



Verification of Cranking Motors - Verification Part

1 Scope

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 document defines the verification procedures for testing the requirements for all cranking motor types.

1.2 Foreword. Cranking motors are used in vehicles to crank the engine to start it.

1.3 Applicability. The cranking motor standards consist of the requirement part GMW3145 (General Specification) and the verification part GMW3163 (Test Procedure).

Note: If not otherwise specified, the requirements of GMW3145 shall be checked as specified to GMW3163.

2 References

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

2.1 External Standards/Specifications.

ISO 20653 VDA 260

2.2 GM Standards/Specifications.

9985010	9986177	GMW3059	GMW14872
9985809	9986196	GMW3092	GMW15267
9985946	9986201	GMW3097	GMW15357
9986086	9986232	GMW3145	GMW15827
9986117	9986284	GMW14729	GMW16444
9986153			

2.3 Additional References.

B20 Biodiesel – P/N GMPT-5-020

Cranking Motor Statement of Requirements (SOR) Appendix C1

E22 Gasoline – P/N GMPT-4-001 Brazilian General Purpose

E85 Gasoline – P/N GMPT-4-002 General Purpose, Summer

E100 Ethanol Fuel – P/N 94616895

GM1829

GM Top Engine Cleaner – P/N 1052626

Loctite Industrial Products (Henkel North America) Part Number 82122 (GM Engine Degreaser)

M85 Gasoline – P/N GMPT-4-017 General Purpose Validation Fuel

Ultra-low Sulfur Diesel Fuel – P/N GMPT-5-019

WD-40 Lubricating Oil

Ziebart International Corporation Undercoating Material

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Originating Department: North American Engineering Standards

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2.3.1 Order of Precedence. Requirements, and associated verification, on electrical/electronic subsystems and components in motor vehicles is valid in the following order of precedence.

2.3.1.1 Requirements stated in applicable legal demands.

2.3.1.2 Requirements stated in the relevant specification for the actual subsystems and components (e.g., a Vehicle Technical Specification (VTS), Subsystem Technical Specification (STS) or Component Technical Specification (CTS) SOR and/or drawing).

2.3.1.3 Requirements stated in this GM Worldwide Engineering Standard.

2.3.1.4 Requirements stated in other GM Worldwide Engineering Standards.

2.3.1.5 Requirements stated in other documents.

3 Resources

3.1 Facilities. Test facilities as required by the relevant test methods and standards. The facilities shall be checked before the tests start.

3.1.1 Calibration. The test facilities and equipment shall follow the calibration requirement per equipment manufacturer and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 General Test Equipment. Test equipment according to the referenced general specifications.

3.2.2 Specific Test Equipment. It is recommended to use equipment as described. If alternative equipment is used, it has to be assured that all measured variables are determined correctly with respect to their physical definition as specified in this specification.

3.2.2.1 Temperature Cabinet.

Temperature range: -60 °C to +150 °C

Temperature accuracy: ± 2 °C for temperatures above 0 °C

Temperature accuracy: ± 3 °C for temperatures below 0 °C

3.2.2.2 Climatic Chamber.

Temperature range: -20 °C to +100 °C

Relative humidity range: 10% to 98%

3.2.2.3 Test Equipment for the Off Road Vehicle Durability Test.

3.2.2.4 Test Equipment for the Mechanical Strength Test.

3.2.2.5 Test Equipment for the Durability Tests.

3.2.2.6 Adjustable Direct Voltage Source.

Voltage capability: 6 V to 16 V

Current capability: 150 A

3.2.2.7 Direct Current Meter.

Measuring ranges: 1 A, 5 A, 10 A, 30 A, 75 A, 150 A

Accuracy class: 0.5 minimum

3.2.2.8 Voltmeter.

Measuring ranges:

Direct current (DC): 300 mV, 3 V, 15 V

Accuracy class: 0.5 minimum

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3.2.2.9 Test Equipment for Recording the Cranking Motor Characteristics Curves.**3.2.2.9.1 Battery Simulation Equipment.**

Voltage capability:	30 V
Current capability:	1500 A
Internal resistance (adjustable):	20 mΩ

3.2.2.9.2 Mechanical unit to brake the cranking motor down.**3.2.2.9.3 Equipment for measuring the cranking motor and the motor speed.****3.2.2.9.4 System for test control and for data recording of motor speed, drive torque effective at the drive pulley, cranking motor current and voltage.****3.2.2.9.5 Temperature cabinet to keep the temperature of the atmosphere of the cranking motor constant during testing.**

Temperature range:	-40 °C to +125 °C
Temperature accuracy:	± 2 °C for temperatures above 0 °C ± 3 °C for temperatures below 0 °C

3.2.2.10 Transformer.

Output voltage:	50 V alternating current (AC)
Alternating frequency:	50 Hz

3.3 Test Vehicle/Test Piece. The total number of cranking motor samples to be provided for first sampling and approval test to this specification, will be determined by the release engineer at the local engineering site. The samples shall be accompanied by a specific test report to GM1829 giving the results of a complete test cycle according to this specification.

3.4 Test Time. Not applicable.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation. Not applicable.

4.2 Conditions. Unless otherwise stated for the individual tests, the tests are performed without conditioning.

4.2.1 Environmental Conditions.

4.2.1.1 Test of Product Characteristic. The cranking motor is installed in the engine, but with poor thermal contact. Unless otherwise specified in this standard, the requirements of engine installation position are required for testing without engine. Unless otherwise stated, all tests have to be performed at room temperature +23 °C ± 5 °C.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.**4.3.1 Basic Electrical Tests.**

4.3.1.1 Overvoltage Protection. Apply a 24 V jump start under the following conditions:

- Test complete vehicle or engine buck with engine specified by engineering. Engine filled with high limit viscosity oil.
- Cold soak the vehicle to -20 °C ± 2 °C if not otherwise specified in the VTS.
- Use largest released battery at 50% state of charge (SOC).
- Use two series connected 85 Ah batteries at 100% SOC connected in parallel with the vehicle battery.

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- Use jumper cables (0.008 Ω maximum).
- Crank for 10 s with the injectors disabled.
- After stressing, the cranking motor shall be checked for full function.

4.3.1.2 Reverse Polarity Voltage Protection. Apply a voltage of -12.0 V direct current (DC) to the battery terminal for 10 s; pinion to be held stationary (applies to only wound field designs). Test to be run a total of three times with a 5 s to 10 s pause between cycles.

4.3.1.3 Electromagnetic Compatibility. The cranking motor shall be tested to GMW3097.

4.3.2 Environmental Tests. Unless otherwise stated, the pinion opening shall be sealed during environmental testing. The cranking motor is to be mounted in the orientation representative of the engine application.

After each stressing, a check for full function shall be performed.

4.3.2.1 High/Low Temperature Storage.

- Subject the cranking motor to temperatures of +150 °C and -60 °C for a period of 192 h at each temperature in a non-operational mode.
- Upon completion, conduct a Room Temperature Motor Performance Test per Section 4.4.1 of this document.

4.3.2.2 Fluids Compatibility. With the cranking motor mounted in design position, nose housing masked to simulate the design intent transmission housing/splash shield; brush on each of the automotive fluids listed in Appendix D, Table D1, to completely wet all exposed exterior surfaces. Compatible fluids, such as fuels, lubes, petroleum distillates, etc., may be mixed together in equal parts to decrease the number of samples tested. If a combined fluid causes a failure, it must be re-run with individual fluids to determine the fluid responsible for the failure. Locally available fluids may be substituted for those listed when approved by a materials engineer at a GM engineering operation located nearest to the supplier. Each fluid group is to be applied to a new starter.

After each application, allow to drip dry for 30 minutes and then expose the starter to +125 °C $\pm$ 2 °C ambient for 8 h. Repeat the procedure for a total of ten cycles. Upon completion, conduct a Room Temperature Motor Performance Test per Section 4.4.1 of this document.

4.3.3 Cyclic Corrosion Laboratory Test (GMW14872, UH, All, 4sp, Method 1/2, Exposure B). Corrosion level rating is based on throttle cable bracket as shown in GMW15357. Cranking motor cosmetic corrosion level must be minimum of nine (9) after test.

4.3.4 Off Road Vehicle Durability. The following test profile is intended to replicate the exposure level experienced during off road vehicle operation. A total of four complete passes of the schedule shall constitute the equivalent of 100 000 vehicle miles. At the discretion of the release responsible engineer, this test may be included in the overall test plan as communicated in the statement of work.

One test cycle shall consist of the following elements: salt spray, humidity, thermal cycling, dust, grit, vibration and duty cycle, and takes approximately 3.5 days. Each test element is described in paragraphs 4.3.4.1. through 4.3.4.12. Motor to be mounted in design configuration including electrical interfaces; pinion opening to be unobstructed. Test cycle to be run in the sequence listed (4.3.4.1. through 4.3.4.12).

4.3.4.1 Motor Performance. Characterize motor performance per 4.4 and document results.

4.3.4.2 Salt Spray. Four (4) h of 5% neutral high pressure salt spray per GMW15267, motor to be operated at free speed for 5 s every 5 minutes.

4.3.4.3 Iron Oxide. This step must start within 3 minutes after paragraph 4.3.4.2 (Salt spray) has been completed. Using 8 mm air nozzle at 172 kPa to 206 kPa (25 psi to 30 psi) of air line pressure, apply spray of iron oxide mist for a minimum of three seconds to the entire front bracket opening area, that includes pinion, driveshaft, and overrunning clutch (see Figure B1 of Appendix B). Keep the applicator agitated to ensure proper iron oxide application (agitate/shake duster between applications). The amount of iron oxide covering the pinion, drive shaft and overrunning clutch areas must be comparable to the pictures in Figure B2 of Appendix B. Supplier must provide pictures to show the iron oxide coverage of the pinion, drive shaft and overrunning clutch areas to GMPT Starter Technical Specialist or Responsible Design Release Engineer for approval before design validation (DV) testing.

4.3.4.4 Room Temperature Storage. Motor to be stored at room temperature +23 °C $\pm$ 5 °C at 50% relative humidity for 24 h.

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4.3.4.5 Duty Cycle. Operate the motor under load per 4.3.8.2 at room temperature for 500 cycles; record any incidents for failure to crank.

4.3.4.6 Vibration. Expose the motor to the vibration profile outlined in Section 4.3.7 for 5 h in each axis specified.

4.3.4.7 Humidity. Expose the motor to 8 h of humidity per GMW14729. Immediately transfer the motor to the thermal cycling cabinet.

4.3.4.8 Thermal Cycle. Upon exiting the humidity cabinet, lower the motor temperature to -18 °C at the rate of -2 °C/minute and hold for 1 h. Operate the motor under load per 4.3.8.2 for 2 minutes at 30 cycles/minute. Record any incidents of failure to crank. Raise the motor temperature from -18 °C to +66 °C at the rate of +2 °C/minute and hold at +66 °C for 1 h. Raise the motor temperature from +66 °C to +120 °C at the rate of +2 °C/minute. Hold at +120 °C for 1 h. While at +120 °C operate the motor under load per 4.3.8.2 for one cycle/minute; record any incidents of failure to crank. Soak the motor at room temperature and stabilize.

4.3.4.9 Duty Cycle. Operate the motor under load per Section 4.3.8.2 at room temperature for 500 cycles; record any incidents for failure to crank.

4.3.4.10 Grit/Salt Contamination: The motor is sprayed with a grit/salt mixture at the rate of 20 L/minute. Spray for 5 minutes with the spray nozzles oriented such that all motor surfaces are equally covered. The spray consists of 5% neutral salt water mixed with grit at the ratio of four parts salt water and one part grit by volume of the following:

- Fire clay
- Cinders – fine
- Crusher dust
- Sand

4.3.4.11 Room Temperature Storage. Motor to be stored at room temperature, +23 °C ± 5 °C at 50% relative humidity for 24 h.

4.3.4.12 Duty Cycle. Operate the motor under load per paragraph 4.3.8.2 at room temperature for 500 cycles; record any incidents for failure to crank.

Note: End of cycle. Any incident where the motor fails to crank or when the motor output is less than 90% of the initial value constitutes a failure.

4.3.5 Test of High Humidity Resistance. The pinion opening shall not be sealed for this test. Place the cranking motor in a cold soak at -10 °C for 4 h, then in an atmosphere of 98% relative humidity at +25 °C for 30 minutes, then in -10 °C for 3 h.

- Test shall consist of ten (10) such cycles.
- A check for full function shall be conducted after the stressing.

4.3.6 Resistance to Water Ingress.

4.3.6.1 Motor Frame Water Ingress. Mount the cranking motor in the design intent orientation, pinion opening sealed and electrical leads connected. Test motor to ISO 20653, degree of protection IPX6K (level of water spray pressure). Within one minute of test completion, remove the motor from the test chamber while maintaining the original part orientation. Remove the pinion opening seal, drain and measure any water that has entered the motor field and frame.

4.3.6.2 High Pressure Test. Mount the cranking motor in the design intent orientation, pinion opening sealed and electrical leads connected. Test motor to ISO 20653, degree of protection IXP9K (level of water spray pressure). Within one minute of test completion, remove the motor from the test chamber. Remove pinion opening seal and drain any water that has entered the motor field and frame. Perform a visual check for damages. After 168 h, subject the cranking motor to a durability test with 15 000 cycles to 4.3.8.1 or 4.3.8.2 respectively.

A check for full function shall be conducted after the stressing.

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