



Drum-in-Hat Park Brake Assembly 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 program-specific technical requirements for the Rear Park Brake Drum-in-Hat (DiH) Assembly. The DiH brake performance requirements are focused on a mechanically or electromechanically actuated Drum-in-Hat (eDiH) brake mechanism.

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 rear park brake DiH assembly. These requirements apply to the bandwidth parameters described in the Brake Corner Assembly Program-specific Technical Specification.

1.2 Applicability. This standard applies to all rear park brake DiH assemblies with a friction-based, mechanically or electromechanically actuated drum park brake mechanism.

1.3 Remarks. The DiH assembly transforms force and travel from an actuator (actuated by an external park brake cable system or electric motor/drive mechanism) into torque applied to the rotor center hat section. If the DiH is electromechanically actuated, it will include an electric motor and drive mechanism as part of the DiH assembly, and shall meet the requirements of the Electric Park Brake Component Technical Specification (CTS) and Subsystem Technical Specification (SSTS).

2 References

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

2.1 External Standards/Specifications.

ASTM A313	ISO/TS 16949	SAE J866	USCAR EWCAP-001
GB 5763-2008	SAE AMS2757		

2.2 GM Standards/Specifications.

GMW3059	GMW14165	GMW14937	GMW15626
GMW3091	GMW14283	GMW15193	GMW15841
GMW3097	GMW14375	GMW15272	GMW15862
GMW3103	GMW14376	GMW15344	GMW16066
GMW3172	GMW14386	GMW15363	GMW16316
GMW3191	GMW14559	GMW15367	GMW16331
GMW4700	GMW14671	GMW15386	GMW16352
GMW8518	GMW14700	GMW15392	GMW17000
GMW14089	GMW14872	GMW15466	GMW17026
GMW14155	GMW14925	GMW15587	

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2.3 Additional References.

- CG1290 Knuckle Technical Specification (ID)
- CG3856 Specifications Table for GMW15392 Brake Corner Technical Specifications (ID)
- GM Best Practice: Brakes – 137 (ID)
- GM Best Practice ELEC86-69 (ID)
- 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 Global Preferred Materials Catalog (ID)
- GM Labels and Literature web site (<https://gmweb.gm.com/sites/toolkit/48Inl/Pages/Home-Page.aspx>) (ID)
- GM Materials and Corrosion web site (https://gmweb.gm.com/sites/veh_matls/Pages/default.aspx) (ID)
- Interface Control Document (ICD)
- Interface Dimension Chart
- Key Characteristics Designation System (KCDS) Database
- Program-specific Component Technical Specification (CTS)
- Program-specific Statement of Requirements (SOR)
- Program-specific Subsystem Technical Specification (SSTS)
- Program-specific Vehicle Technical Specification (VTS)
- Squeak and Rattle Noise Glossary

(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 DiH assembly transforms mechanical force and travel (such as from a cable input or an electric motor and drive mechanism), into static (park) torque for park brake functionality.

3.1.1 Appearance. See 3.2.1.1 for appearance and performance specifications related to corrosion exposure.

3.1.2 Content. Including content and splash, debris, and corrosion protection.

3.1.2.1 Physical Content. The DiH assembly contains all the hardware necessary to perform the requirements set forth in this document. The assembly can include a knuckle (if applicable), linings/shoes, brake rotor, wheel bearing, shoe mechanical actuator/lever mechanism, torque reaction plate/splash shield, shoe return and hold down springs, shoe adjuster and may include wheel speed sensors and miscellaneous protective covers for items such as a backing plate inspection hole. The assembly will contain the park brake mechanism.

3.1.2.2 Functional Content. The DiH assembly transforms force and travel from an actuator (actuated by an external park brake cable system or electric motor/drive mechanism) into torque applied to the rotor center hat section. If the DiH is electromechanically actuated, it will include an electric motor and drive mechanism as part of the DiH assembly. The DiH assembly may provide wheel speed information to the chassis electrical system for chassis control systems.

3.1.2.3 Wheel Bearing Protection. The DiH assembly must include a method or related structure(s) for protecting the wheel bearing seals (and if applicable, the wheel speed sensor tone ring) from debris exposure. See program-specific technical specification.

3.1.2.4 Rotor Splash Shield. The DiH assembly must include a rotor splash shield. The splash shield must extend beyond the outer edge of the rotor (in the radial direction) and allow for a rotor wrap around feature to provide coverage from under vehicle airborne debris flow. The outer edge of the splash shield must incorporate a 180 degree full hem. The splash shield must allow for features (such as central vents or louvered slots) to provide airflow to the rotor braking surfaces without allowing for direct exposure of the rotor friction surface to debris flow.

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For a reference of suitable splash shield materials, refer to the GM Global Preferred Materials Catalog and the Rotor Splash Shield CTS and the Corner Assembly Technical Specification, GMW15392. A coating must be used to separate the shield from interfaces constructed of dissimilar materials. See GM Materials and Corrosion web site. The rear splash shield will utilize aluminized steel, GMW2M-ST-S-CR2-AI-T1M-120, 1.0 mm minimum thick. Refer to GMW16066 for the aluminized sheet steel specification.

3.1.2.5 Shoe/Lining Assembly Hold Down Springs. The shoe and lining assembly hold down springs shall be flat style springs. The springs shall be positioned at a distance from the shoe anchor point to provide the maximum attainable resistance to movement of the shoes about the anchor point.

3.1.2.6 Shoe/Lining Assembly Return Springs. The DiH assembly shall utilize dual shoe and lining return springs located on opposite sides of the shoe web to minimize bear trapping of the shoe and linings when they are in the released position.

3.1.2.7 Spring Material. All internal shoe return springs, hold down springs, adjuster springs, etc., shall be capable of withstanding internal DiH operating temperatures generated by the hydraulic service brake without loss of tension. The springs shall be manufactured from Type 17-7 PH stainless steel per ASTM A313 or Type 302 stainless steel per ASTM A313, to minimize the load loss under elevated temperatures and to provide cyclic loading spring fatigue life.

3.1.2.8 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.

3.1.2.9 Fastener Selection. GMW17000, GM Global Fastening Catalog, contains the recommended brake system fasteners. See the GM Global Fastening 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.

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

3.1.3 Ambient Environment. Operating and Non-Operating Environments.

3.1.3.1 Environmental Definition. The DiH assembly will be exposed to the environmental conditions (Table 1) in either customer usage or in the manufacturing and assembly process. The DiH assembly shall meet the requirements contained in this document during and after these exposures. Appropriate laboratory tests may be used to demonstrate this performance. The Electric Park Brake (EPB) shall pass the tests contained in GMW3172 per the validation classifications in Table 1 and GMW15466 (as approved by GM Engineering).

Table 1: Validation Classifications

Exposure	Classification
Electrical Loads	C
Mechanical Loads	C (F if electrical parts are unsprung mass)
Operating Temperature	C
Climatic Loads	J
Chemical Loads	F
Dust and Water Protection	IP6K9K

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

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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 > 160 000 km, the hours and cycles should be adjusted accordingly.

3.1.3.2 Temperature Range. The temperature range for ambient conditions is -40 °C to +85 °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 generated by the dynamic requirements specified in this document for the DiH, or the temperature reached due to extreme usage of the service brake components surrounding the DiH.

Excursion conditions represent elevated temperature exposure not to exceed 30 minutes continuous. Materials and component geometries shall be selected/designed that allow the operating temperature conditions (a, b and c) to be met.

Extreme service brake temperatures that the DiH assembly can be subjected are:

- Lining:** TMAX = 600 °C; 800 °C excursion. TMAX for the lining backing plate/shoe 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 shoe assemblies, and to the back of the backing plate/shoe.
- Cast Iron Rotor:** TMAX = 700 °C; 800 °C excursion for cast iron rotors. See program-specific technical specifications for rotors constructed from alternate materials.
- Bearing:** TMAX = 120 °C, 180 °C excursion with no seal damage.

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 +85 °C.

3.1.3.4 Atmospheric Pressure. The DiH assembly will be exposed to between 330 mmHg and 860 mmHg during operation and storage.

3.1.3.5 Potential Contaminants. The DiH assembly must either be able to withstand prolonged exposure to contaminants which could be encountered in vehicle use or must be packaged to protect 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 DiH assembly 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 DiH 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 Cooling Coefficient. Shall be specified for the selected DiH rotor geometry and working mass to support meeting system-level thermal performance requirements. See program-specific technical specification.

3.1.3.7 Air Flow Requirements. When applicable, DiH structure(s) (e.g., backing plate) shall provide features or openings to route air flow to the brake rotor or any other appropriate brake corner component specified by GM Engineering. See program-specific technical specification.

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

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3.1.3.9 Non-Operating Environmental Exposure. The DiH shall meet all operating performance requirements, without loss of function or degradation of service life, as defined in this document, under the operating environment defined in 3.1.2.1 through 3.1.2.4 after exposure to the non-operating conditions (a through d). This requirement must be met with the park brake being applied during the vehicle transportation techniques listed (a through d). Loads imparted to the DiH in the maximum applied condition during vehicle shipping must be considered in the design, with no part failure or service life degradation allowed.

- 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. Vehicle Interfaces, Driver Interfaces, and Loads.

3.1.4.1 Structure Interface. The DiH assembly shall interface with the brake, suspension and chassis structure as shown in the appropriate drawing file. See program-specific technical specification.

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

3.1.4.2.1 Parking Brake Interface.

3.1.4.2.1.1 Rear Foundation Brake Knuckle/Backing Plate. 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. The reaction point must adhere to the requirements found in GM Best Practice: Brakes – 137. (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.) 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 ensure 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.

The DiH actuator shall be located at the 12 o'clock position. A deviation to the 12 o'clock position may be allowed, if not possible due to packaging, but the position must be approved by GM Engineering.

The DiH assembly shall have an access window (with appropriate seal plug) that allows shoe diameter adjustment without removal of corner assembly parts.

The DiH backing plate shall also serve as a rotor splash shield as specified in 3.1.2.4.

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 with a 200 N force.

3.1.5 Usage Definition. The customer usage data given in this section are for high levels of usage in 195 000 km of retail customer driving for car applications. Trucks require 320 000 km. Note that low levels of usage may be more appropriate for certain failure mechanisms, such as corrosion.

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. Components may be exposed to gravel roads and subjected to stone impingement. The vehicle may be subjected to home or hand washing, drive through washing or wand washing throughout its life. The entire DiH assembly will be exposed to the corrosive environment, which occurs in the Scandinavian countries, the Northeast United States of America and Southeast Canada. The environment is composed of temperature, humidity, salt, splash, mud, and component usage. The DiH assembly should be expected to be exposed to all of these environments and shall maintain full functionality while operating in these environments. Corrosion will be evaluated on durability vehicles completing fifteen (15) year corrosion schedule. Test procedures will be listed in the vehicle program-specific Vehicle Technical Specification (VTS).

3.2 Product Characteristics.

3.2.1 Performance Requirements. The performance characteristics (3.2.1.1 through 3.2.1.10) apply to the DiH assembly. These requirements are in addition to requirements contained in other applicable technical specifications. The DiH assembly and its associated components shall meet the performance requirements for

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all applicable regions defined in the program-specific technical specifications, using GM approved lining/friction material(s).

Supplier shall provide the GM engineer with test data that verifies that performance will meet the requirements as stated in 3.2.1.1 through 3.2.1.10. 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 Cosmetic Corrosion Resistance. The DiH components and assembly must meet the corrosion performance and validation requirements specified in GMW15272 for both functional and cosmetic corrosion performance. When invoked by GMW15272 for DiH 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.

Components or sections of components visible through the wheel must meet the cosmetic corrosion requirements for exterior surfaces (GMW15272) instead of those for the underbody. They must also meet the same requirements following an equivalent level of exposure during vehicle durability testing.

Laboratory (component level) validation testing of the splash shields shall be to GMW14872: Underbody; All mounting locations; four (4) salt sprays per cycle; Method 1/2; Exposures A (cosmetic), and E (functional). Prior to the start of test, the splash shield face and any applicable wheel bearing shield or shielding surface shall be subjected to stone chip exposure per GMW14700 Method B. Thermal cycling of the shield during the ambient portion of the GMW14872 test cycle shall also be conducted using a temperature target provided by the GM Design Engineer.

3.2.1.2 Functional Corrosion Resistance. The definition of the DiH remaining functional after corrosion exposure is meeting the following requirements after 10 years simulated corrosion exposure/15 years projected corrosion exposure, as defined in GMW15272. Specifically, the GMW14872 functional corrosion testing shall be: Underbody; All mounting locations; four (4) salt sprays per cycle; Method 1/2; Exposure E (functional). GMW17026 shall also be used for functional corrosion testing in order to comprehend the effect of wear on the functional corrosion performance (specific procedure selectable cycles and sequences shall be approved by GM Engineering).

- All seals intact, no cracks or separation that may allow leakage.
- All threaded fasteners can be loosened without using applied heat, without breakage (external lubricant is permitted).
- All lubricated or sealed moving components continue to move/slide freely – no seizing. This includes, but is not limited to, guide pins, pistons, actuation levers, and motor-gear units. Any lubricated components should incorporate lubricant retention features in order to maintain movement functionality.
- External, non-wearable moveable components shall remain functional with no seizure or fracture. This includes, but is not limited to, levers and return springs.

In order to ensure a working DiH assembly at the end of all corrosion testing, the minimum design requirement is to use a low-carbon SAE1008-1010 steel, ferritic nitrocarburize per SAE AMS2757, zinc nickel plate per GMW4700 Zn-Ni Type B with a Poly Tetra Fluoro Ethylene (PTFE) top coat per GMW14671-F-U/B, on interfacing surfaces (as approved by GM Engineering), with a sealing boot on the actuation lever as it passes into the internal actuator.

- The eDiH Motor Gear Unit (MGU), must be sealed to prevent any water or debris intrusion within the unit and, in particular, sealed to prevent intrusion at the electrical connector and at the interface between the MGU and any DiH mechanical actuator.
- The EPB actuator shall meet the corrosion durability life cycle defined in GMW3172 and GMW15466.

3.2.1.3 Parking Brake Performance.

3.2.1.3.1 Park Brake Torque. The expected static park brake performance from the rear corner assembly is shown in Table 2. Supplier shall provide the GM engineer with test data that verifies the -3σ assembly (with semi-green linings, temperature at 50 °C to 100 °C) will meet the requirements as stated in Table 2, with the

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vehicle at Gross Vehicle Mass (GVM) and maximum Static Loaded Radius (SLR) tire/wheel, per the GMW14925 test procedure. Semi-green linings are defined as linings that are unused, but present in the DiH assembly during the Federal Motor Vehicle Safety Standard (FMVSS) burnish procedure for service brake linings. If the Electronic Control Unit (ECU) is located separately from the MGU, then the losses from the vehicle wiring from the ECU to the MGU must be considered in the DiH system design.

Table 2: Park Brake Static Torque Performance

Inputs		Minimum Static Torque Achieved Per Side
Cable Force	(Newtons)	To hold 30% grade at Gross Vehicle Weight Rating (GVWR)
Cable Travel	(millimeters)	To hold 12% grade at Gross Curb Weight Rating (GCWR)
eDiH	9 V at ECU 6 V at Actuator	To hold 30% grade at GVWR To hold 12% grade at GCWR

Note: The requirements must be met using components in the as-shipped condition, in both the forward and reverse direction, assuming a 60%/40% torque split side to side.

Potential DiH suppliers to General Motors shall quote, as an option, an assembly that has been burnished in their facility to attain the maximum static torque output possible. This improved static torque performance shall be measured and reported per the requirements in GMW14925.

3.2.1.3.2 Park Brake Apply/Release Time. See 3.2.1.7, Electric Parking Brake Requirements.

3.2.1.3.3 Park Brake Apply/Release Noise. There shall be no customer annoyance due to mechanical or electromechanical apply and release of the DiH (squeaks, creaks, groans, clicks, etc.) Additionally, eDiH noise requirements are specified in 3.2.1.7, Electric Parking Brake Requirements.

3.2.1.3.4 Dynamic Park Brake Usage. The park brake shall be functional after the inputs listed in 3.2.1.3.4.1 and 3.2.1.3.4.2. Cooling is permitted between cycles. The shoe diameter may be adjusted back to specifications after test.

3.2.1.3.4.1 Emergency Usage. Ten (10) maximum deceleration park brake applies will be made: five (5) from 112 km/h and five (5) from 60 km/h.

3.2.1.3.4.2 Cornering. Twenty (20) (ten (10) right hand and ten (10) left hand) park brake applies will be made from 64 km/h to lock the rear wheels with maximum lateral loading. For vehicles intended for police usage, increase the number of applies to 80 (40 right hand and 40 left hand).

3.2.1.3.5 eDiH Total Travel. The eDiH actuator shall provide total travel that enables full usage of the agreed lining thickness, and also enable a nominal running clearance to the rotor of 1.0 mm.

3.2.1.3.6 Lining Wear Indication. eDiH designs must include a control algorithm that can alert the driver when a shoe replacement is required due to lining wear.

3.2.1.3.7 Park Brake Performance after Heating. Per GMW15587, after using service snubs to achieve 150 °C parking brake lining temperatures, the vehicle must hold a 20% or 30% grade (whichever is the applicable vehicle-level gradeability specification) continuously, while the linings cool down to 25 °C. If vehicle is equipped with an electric park brake system, the EPB system output shall be what the system is calibrated to deliver for normal parking operation (this can include a re-clamp if the control algorithms are designed to include this).

3.2.1.3.8 Parking Brake Lining Wear. The DiH shoes shall have provisions to prevent vertical translation of the shoe lining assembly. The shoe assembly hold down springs shall be flat (i.e., no coils). A provision to adjust the lining clearance to the rotor shall be included (with access hole sealed with a plug). The adjustment design shall be such that a method to set the clearance can be accomplished with standard shop tools. The parking brake system shall retain ability to hold a 20% grade at Gross Vehicle Weight (GVW) loading (12% grade with

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