazardous Emissions during Charging. The venting system shall contain the acid in the battery during battery recharge.

3.2.5.4.2 Hazardous Emissions during Tilt. The battery shall not vent or leak acid when subjected to the tilt angles shown in Table 11.

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3.2.5.4.3 Flame Retardant Venting. The battery shall not suffer any damage when evaluated according to the SAE J1495 Flame Retardant Venting test.

3.2.6 User-To-Battery Interface. The user or human-to-battery interface requirements for the battery are specified as follows.

3.2.6.1 Hydrometer. The SOR shall specify if the battery shall have a built-in, easy to interpret, service hydrometer to be used for trouble analysis. As requested in the part drawing, the hydrometer can be equipped with green ball for SOC indication (Type A). Without the green ball, the hydrometer shall be used only as an electrolyte level indicator (Type B).

3.2.6.1.1 The **Type A** built-in hydrometer specified on the part drawing shall function as follows at 25 °C (77 °F).

3.2.6.1.1.1 Appear **Green** when the battery SOC is 70% or higher.

3.2.6.1.1.2 Appear **Black** when the battery needs to be charged.

3.2.6.1.1.3 Appear **Clear** when the electrolyte drops under the bottom of the hydrometer.

3.2.6.1.2 The **Type B** built-in hydrometer called out on the part drawing shall function as follows at 25 °C (77 °F).

3.2.6.1.2.1 Appear **Black** when the electrolyte level is correct.

3.2.6.1.2.2 Appear **Clear** when the electrolyte drops under the bottom of the hydrometer.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines. The supplier shall not change design, process, or material subsequent to design verification (GP11) or the European equivalent without the written consent of the GM release engineer.

3.3.1.1 Material Guidelines. Not applicable.

3.3.1.2 Processes Guidelines. Not applicable.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.2 Labeling. The battery labeling shall meet the requirements specified by the government, legal, and GM requirements (reference SOR) and must meet GMW14573.

3.3.3 Identification and Marking. All identification and markings on the battery are to follow the guidelines in the battery SOR or part drawing.

3.3.4 Workmanship. Not applicable.

3.3.5 Interchangeability. Not applicable.

3.4 Documentation.

3.4.1 Battery Drawing Content. The battery part drawing shall contain or reference the following:

3.4.1.1 All dimensional requirements.

3.4.1.2 Performance requirements (CCA, RC, 20 h capacity, mass, etc.)

3.4.1.3 GM part number.

3.4.1.4 Reference to applicable portions of this and other specifications including supplier documents.

3.4.1.5 The typical mating connector(s).

3.4.1.6 Federal Motor Vehicle Safety Standards (FMVSS) or other government standards.

3.4.1.7 Key Product Characteristics (KPC).

3.4.1.8 Permanent assembly and production date code.

3.4.1.9 Key Control Characteristics (KCC).

3.4.1.10 Revision block.

3.4.1.11 Load specification for load test.

3.4.1.12 Hydrometer type, if included in the battery.

3.4.2 Statement of Requirements (SOR), Alternative Tests and Limits.

3.4.2.1 When not all requirements for specific applications are provided on the part drawing, the SOR shall document requirements or changes to requirements.

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3.4.2.2 If tests, order of test performance, or parameter limits are different from those indicated in this procedure, the changes shall be documented in the SOR.

3.5 Support of Battery After Sale. Not applicable.

3.6 Battery Operator Training. Not applicable.

3.7 Battery Characteristics.

3.7.1 Battery Definition. Not applicable.

3.7.2 Battery Interface Description. Not applicable.

3.7.3 Battery Mounting Tab Specification. Use the SOR or part drawing.

4 Validation

4.1 General.

4.1.1 All tests shall be conducted on fully charged, new batteries unless otherwise indicated.

4.1.2 The testing facility shall meet the requirements of IATF 16949 and ISO 17025.

4.1.3 Safety Precautions and Procedures. Not all potentially unsafe situations can be envisioned at the writing of this specification; therefore, it is very important that those involved in testing batteries observe all safety precautions normally observed by those skilled in battery testing with due diligence at all times.

While not intended to be exhaustive, or intended to supercede any safety precaution normally observed by those skilled in the art of battery testing, the following is offered as general safety guidelines.

All connections made during the test shall be firmly made with standard, available hardware. Cables shall have large enough diameter to carry necessary discharge currents and have resistance low enough to allow the battery to be discharged.

4.1.4 Uniform Conditioning, Calibration Procedures, Tolerances. The following procedures are recommended for battery laboratory sample preparation to assure test-to-test repeatability. These procedures are for testing batteries at various capacities.

4.1.4.1 Default Test Conditions. When specific test conditions are not given either in this standard or in the test procedure, the following basic conditions shall apply.

4.1.4.1.1 Room Temperature: $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

4.1.4.1.2 Relative Humidity: $50\% \pm 30\%$.

4.1.4.1.3 Atmospheric Pressure: 650 mm Hg to 800 mm Hg.

4.1.4.2 Default Tolerances. When tolerances are not provided in this standard, the following default tolerances shall apply.

4.1.4.2.1 Temperature: $\pm 3\text{ }^{\circ}\text{C}$.

4.1.4.2.2 Voltage: $\pm 0.1\text{ V}$.

4.1.4.2.3 Current: $\pm 1\%$.

4.1.4.2.4 Time: for $t \leq 10\text{ s}$, $\pm 2\%$; for $t > 10\text{ s}$, $\pm 1\%$.

4.1.4.3 Battery Stabilization Temperature.

4.1.4.3.1 Before testing a battery at room temperature or at a specified hot temperature, the battery must stand at the specified temperature for a minimum of 16 h or until the electrolyte reaches the specified temperature.

4.1.4.3.2 Before testing a battery at a specified cold temperature, the battery must stand at room temperature for a minimum of 24 h. Then place the battery in the specified cold temperature for a minimum of 16 h or until the electrolyte reaches the specified temperature.

4.1.4.3.3 The battery temperature shall be maintained in the specified range and, if necessary, an appropriate environmental control system, e.g., a controlled-temperature water bath or conducted air, shall be used.

4.1.4.4 Battery Conditioning.

4.1.4.4.1 Battery Conditioning for 100% Capacity.

4.1.4.4.1.1 Place the battery at room temperature for a minimum of 16 h or until the electrolyte reaches room temperature.

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4.1.4.4.1.2 Charge with a constant $16\text{ V} \pm 0.1\text{ V}$ for 23 h at a maximum current of 25 A, followed by 1 h at a constant current, $I_K = 0.1 \times C_{20}$ (rated).

4.1.4.4.2 Battery Conditioning after Cold Crank Test at -18 °C.

4.1.4.4.2.1 Place the battery at room temperature for a minimum of 16 h or until the electrolyte reaches room temperature.

4.1.4.4.2.2 Charge with a constant $16\text{ V} \pm 0.1\text{ V}$ for 16 h at a maximum current of 25 A.

4.1.4.4.3 AGM Battery Conditioning for 100% Capacity.

4.1.4.4.3.1 Place the battery at room temperature for a minimum of 16 h or until the electrolyte reaches room temperature.

4.1.4.4.3.2 Charge at constant current of 25 A until the voltage reaches $15\text{ V} \pm 0.1\text{ V}$. Continue charge at $15\text{ V} \pm 0.1\text{ V}$ until current reaches 0.2 A, or until the total time reaches 14 h.

4.1.5 Validation Test Quantities and Sequence.

4.1.5.1 Validation test quantities and test sequence are provided in Appendix A, Table A1. Exceptions may be made to reduce sample size when there is no difference in the design or implementation of the design across a product family after one family member has been verified.

4.1.5.2 Sample sizes may also be reduced when the verified product has been in service for some time and the Supplier can show that no changes have been made that would affect the verification.

Note: Exceptions must be documented and approved by the GM release engineer.

4.2 Validation Cross Reference Index. Reference Table 4.

Table 4: Validation and Requirements Cross Reference

Requirement Description	Paragraph Number	
	Requirement	Validation
Cold Cranking Discharge	3.2.1.1	4.3.1
Low Capacity/Low Temperature CCA	3.2.1.2	4.3.2
Reserve Capacity	3.2.1.3	4.3.3
20 h Capacity	3.2.1.4	4.3.4
Self-Discharge	3.2.1.5	4.3.5
Charge Rate Acceptance	3.2.1.6	4.3.6
Field Rechargeability	3.2.1.7	4.3.7
Total Discharge Rechargeability	3.2.1.8	4.3.8
Water Consumption	3.2.1.9	4.3.9
Structural Integrity, Leak Test	3.2.2.1.2	4.3.10
Side Lifting	3.2.2.1.3.1	4.3.11.1
Handle Lift	3.2.2.1.3.2	4.3.11.2
Top Post Lift	3.2.2.1.3.3	4.3.11.3
Terminal Strength, Top Terminals	3.2.2.1.4.1	4.3.12.1
Case Hold-Down	3.2.2.1.5.1	4.3.15, 4.3.16
Strap	3.2.2.1.5.2	4.3.15, 4.3.16
Case Impact	3.2.2.1.6	4.3.13
Thermal Shock	3.2.2.1.7	4.3.14
Bump	3.2.2.1.8	4.3.15
Vibration	3.2.2.1.9	4.3.16
Chemical Resistance of Case	3.2.2.1.10	4.3.17
Cycle Life	3.2.3.2.1	4.3.18

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