



Standalone Parking Brake Caliper Technical Specification

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 document provides the standard technical requirements for standalone parking brake calipers (manual and electric). The performance requirements are focused on a manually or electrically actuated parking mechanism fitted to a disc brake and operating against the service brake friction surfaces. This document must only be used when invoked by a program-specific technical specification. References to the program-specific technical specification are included in this document where program-specific requirements are expected to exist.

Note: The program-specific technical specification may include additional program-specific requirements that are not referenced in this document and does supercede any requirements included in this document. In the case of any conflicts between this document and the program-specific technical specification, the program-specific technical specification takes precedence.

Note: The program-specific Statement of Requirements (SOR) shall determine if this document is issued as one entity for corner level performance or as part of packet of documents that may additionally include specifications for vehicle level performance, component level performance, or both.

This specification establishes requirements for the standalone parking brake caliper. These requirements apply to the bandwidth parameters described in the standalone parking brake caliper program-specific technical specification.

1.2 Applicability. This standard applies to all standalone (separate from service brake) parking brake calipers.

1.3 Remarks. The park brake assembly transforms force and travel from an actuator (park brake cable system or electric motor and drive mechanism) into torque applied to the rear rotor. See program-specific technical specification.

2 References

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

2.1 External Standards/Specifications.

FMVSS 135 USCAR EWCAP-001

2.2 GM Standards/Specifications.

GMW3059	GMW14155	GMW15104	GMW15841
GMW3091	GMW14165	GMW15272	GMW15862
GMW3097	GMW14351	GMW15367	GMW16316
GMW3103	GMW14375	GMW15392	GMW16331
GMW3172	GMW14376	GMW15394	GMW16696
GMW3191	GMW14872	GMW15466	GMW17000
GMW8518	GMW14925	GMW15587	GMW17012
GMW14089	GMW14926	GMW15626	

2.3 Additional References. Use of the following documents may be required. See the GM Global Legal Database for applicable documents. The supplier shall work with the GM Design Responsible Engineer (DRE) to comprehend Best Practice requirements.

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- Architectural Homeroom Statement of Requirements (SOR)
- Best Practice ELEC86-69 (ID)
- Best Practice ELEC86-S5125 (ID)
- CG3856
- Component Technical Specification (CTS)
- GM Drawing 13246040
- GM Global Fastener Engineering web site (<https://gmweb.gm.com/sites/fastening1/Pages/Home.aspx>) (ID)
- GM Global Legal Database (ID)
- GM Labels and Literature web site (<https://gmweb.gm.com/sites/toolkit/48Inl/Pages/Home-Page.aspx>) (ID)
- Interface Control Document (ICD) (ID)
- Interface Dimension Chart
- Key Characteristics Designation System (KCDS) Database (ID)
- Program-specific Brake System Subsystem Technical Specification (SSTS)
- Program-specific Statement of Requirements (SOR)
- Program-specific Vehicle Technical Specification (VTS)

(ID) = These documents/web sites are limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The stand-alone parking brake caliper transforms level displacement (manually actuated) or electrical energy (electrically actuated) into braking torque transmitted to the tire/wheel system to hold the vehicle stationary in a parking situation or to serve as a backup to the service brake system.

3.1.1 Appearance. The appearance requirements will be included in the architectural homeroom program-specific SOR for additional requirements. Also see program-specific technical specification.

3.1.1.1 Corrosion. See Table A1, Appendix A for a map showing the recommended cosmetic and functional corrosion test strategy for brake calipers. These requirements replace the corrosion cycling requirements in GMW3172.

3.1.1.2 Cosmetic Corrosion Resistance. The front brake caliper must meet the corrosion performance and validation requirements specified in GMW15272 for both functional and cosmetic corrosion performance. When invoked by GMW15272 for caliper cosmetic corrosion testing, GMW14872 must include the following additional stresses during the ambient phase of the test:

- Parts shall be sprayed every cycle with a 3.5% chloride content solution.
- Every fifth cycle, parts shall be heated in a 150 °C environment for 1 h.

Surfaces of the caliper typically visible through the wheel must meet the cosmetic corrosion requirements for Exterior Surfaces (Table A1, Appendix A) instead of those for the underbody. Surfaces of the caliper typically not visible through the wheel must meet the requirements pertaining to underbody chassis components.

Painted calipers are subject to the additional requirements in 3.1.1.2.1.

3.1.1.2.1 Additional Requirements for Painted Calipers. Painted calipers must meet the corrosion requirements specified in GMW17012.

When evaluating painted calipers per these specifications, any surface discoloration relative to the main body of the caliper shall be treated as **red rust** for purposes of evaluation.

3.1.1.3 Functional Corrosion Resistance. There are two checks for caliper function after corrosion exposure. The first is a pad slide force check after two years equivalent exposure (per GMW15272, invoking GMW14872 cycles). The second is a function check after ten years equivalent exposure (per GMW15272, invoking GMW14872 cycles).

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The setup of the calipers for functional corrosion evaluation shall allow the calipers to be hydraulically applied (against a rotor or simulated rotor), while maintaining **normal** running clearance (the total pad movement during one apply shall not exceed that which would occur normally by design in a fully assembled brake corner). The calipers shall be actuated via hydraulic pressure with the following parameters:

- Target pressure = 50 bar
- Pressure ramp rate = 50 bar/s
- Pressure hold for 5 s
- Apply every fifth cycle of GMW14872

The definition of the brake caliper remaining functional after corrosion exposure is meeting the following requirements after 15 years equivalent exposure (unless otherwise noted) as specified in GMW15272 (invoking GMW14872 cycles):

- Pad slide meets requirement in Table A1, Appendix A (**Note:** Evaluated at ten years exposure).
- The hydraulic integrity of the caliper is maintained, no loss of sealing.
- All threaded fasteners, including the caliper bleeder screw, can be loosened without using applied heat, and without breakage (external lubricant is permitted).
- All lubricated sliding components continue to slide freely, no seizing.
- The parking brake mechanism (if applicable) remains functional with no degradation in actuator, adjuster performance, or return mechanism.

3.1.1.4 Finish Requirements for Painted Calipers and/or Logos. The caliper finish must meet the requirements set forth in GMW17012 (including, but not limited to, scratch resistance, crosshatch test, resistance to solvents such as brake fluid, fuel, and cleaning agents, water jet resistance, and weathering. See full specification for details).

3.1.2 Content. Splash, Debris, and Corrosion Protection.

3.1.2.1 Physical Content. The standalone parking brake caliper includes the knuckle (if applicable), caliper assembly, brake pads, brake rotor, wheel bearing, rotor splash shield, and may include wheel speed sensors, hydraulic brake hoses, and wheel bearing shield. Standalone parking brake calipers contain the park brake mechanism (as part of the caliper or as a separate mechanism).

3.1.2.2 Functional Content. The standalone parking brake caliper creates decelerating torque at each wheel in response to input from the service brake apply system. The standalone parking brake caliper assemblies transform vehicle kinetic and potential energy into heat. The standalone parking brake caliper provides for temporary storage and dissipation of heat. The standalone parking brake caliper provides wheel speed information to the chassis electrical system for chassis control systems. The standalone parking brake caliper also provides warning of impending lining wear out.

3.1.2.3 Galvanic Corrosion Protection. Materials for adjoining components shall be selected to minimize the potential for galvanic corrosion. This means employing similar materials at interfaces and/or employing a suitable barrier coating.

3.1.2.4 Fastener Selection. GMW17000 contains recommended fasteners for the brake caliper to knuckle attachment, the brake rotor to wheel bearing attachment (rotor retention screw), the brake hose to caliper attachment (banjo bolt), and the wheel bearing to knuckle attachment. See the GM Global Fastener Engineering web site. The design of these interfaces shall accommodate the use of the recommended fasteners. Exceptions can be made for non-standard interfaces or special packaging situations. The brake hose to caliper attachment (banjo bolt) recommendation does not apply to a screw-in type brake hose attachment.

Torque, tension, and angle evaluation of fastened joints shall be evaluated per GMW14165 to determine the correct torque specifications.

3.1.3 Ambient Environment. Definition of Operating and Non-Operating Environment.

3.1.3.1 Environmental Definition. The standalone parking brake caliper will be exposed to the following environmental conditions in either customer usage or in the manufacturing and assembly process. The standalone parking brake caliper shall provide satisfactory performance during and after these exposures. Appropriate laboratory tests may be used to demonstrate this performance.

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The minimum temperature is the minimum temperature at which a component will be expected to operate. Assisted vehicle starting shall be permitted. Temporary degradation of the component function shall be permitted, but permanent loss of function shall not result in a walk home situation.

The maximum continuous temperature is the maximum temperature a component will experience on a continuous basis and be expected to maintain design functional life. The vehicle shall be able to experience 1200 h/12 000 cycles per 160 000 km of operation during continuous thermal conditions. Occupant safety shall not be compromised during continuous thermal conditions.

The maximum excursion temperature is the maximum temperature the component will experience on an infrequent basis and be expected to maintain functional life. The vehicle shall be able to experience 60 h/400 cycles per 160 000 km of operation during excursion thermal conditions. Occupant safety shall not be compromised during excursion thermal conditions.

If the vehicle target life is greater than 160 000 km, the hours and cycles should be adjusted accordingly. See program-specific technical specification.

The Electric Park Brake (EPB) shall pass the tests contained in GMW3172 and GMW15466 with the exceptions and clarifications in Table 1.

Table 1: Temperature and Humidity Ranges

Definition	Parameter
Minimum Temperature	-40 °C
Maximum Sustained Temperature (> 10 minutes)	85 °C
Relative Humidity Range	0% to 100%

3.1.3.2 Temperature Range. The temperature range for ambient conditions is -40 °C to +50 °C. The temperature range of each component during operation and storage shall range from -40 °C (-48 °C for Siberia) to a Maximum Temperature (TMAX) which is specified per the component. Excursion conditions represent elevated temperature exposure not to exceed 30 minutes continuous. Materials and component geometries shall be selected/designed that allow the following operating temperature conditions to be met:

- Lining (Iron Disc):** TMAX = 600 °C; 800 °C Excursion. TMAX for the lining insulator/backing plate is determined through static (rotor not spinning and vehicle not moving) physical test or heat transfer analysis with the rotor set at 600 °C and heat transfer driven through conduction from the rotor, through the pad assemblies, and to the back of the backing plate.
- Lining (Ceramic Disc):** TMAX = 900 °C; 1200 °C Excursion. TMAX for the lining insulator/backing plate is determined through static (rotor not spinning and vehicle not moving) physical test or heat transfer analysis with the rotor set at 900 °C and heat transfer driven through conduction from the rotor, through the pad assemblies, and to the back of the backing plate.
- Caliper:** TMAX = 125 °C; 150 °C excursion for Ethylene Propylene Diene Monomer (EPDM) rubber components; TMAX = 300 °C for Silicon rubber components. Caliper TMAX is determined through static (rotor not spinning and vehicle not moving) physical test or heat transfer analysis with the rotor set at 600 °C and heat transfer driven through conduction and radiation to nearby caliper surfaces, for a total exposure time of 45 minutes. High performance applications with race track usage may specify additional requirements to account for convective heat transfer from rotor vent exhaust into caliper surfaces higher rotor temperatures. See program-specific technical specifications for additional requirements.
- Motor Gear Unit (MGU) Temperature:** TMAX = 85 °C.

3.1.3.3 Humidity Range. The relative humidity range for each component during operation and storage shall range from 0% to 100% in the specified ambient temperature range of -40 °C to +50 °C.

3.1.3.4 Atmospheric Pressure. The standalone parking brake caliper will be exposed to between 330 mmHg and 860 mmHg during operation and storage.

3.1.3.5 Potential Contaminants. The standalone parking brake caliper must either be able to withstand prolonged exposure to contaminants which could be encountered in vehicle use or must be packaged to protect

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from them. Validation is accomplished through physical testing or through prior knowledge of material and coating compatibility with contaminants.

Coatings or exposed construction material used on the caliper assembly, rotor splash shield, wheel bearing seal protection (slinger), and the rotor must withstand the application of a film (the viscosity of the liquid will define the film thickness) of the following contaminants, applied at ambient temperature, for a duration of 2 h, without penetration of the coating or damage (pitting or erosion) of the base material: engine oil, transmission fluid, power steering fluid, coolant/antifreeze, brake fluid, windshield washer fluid, ammonia glass cleaner, applicable fuels (gasoline, diesel, ethanol, or methanol), transaxle or differential lube, wheel bearing lube, air conditioning refrigerant, water, salt water, snow, ice, acid rain, road tar, rust proofing/undercoating, ozone, acid rim cleaner, and urea (Diesel Emission Fluid).

Any standalone parking brake caliper components that move relative to other components must be sealed against dirt, dust, grit, sand, and mud exposure, or feature a design that can withstand this exposure over the life of the vehicle while remaining functional.

3.1.3.6 Chassis Electronics and Controls. The chassis electronics and controls subsystem may provide electrical power to the standalone parking brake caliper for wheel speed sensors. As required, the standalone parking brake caliper may provide wheel speed signals from each corner to the chassis electronics and controls subsystem. See program-specific technical specification.

3.1.3.7 Non-Operating Environmental Exposure. The standalone parking brake caliper shall meet all operating performance requirements, without loss of function or degradation of service life, under the operating environment defined in 3.1.3.1 thru 3.1.3.4 after exposure to the following non-operating conditions:

- a. Component transport by airplane at altitudes up to 13 700 m, with air temperature of -50 °C and pressure of 125 mmHg.
- b. Free air temperature up to 93 °C.
- c. Vehicle transport by ground via haul-away carriers and train.
- d. Vehicle transport via ocean transport cargo ship (vibration and corrosion).

3.1.4 Interfaces. The program-specific technical specification must reference the necessary Interface Dimension Chart (provided by GM Chassis) and appropriate drawing files. See program-specific technical specifications.

3.1.4.1 Vehicle Interfaces, Driver Interfaces, and Loads.

3.1.4.1.1 Structure Interface. The standalone parking brake caliper shall interface with the suspension and chassis structure as shown in the appropriate drawing file. See program-specific technical specification.

3.1.4.1.2 Load Capacity. The rear suspension shall provide support and reaction capability for the standalone parking brake caliper. See 3.2.3.2.4.1 and 3.2.3.2.4.2 for standalone parking brake caliper torque capacity requirements.

3.1.4.1.2.1 Suspension/Knuckle Loads. See Knuckle Technical Specification SOR.

3.1.4.2 Parking Brake Interface.

3.1.4.2.1 Rear Foundation Brake Knuckle/Backing Plate (manually actuated calipers). The rear brake assembly will provide a reaction point for the park brake rear cable conduits. The conduit reaction element will allow end-fitting insertion with less than 50 N insertion force. Stiffness of the reaction element will be such that loaded deflections will consume less than 5% of required cable travel. The reaction element will provide a cable exit angle that allows a minimum of 40 mm of clearance between the tire/wheel and rear park brake cables.

In order to insure adequate space for a cable return spring, the minimum distance from the reaction bracket to the apply lever shall be 80 mm. This requirement will be waived if the internal mechanisms of the component provide adequate force to fully return the cable system.

3.1.4.2.2 Rear Brake Interface to the Park Brake Cable. After assembly, the park brake cable strand end shall not disengage from the brake lever assembly when the strand is pushed from the input end.

3.1.5 Usage Definition. The customer usage data given in this section are for high levels of usage in 240 000 km of retail customer driving. (Trucks may require higher mileage. See program-specific technical specification.) Note that low levels of usage may be more appropriate for certain failure mechanisms, such as corrosion.

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Components may be exposed to water based fluid spray due to vehicle usage. Components may be exposed to water submersion during special vehicle usage, e.g., boat launches from towed trailers and/or fording. The vehicle may be subjected to underhood wash including engine degreaser. The vehicle may be subjected to home or hand washing, drive through washing or wand washing throughout its life. The wheel bearing assemblies will be exposed to the corrosive environment, which occurs in the Scandinavian countries, Northeast United States of America and Southeast Canada. The environment is composed of temperature, humidity, salt, splash, mud, and component usage. Corrosion will be evaluated on durability vehicles completing ten (10) year corrosion schedule. Test procedures will be listed in the vehicle program-specific Vehicle Technical Specification (VTS). See program-specific technical specification.

3.1.5.1 Estimated Worst Case Usage during 15 years/240 000 km. During one life the standalone parking brake caliper assembly shall be capable of performing 100 000 cycles to the maximum apply force (at 45 mm of cable take-up, beyond the cable pre-tensioned condition for cable-puller assemblies). Motor gear units located directly on the rear brake must have the whole assembly survive durability testing with simulated wheel reaction torque after each apply. The assembly shall meet the usage requirements in this section with cables mounted in the vehicle position. The assembly shall not exhibit any visible cracks during or after testing. Reference GMW15466 and GMW14376 test procedure.

3.1.6 Clearance to Surrounding Components.

3.1.6.1 Minimum Allowable Wheel Clearance. The maximum envelope of the standalone parking brake caliper (including build tolerances, lining wear, and deflections) will be less than the minimum envelope of the wheel (including build tolerances, runout, wheel balance weights, tire chains, and deflections under load). The design envelope will be 3.0 mm lateral and radial clearance between the standalone parking brake caliper and the wheel. The supplier shall provide component design information, including the component packaging envelope and all positioning dimensions and tolerances. See program-specific technical specification.

3.1.6.2 Caliper Clearance with Lining Wear. The caliper (including the park brake lever, if an integral park brake design) shall clear all nearby components, including suspension components, with the lining in a fully worn state. The lining fully worn state shall be simulated (in sliding calipers) by removing the outboard lining completely and touching the caliper fingers (or outer housing pad interface surface, if applicable) to the nominal (new) rotor outboard surface. Position variation and movement of other components shall be comprehended in this study. A minimum design clearance (nominal caliper in fully worn pad and rotor condition) to nearby components on the inboard side of the caliper is 8 mm.

3.1.6.3 Nominal Caliper Envelope. All features of the caliper with nominal design dimensions must be contained within the nominal caliper assembly design envelope. See program-specific technical specification.

3.1.6.4 Engine Control Unit Wiring Connector. Appropriate routing, protection and consideration needs to be applied for the wiring and wiring connector for the sensors for the brake control systems. See program-specific technical specification.

3.2 Product Characteristics.

3.2.1 Performance Requirements. The performance characteristics (3.2.1.1 through 3.2.1.8) apply to the standalone parking brake caliper. These requirements are in addition to requirements contained in other applicable technical specifications.

For all procedures for which an applicable Test Improvement Process (TIP) Certification program exists, data must be generated using TIP certified equipment. Inertia dynamometer procedures that do not have a TIP certification program established must be TIP certified to run GMW14925. Consult the GM engineer responsible for administering the TIP program for the most current list of procedures with TIP certification programs.

3.2.1.1 Noise, Vibration, and Harshness

3.2.1.1.1 Squeaks and Rattles. Brake pad rattle or caliper suspension related noise is unacceptable at all conditions of use. For vehicle-level specifications, see the applicable brake corner technical specifications (GMW15392).

Calipers shall be evaluated for rattle at a component level (caliper assembly only on test rig per GMW16316) and at a vehicle level (GMW8518), using Power Spectral Density (PSD) data to drive the test.

The caliper assembly must meet the requirements specified in 3.2.1.1.1.1 when tested per GMW16316 in a new pad condition. Calipers must also meet these requirements after durability testing. The applicable component-level durability test is GMW15367.

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3.2.1.1.1.1 Requirements for Calipers for Vehicles < 3500 kg Gross Vehicle Weight (GVW).

- **Instationary Zwicker Loudness < 5.0 sones N10 during Medium Random Excitation Input (per GMW8518).** Use application-specific PSD recorded from brake corner knuckle or caliper adapter plate position when possible; if not available, use available PSD from similar vehicle.
- **Instationary Zwicker Loudness < 10.0 sones N10 during High Random Excitation Input (per GMW8518).** Use application-specific PSD recorded from brake corner knuckle or caliper adapter plate position when possible; if not available, use available PSD from similar vehicle. **Note:** Certain vehicle applications may cause equipment commonly used for this type of testing to become stroke-limited during high random excitation inputs. In these cases, consult with GM engineering to determine an appropriate alternate test plan.
- **Instationary Zwicker Loudness < 15.0 sones front N10 on Brazilian Belgium Blocks (D2) Road Profile.** Use application-specific PSD recorded from brake corner knuckle or caliper adapter plate position when possible; if not available, use available PSD from similar vehicle. **Note:** Certain vehicle applications may cause equipment commonly used for this type of testing to become stroke-limited during high random excitation inputs. In these cases, consult with GM engineering to determine an appropriate alternate test plan.

3.2.1.1.2 Sound Quality during Actuation and Release (Electrically Actuated). All sounds shall convey solid construction and smooth operation. All sounds shall meet the requirements listed in Table 2 and Figure 1 when measured in a free-free boundary at a distance of 500 mm perpendicular to the face opposite the mounting bracket.

Table 2: Electric Park Brake Sound Quality

Requirement Suffix	Operating Condition	Test Procedure	.a	.b	.c	.d	.e	.f
			Specific Loudness (Summed Exceedance)	Steady State Average Loudness (Sones)	Maximum Transient Loudness (Sones)	Relative Pitch Allowed Variation (Summed Exceedance at ± 0.3 scale-steps Relative Pitch Slope Variation)	Relative Pitch Slope (Scale Steps/s)	Warble (Percent Difference)
.1	Electric Park Brake Engage	GMW14155	≤ 10	≤ 10	≤ 12	≤ 0	≥ -0.3 and ≤ +0.3	≤ 10
.2	Electric Park Brake Disengage	GMW14155	≤ 10	≤ 10	≤ 12	≤ 0	≥ -0.3 and ≤ +0.3	≤ 10

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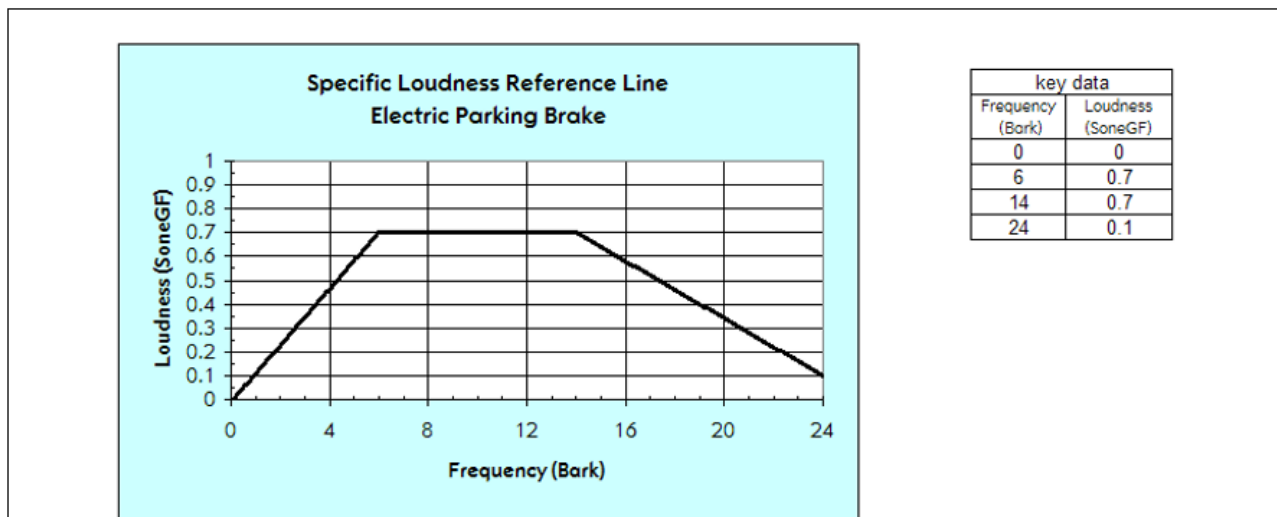


Figure 1: Electric Park Brake Sound Quality Specific Loudness Reference Line

3.2.1.2 Output Characteristics. The standalone parking brake caliper shall meet the following requirements when tested per GMW14925.

3.2.1.2.1 Apparent Friction. The apparent friction for any proposed lining must be reviewed and approved by GM engineering. The static friction of the standalone parking brake caliper friction material should be mapped in a temperature range from -30 °C to +400 °C, and a clamp load range of 10% maximum up to 100% maximum. The procedure and test points in the evaluation matrix are to be defined between GM and the supplier.

3.2.1.3 Brake Drag and Rotor Thickness Variation Development.

3.2.1.3.1 Drag Torque. The caliper shall meet the specified brake drag requirements, following the pressure apply conditions listed, per GMW14351. See CG3856, Requirements Table External Supplement to GMW15392 for requirements.

3.2.1.3.2 Pad Slide Forces. The pad slide force (per pad) should be within the specified range.

- New Condition: 15 N < Slide Force < 25 N.
- Following 2 years equivalent corrosion exposure: 15 N < Slide Force < 40 N.
- Following 10 years equivalent corrosion exposure: < 100 N.

3.2.1.3.3 Off-Brake Rotor Thickness Variation Development. The rotor shall develop less than the specified thickness variation during GMW14926. See CG3856, Requirements Table External Supplement to GMW15392 for conditions and requirements. For standalone parking brake calipers, the rotor should be burnished with the service brake according to GMW14926. The main procedure of GMW14926 is run with the service brake removed, and the parking brake actuated instead of the service brake where specified in the procedure.

3.2.1.4 Breakaway Force. Following the brake pad to rotor corrosion breakaway force measurement method per GMW16696, the breakaway force shall meet the specified requirement. See CG3856, Requirements Table External Supplement to GMW15392 for conditions and requirements.

3.2.1.5 Knockback. The input travel to achieve 20% grade holding torque (manual calipers) or the apply response time to achieve 20% grade holding torque (electric calipers) must not increase by more than .10% following exposure to inertial knockback conditions detailed in GMW15104. Lab-based simulations of GMW15104 conditions may be used for development with GM approval.

3.2.1.6 Caliper Piston Boot and Rubber Component Integrity. The brake caliper piston boot and rubber components shall not incur any damage that results in a loss of sealing ability through their full range of travel during the specified tests. See CG3856, Requirements Table External Supplement to GMW15392 for conditions and requirements. See program-specific technical specifications for additional requirements.

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