



## **Global Carbon Canister Component 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.** The carbon canister is a component of the Evaporative Emissions Subsystem and the Powertrain Controls and Diagnostics System. The carbon canister provides the means for storing fuel vapors within the vehicle system.

**1.2 Applicability.** This document defines application requirements for a carbon canister. The functions, performance, reliability and validation required of the carbon canister are defined in this document.

The intent of this document is to:

- Provide a structured information flow process between the carbon canister supplier and the carbon canister customer.
- Provide a controlled, disciplined design/change process.
- Provide a useful design history through the revision summary.

**1.3 Remarks.** This document is used in conjunction with CG2929, Global Carbon Canister Application Specific Requirements, to form the total requirements for a carbon canister.

### **2 References**

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

#### **2.1 External Standards/Specifications.**

|                |            |            |                      |
|----------------|------------|------------|----------------------|
| 40 CFR Part 86 | Euro 6     | Korea LEV3 | United States LEV2   |
| Beijing 6      | ISO 1431-1 | SAE J726   | United States LEV3   |
| China 6        | ISO 12500  | SAE J2044  | USCAR LEV III/Tier 3 |
| Euro 5         | Korea LEV2 |            |                      |

#### **2.2 GM Standards/Specifications.**

|         |          |          |          |
|---------|----------|----------|----------|
| GMW3059 | GMW14264 | GMW15311 | GMW15826 |
| GMW3286 | GMW14889 | GMW15570 | GMW15862 |

**Note:** These documents form a part of this specification to the extent specified herein. In the event of a conflict between the text of this specification and the applicable General Motors documents, the text of this specification takes precedence. Nothing in this specification, however, supercedes applicable laws unless a specific exemption has been obtained. Quality and Product Assurance (Q and PA) is responsible for maintaining current GM documents necessary to define subsystem requirements and specifications. (Check with Q and PA Systems Engineering Library for available test procedures and other applicable documents.)

#### **2.3 Additional References.**

- CG2928, Carbon Canister Validation Cross Reference Index
- CG2929, Global Carbon Canister Application Specific Requirements
- China V Testing Procedure
- Component Technical Specifications (CTS)

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- GM Powertrain Fuels and Lubes Website: [https://gmweb.gm.com/sites/materials\\_eng/Pages/Home.aspx](https://gmweb.gm.com/sites/materials_eng/Pages/Home.aspx) (ID)
- Instron Company, Norwood, Massachusetts ([www.instron.com](http://www.instron.com))
- TF1 (GMPT-6-005), Refers to fuel containing 90% gasoline and 10% ethanol
- TL.46.0005, GM Mechanical Stress Testing of Chassis Mounted Products (Evaporative Emissions (Evap) Guideline 60):  
<https://documents.naeng.gm.com/gdm3/drl/objectId/090163bd803d91ba/chronicleId/090163bd803d91ba> (ID)
- United States Council for Automotive Research (USCAR) LEV III/Tier 3 Bleed Emissions Test Procedure (BETP): <http://www.uscar.org/guest/teams/55/Evaporative-Emissions-EVAP-Team>
- Vehicle Technical Specification (VTS)

(ID) = These references are internal to General Motors and cannot be accessed outside the company. Contact the GM Lead Engineer for further instructions.

### 3 Requirements

#### 3.1 System/Subsystem/Component/Part Definition.

##### 3.1.1 Appearance.

**3.1.1.1 Appearance by Design.** The aesthetic requirements of the carbon canister shall be negotiated with the design release engineer who shall have the responsibility to conform to the requirements defined in the Vehicle Technical Specification (VTS).

**3.1.1.2 Appearance After Durability.** Appearance shall not be significantly degraded after durability. Components shall be cleaned using common soap and water. The criteria in 3.1.1.2.1 through 3.1.1.2.3 shall be met.

**3.1.1.2.1** No cracking or swelling observable using the naked eye at 1 m distance.

**3.1.1.2.2** No color fade or discoloration (GMW14264, Subjective Rating Scale  $\geq 6$  moderate).

**3.1.1.2.3** External metallic parts shall not exhibit red or white rust or corrosion (GMW14264, Subjective Rating Scale  $\geq 8$  trace).

**3.1.2 Content.** The required physical and functional contents for the carbon canister are identified in 3.1.2.1 and 3.1.2.2.

**3.1.2.1 Physical Content.** Features defined in this section must be compatible with the system architecture definition:

- Partitioned carbon bed
- Integral liquid trap (integrated canister only)
- Buffered fuel/vapor (non-integrated pressurized canister only)
- Robust to underbody environment
- Quick connect vapor plumbing
- Integral volume compensator
- Global design dovetail mounting feature with multiple mounting orientations
- Canister Vent Solenoid (CVS) for On Board Diagnostics (OBD) with global common interface (reference GMW15826)

**3.1.2.2 Functional Content.** The carbon canister shall provide the functions:

- Adsorb vapor/Desorb vapor
- Transport air and vapor (liquid)
- Provide for adequate flow
- Provide connection to components
- Provide mounting
- Contain carbon
- Maintain carbon pack

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**3.1.3 Ambient Environment.** The environmental conditions that the carbon canister may encounter during its life are defined in 3.1.3.1 through 3.1.3.4.

**3.1.3.1 Operating Environment.** The carbon canister shall satisfy all performance requirements within the conditions outlined in the Fuel Subsystem Technical Specification (SSTS), GMW15311.

**3.1.3.2 Non-Operating Pressure and Temperature.** The carbon canister 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 after exposure to the following non-operating conditions:

- Transport at altitudes up to 13 700 m
- Free air temperature of -48 °C to 93 °C

**3.1.3.3 Fuels.** The carbon canister shall meet 100% of the performance requirements specified in 3.2, after exposure to the fuels identified in the appendix of the Fuel SSTS, GMW15311. These test fuels are defined in the GM Powertrain Fuels and Lubes Website and shall be purchased from an approved supplier.

**3.1.3.4 Contamination.** The carbon canister shall meet all performance requirements in 3.2, after exposure to the contaminants listed in the appendix of the Fuel SSTS, GMW15311.

**3.1.3.4.1 Water/Snow/Mud Exposure.** The carbon canister shall not incur performance degradation as a result of exposure to water, snow or mud as described in the Fuel SSTS, GMW15311.

**3.1.3.4.2 Gravel and Stone Chip Impingement.** The subsystem components shall be exposed to gravel and stone environment due to operation of the vehicle on loose surfaced roads without functional degradation.

**3.1.3.4.3 Dust Exposure.** The carbon canister shall be capable of withstanding exposure to exterior sand and dust concentration levels during its useful life as shown in Table 1.

**Table 1: Dust Exposure**

| Dust Concentration (mg/m <sup>3</sup> ) | Time at Concentration (%) |
|-----------------------------------------|---------------------------|
| 6113                                    | 1.0                       |
| 1484                                    | 7.6                       |
| 441                                     | 5.9                       |
| 240                                     | 16.9                      |
| .0139                                   | 68.6                      |
| Total                                   | 100.0                     |

**3.1.3.4.4 Chemical Corrosives.**

- Sodium Chloride (NaCl) in quantities equivalent to 15 years of service life in Montreal, Quebec area
- Calcium Chloride (CaCl) in quantities equivalent to 15 years in rural areas where CaCl is used as a dust control agent on unpaved roads

**3.1.3.4.5 Internal Contaminants.** The contaminants in Table 2 are likely to be found within the Evap subsystem components. The contaminants enter the components primarily through the fresh air inlet to the carbon canister. Some are the result of corrosion and interaction within the component.

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Table 2: Internal Contaminants

|                                    |                        |                           |
|------------------------------------|------------------------|---------------------------|
| Aluminum                           | Copper                 | Plastic <sup>Note 1</sup> |
| Barium                             | Corrosion              | Potassium                 |
| BBSA Plasticizer <sup>Note 2</sup> | Dust <sup>Note 1</sup> | Potassium Chloride        |
| Calcium                            | Fluorine               | Salt                      |
| Calcium Carbonate                  | Grease/Lubricant       | Sand <sup>Note 1</sup>    |
| Calcium Chloride                   | Iron                   | Silicon                   |
| Carbon <sup>Note 1</sup>           | Nickel                 | Sodium Chloride           |
| Chloride                           | Nickel Oxide           | Sulfur                    |
| Chromium                           | Organic Residue        | Zinc                      |
| Clay                               | Phosphorus             | Zinc Oxide                |

**Note 1:** The carbon canister shall be robust to random incidence of foreign particles that could plug or cause malfunction.

**Note 2:** BBSA = N-n-Butylbenzenesulfonamide.

### 3.1.4 Interfaces.

**3.1.4.1 Connections.** The components shall be designed unless otherwise designated with snap lock; positive seal and quick connect features per SAE International (SAE) J2044.

Recommended nominal SAE port sizes for canisters:

- Purge port, 12.7 mm (0.5 in)
- Emerging market purge port, 8.0 mm (0.3125 in)
- On Board Refueling Vapor Recovery (ORVR) tank port, 15.88 mm (0.625 in)
- Non-ORVR tank port, 8 mm (0.3125 in)
- Air port, 15.88 mm (0.625 in)

The port shall be designed in the straight position in order to optimize airflow. In some cases, vehicle packaging constraints drive the necessity of a 90 degree bend. If a 90 degree bend cannot be avoided, then special care shall be taken to understand the effects of airflow through the 90 degree bend. Computer Aided Engineering (CAE) analysis shall be conducted by the supplier to analyze airflow for restriction, and for airflow disruptions or turbulence that can lead to excessive dust accumulation in the port. A 90 degree bend in the port shall be designed with a larger radius opening at the bend for optimal airflow.

**3.1.4.2 Mounting.** The carbon canister shall provide a dovetail mounting feature that allows for mounting in any of the three primary orientations. Contact the Canister Design Engineer (DE) for the latest dovetail drawing.

- The canister shall be mounted consistent with liquid trap function.
- The tank tube should be at the lowest point of the liquid trap and lower than the purge tube when mounted in a non-vertical orientation.
- The canister mounting shall limit vibration and shock input to the carbon canister through its recommended mounting configuration to levels below those values defined in GMW15570.
- The canister shall be mounted as near the fuel tank as practical to avoid excessive vapor line restriction during refueling, ORVR.
- Vapor transport tubes shall be routed such that OBD (if applicable) and Evap functions are not adversely impacted due to liquid fuel intrusion.

**3.1.4.3 Canister Vent Solenoid.** For canisters using an integrated canister vent solenoid, reference GMW15826 for requirements. Contact the canister DE for mounting provisions.

**3.1.5 Usage Definition.** The design and operation of the carbon canister must comprehend typical severe environment and customer usage conditions to successfully meet the intended (useful) life defined in the VTS

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for the specific application. It is intended that the operation of the carbon canister will be transparent to the driver. Reference VTS, Usage Over Life Cycle.

**3.1.5.1 Vehicle Wash.** The carbon canister shall not incur performance degradation as a result of exposure to vehicle wash as described in Fuel SSTS, GMW15311.

**3.1.5.2 Road Splash.** The carbon canister shall not incur performance degradation as a result of exposure to vehicle wash as described in Fuel SSTS, GMW15311.

**3.1.5.3 Water Submersion/Fording.** The carbon canister shall not incur performance degradation as a result of exposure to water submersion/fording as described in Fuel SSTS, GMW15311.

## **3.2 Product Characteristics.**

**3.2.1 Performance Requirements.** The Canister shall meet all operational performance requirements as stated herein per 3.1.3 and 3.1.5, unless otherwise specified. Techniques utilized to satisfy the performance requirements will be reviewed by and approved by the lead canister engineer and canister release engineer.

Flow and leakage measurements shall be corrected to standard temperature and pressure (20 °C and 101.3 kPa absolute pressure) with applied vacuum of  $\pm 0.5$  kPa unless noted.

**3.2.1.1 Adsorb/Desorb Vapor.** The carbon canister shall adsorb/desorb vapor into the carbon bed.

**3.2.1.1.1 Environmental Protection Agency (EPA) Working Capacity.** The carbon canister shall adsorb/desorb hydrocarbon vapors per the EPA working capacity target specified in CG2929. The EPA capacity reported for certification shall be the average of five (5) canisters minimum. This value shall be recorded on the canister drawing with a tolerance of  $\pm 5\%$ . The canister shall include the hydrocarbon scrubber (or similar device), if applicable, as part of the EPA working capacity and volume measurement.

**3.2.1.1.2 ORVR Working Capacity.** The carbon canister shall adsorb/desorb hydrocarbon vapors per the ORVR working capacity target specified in CG2929. The ORVR capacity shall be considered a minimum target.

### **3.2.1.1.3 Diurnal Bleed Emissions.**

- a. Euro 5/Euro 6: Maximum breakthrough  $\leq 165$  mg during one (1) day diurnal test.
- b. Korea Low Emissions Vehicle (LEV)2: Maximum breakthrough  $\leq 136$  mg during one (1), two (2) day diurnal test.
- c. Korea LEV3: Maximum breakthrough  $\leq 25$  mg during two (2) day diurnal test.
- d. United States LEV2: Maximum breakthrough  $\leq 136$  mg during two (2) day diurnal test.
- e. United States LEV3 Average breakthrough  $\leq 14$  mg during two (2) day diurnal test. Maximum breakthrough shall not exceed 17 mg.
- f. Beijing 6/China 6: Maximum breakthrough  $\leq 25$  mg during two (2) day diurnal test.

**3.2.1.1.4 China National V Working Capacity.** The carbon canister shall be measured for China National V Working Capacity. The China V capacity reported shall be the average of three (3) canisters minimum. This value shall be recorded on the canister drawing in terms of grams/100 mL.

### **3.2.1.2 Transport Air and Vapor/Liquid.**

#### **3.2.1.2.1 Manage Entrained/Condensed Liquid Fuel (Integrated Canister Only).**

**Storage:** The canister shall be capable of trapping liquid fuel entering the canister via the tank tube and preventing the liquid from contacting the carbon. The canister shall provide a liquid fuel trap with a capacity of  $\geq 30$  mL and  $< 70$  mL in the application specific orientation.

**3.2.1.2.2 Buffered Fuel/Vapor Flow (Non-integrated Pressurized Canister Only).** Fuel/vapor from the fuel tank shall be buffered such that vapor flow is forced through the carbon bed.

**3.2.1.2.3 Vacuum Cycling.** The ORVR carbon canister shall be capable of withstanding 16 425 vacuum cycles from 0 kPa to -5 kPa at 24 °C without loss of function. Requirement changes to 0 kPa to -16 kPa for a non-integrated pressurized canister.

**3.2.1.2.4 Maximum Pressure.** The carbon Canister shall withstand a maximum pressure of 35 kPa for 60 s at 90 °C without permanent damage.

**Note:** If canister is packaged within 150 mm of exhaust system or under hood, the temperature requirement is increased to 115 °C.

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**3.2.1.2.5 Pressure Cycling.** The carbon canister shall withstand pressure cycling of 0 kPa to 24 kPa pressure for 1100 cycles at 24 °C, without loss of function. Requirement changes to 0 kPa to 28 kPa for 5475 cycles for non-integrated pressurized canister.

**3.2.1.2.6 Creep (Non-integrated Pressurized Canister Only).** The carbon canister shall withstand 28 kPa of pressure at 60 °C for 1500 h without loss of function.

**3.2.1.2.7 Maximum Vacuum.** The carbon canister shall withstand a maximum vacuum of 68 kPa at -20 °C for 1 minute without permanent damage.

**3.2.1.2.8 Leakage.**

- a. LEV2, LEV3, Korea LEV3, Beijing 6 and China 6 and Partial Zero Emissions Vehicle (PZEV) canisters shall have a maximum allowable 15 µm leak rate equivalent. This specification requires a continuous production audit. See Appendix C.
- b. All other canisters shall have a maximum leak rate of 5 cm<sup>3</sup>/minute at 14 kPa in air. If an integrated canister vent solenoid is included in the canister assembly, test to a maximum leak rate of 9.5 cm<sup>3</sup>/minute at 14 kPa in air.

**3.2.1.2.9 Hydrocarbon Loss to Environment – Permeation and Leakage.**

- a. Euro/Korean: Maximum allowable permeation and leakage rate of 16 mg/day.
- b. LEV2/LEV3/Korea LEV3/Beijing 6 and China 6/PZEV: Maximum allowable permeation and leakage rate of 0 mg/day (+2 mg/day, -0 mg/day).

**3.2.1.3 Provide for Adequate Flow.**

**3.2.1.3.1 Purge Vacuum Drop.** Purge vacuum drop is a measure of the vacuum that will be applied to the fuel tank when purging canister. The total allowable purge vacuum drop across the carbon canister shall be < 3.0 kPa for a new canister and < 4.5 kPa after dust test. This is based on the assumption of normal distribution containing 99.8% of sample with 50.0% confidence.

This pressure drop value shall be met across the carbon canister as measured at the tank tube with a dead headed pressure gauge, while pulling a vacuum from the canister air tube to the purge tube at 70 L/minute. For vehicle applications unique to emerging markets, or specifically calibrated for emerging markets, the flow rate can be reduced to an application specific rate per CG2929.

**Note:** The ORVR loading specification and test can be used in lieu of the purge vacuum drop specification and test if the following conditions exist:

- The canister fresh air port is larger or the same diameter as the tank port.
- The canister tank and purge port have a direct unrestricted connection within the canister.

**3.2.1.3.2 Loading Pressure Drop.**

**3.2.1.3.2.1 Diurnal Load.** The total allowable pressure drop across the carbon canister shall be 0.25 kPa maximum at 20 L/h air flow. The pressure drop value shall be met across the carbon canister as measured at the tank tube while flowing air from the canister tank tube to the fresh air tube.

**3.2.1.3.2.2 Refueling (ORVR).** The total allowable air and tank tube pressure drop across the carbon canister for a new part shall be 0.90 kPa ± 0.225 kPa at 60 L/minute air flow, and 1.120 kPa ± 0.5 kPa maximum at end of operational life test or dust test. The above pressure drop value shall be met across the carbon canister as measured at the tank tube while flowing air from the canister tank tube to the fresh air tube.

**3.2.1.3.3 Purge Restriction.** The total allowable purge vacuum restriction across the carbon canister shall be less than 4.5 kPa for non-ORVR and non-OBD2 canisters and less than 2.3 kPa for ORVR or OBD2 canisters. The preceding vacuum restriction shall be met across the purge tube while applying vacuum at the purge tube at a flow rate of 70 L/minute. For vehicle applications unique to emerging markets, or specifically calibrated for emerging markets, the flow rate can be reduced to an application specific rate per CG2929. For canisters with an integrated CVS, reference GMW15826 for additional restriction allowed. Note, any vehicle with a purge pump needs to meet 2.3 kPa at 70 L/minute regardless of region or regulatory requirements.

**3.2.1.4 Port Strength.** The canister ports shall have sufficient strength to withstand a minimum load of 22.7 kg.

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**3.2.1.5 Contain Carbon.**

- a. Filter material specification: The carbon filter shall be 99.7% efficient to 350  $\mu\text{m}$  at the fresh air and tank ports and 100% efficient at 500  $\mu\text{m}$ . The carbon filter shall be 99.7% efficient to 100  $\mu\text{m}$  at the purge ports. For a non-integrated pressurized canister, the fresh air side carbon filter shall be 97% efficient to 75  $\mu\text{m}$ .
- b. Canister: The carbon canister shall not permit more than 0.5 mg of particles greater than 150  $\mu\text{m}$  to migrate out of the purge port under any condition. The carbon canister shall not lose more than 80 mg carbon mass over its useful life. The design of the canister and the assembly of the canister shall be optimized to minimize carbon dust over the life of the vehicle.

**3.2.1.6 Maintain Carbon Pack.** The carbon canister shall be designed to control carbon relative motion throughout its useful life. The carbon canister container shall compensate for normal volume change over its useful life.

**3.2.1.7 Structural Integrity.** The carbon canister shall be robust to normal handling and mishandling. Any canister which is damaged shall have obvious indication of the damage. The canister shall not sustain unobservable internal damage through normal handling and mishandling.

**3.2.1.8 Transmitted Shock, Vibration and Impact.**

- a. Mechanical Shock: Consideration shall be given to effect of shock input to component and component mounting
- b. Vibration: The carbon canister shall meet vibration levels specified in GMW15570, Fuel System Vibration Test.
- c. Impact: The carbon canister shall:
  1. Meet all operational performance requirements, without loss of function or degradation of service life, as stated herein, or
  2. Exhibit obvious exterior (physical) damage, which would cause rejection of the subsystem to the requirements stated herein.

**3.2.1.9 Corrosion Resistance.** The carbon canister shall meet all corrosion requirements stated in the Fuel SSTs, GMW15311.

**3.2.2 Physical Characteristics.**

**3.2.2.1 Dimensions and Capacity.** Drawing and drafting document handling between GM and the carbon canister supplier shall be communicated using three dimensional (3-D) Unigraphics (UG) math data. Conversion to UG from another Computer Aided Design (CAD) system is not allowed.

**3.2.2.2 Mass Properties.** The mass of the carbon canister shall be typically 700 g or less, per liter of carbon.

**3.2.3 Reliability.** The carbon canister shall meet all requirements of this specification under any reasonable combination of conditions given in 3.1.3 and 3.1.5 within its target life.

**3.2.3.1 Reliability Evaluation Point.** The carbon canister shall demonstrate reliability to a minimum of 241 000 km/15 years (150 000 mi/15 years). Should a program specify a higher value, such as heavy duty trucks, the higher requirement shall take precedence.

**3.2.3.2 Reliability Requirements.** The carbon canister shall meet all requirements of this specification, within its target life with 98% probability at a 50% confidence level. A statistically significant sample size, limit part testing, or simulations should be employed to demonstrate compliance with expected variation.

**3.2.3.3 Durability.** The carbon canister shall meet 100% of the performance requirements specified in 3.2, during its target life.

**3.2.4 Serviceability.** Not applicable.

**3.2.5 User System/Subsystem/Component/Part Interface.** Not applicable.

**3.3 Design and Construction.****3.3.1 Materials, Processes and Parts Selection Guidelines.**

**3.3.1.1 Material Guidelines.** Materials to be used in the subsystem shall satisfy the material guidelines stated in the Fuel SSTs, GMW15311.

**3.3.1.2 Processes Guidelines.** Not applicable.

**3.3.1.3 Parts Guidelines.** Not applicable.

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### 3.3.2 Design Guidelines and Constraints.

**3.3.2.1 Key Characteristics Designation System (KCDS).** The canister supplier, lead canister engineer and the canister release engineer shall mutually agree upon the key characteristics shown on the GM drawing. The following should be considered for designation.

- Vent Restriction
- Purge Restriction
- Working Capacity
- Body Leakage

**3.3.3 Identification and Marking.** Identification and markings, when required, of the subsystem components shall be permanent and legible throughout its service life.

**3.3.3.1 Canister Port Identification.** The canister tank port should be identified with the International Organization of Standardization (ISO) symbol of a gas pump (Figure 1). Other ports are not to be identified.



Figure 1: ISO Gas Pump Symbol

**3.3.3.2 Component Identification and Traceability.** The carbon canister shall be clearly and permanently identified with the base canister and assembly (base canister plus any additional components such as bracket, CVS and tubes), part number and build date in accordance with GM traceability identifier requirements per GMW15862. The location of this label shall be agreed upon between GM and the supplier. The carbon canister must be permanently identified with a made in location, supplier name, and a unique canister identifier. The unique canister identifier should be located in a region that is viewable from the underside of the vehicle and should read as follows without spaces or decimals; Size of canister in liters, initial production program first two characters of the alpha numeric program identifier code, and the number of chambers the canister has (scrubbers count as one (1) chamber). An example can be seen in Figure 2.

Made in "Country"  
Supplier Name  
XXLYYZ

Size – X.XL

Initial Program – YY

# of Chambers - Z

**Note:** # = Number

Figure 2: Canister Identifier

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