



Vehicle Ballast

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. To subject test vehicles to passenger and cargo loading representative of customer service by the use of ballast.

1.2 Applicability. Refer to the durability test procedure specifying this test procedure.

1.3 Remarks. This procedure defines the ballast conditions that are to be used for full vehicle durability tests. Refer to the durability test procedure specifying this test event for more information.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15444

3 Resources

3.1 Facilities. Refer to the durability test procedure specifying this test procedure.

3.1.1 Calibration. The test facilities and equipment shall be in good working order 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. Ballast as referred to in this procedure is limited to the mass added to a test vehicle to simulate passenger and cargo loading. The following types of ballast may be appropriate:

- Bags filled with sand, metal shot, or similar material.
- Solid mass units.
- Liquid in appropriate and securable containers (may be 50% antifreeze and 50% water mix in some regions).
- Special ballast containers used for heavier mass. These containers must be securely attached to the vehicle and cannot modify the structural response of the vehicle. This ballast method must comply with the appropriate Proving Ground Driving Regulations.
- Occupants and test equipment. The driver, observers, and necessary test equipment.

3.3 Test Vehicle/Test Piece. There are a number of ballast conditions that are specified in the car and truck durability tests (listed below in increasing mass):

- Light Vehicle Mass (LVM).
- Structural Vehicle Mass (SVM).
- Gross Vehicle Mass (GVM).
- Overload Vehicle Mass (OVM).
- Heavy Cargo Mass (HCM).

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These ballast conditions are defined in 7.1.

Table 1 shows the ballast conditions specified in the structural and general durability tests by vehicle type. Refer to the appropriate GMW durability test document for more information.

Table 1: Structural and General Durability Test Ballast Conditions by Vehicle Type

	Station Wagons and BFI Architectures Without Configurable Cargo Area	BFI Architectures With Configurable Cargo Area (excluding Station Wagons)	BOF Architectures to Primarily Carry Passengers	BOF Architectures to Primarily Carry Cargo
	Cars (Sedans, Coupes, Hatchbacks, Wagons)	Crossovers, SUVs and Passenger Vans	SUVs and Passenger Vans	Pickup Trucks, Cargo Vans and Cab Chassis Trucks
Structural Durability Test (Lab) Ballast Conditions	SVM	LVM GVM	LVM GVM	LVM GVM OVM HCM
General Durability Test (Road) Ballast Conditions	LVM GVM	LVM GVM	LVM GVM	LVM GVM OVM HCM

BFI = Body Frame Integral, BOF = Body On Frame

3.4 Test Time.

Calendar time: 30 minutes to 4 h (vehicle dependent)

Test time: 0 h

Coordination time: 0 h

3.5 Test Required Information. Refer to local proving ground requirements for securing ballast.

3.6 Personnel/Skills. Refer to the durability test procedure specifying this test procedure.

4 Procedure

4.1 Preparation.

4.1.1 Ballast Mass Determination. The amount of ballast to be added to a test vehicle is determined by completing the appropriate ballast worksheet in the appendices. Each appendix contains two ballast worksheets. The worksheets are equivalent with one for mass in kilograms and the other for weight in pounds.

An appropriate ballast worksheet can be printed, calculations completed and then maintained in the vehicle logbook as a permanent record of the ballast conditions used on test.

- Appendix A: Ballast Mass Worksheet for BFI Architectures without Configurable Cargo Area -- Sedans/Coupes/Hatchbacks (Excludes Police Vehicles).
- Appendix B: Ballast Mass Worksheet for BFI Architectures with Configurable Cargo Area -- Crossovers, Passenger Vans, SUVs (Excludes Police Vehicles and Station Wagons).
- Appendix C: Ballast Mass Worksheet for Station Wagons and BOF SUVs and Passenger Vans (Excludes Police Vehicles).
- Appendix D: Ballast Mass Worksheet for Pickup Trucks and Cargo Vans (Excludes Midsize Trucks with a > 700 kg Payload).
- Appendix E: Ballast Mass Worksheet for Midsize Trucks (> 700 kg Payload).
- Appendix F: Ballast Mass Worksheet for Passenger Car and Station Wagon Structural Ballast Condition.
- Appendix G: Ballast Mass Worksheet for Police Vehicles (Cars and SUVs).
- Appendix H: Ballast Mass Worksheet for Cab Chassis Trucks and Medium Duty Vehicles (Family 2).
- Appendix J: Ballast Mass Worksheet for Medium Duty Vehicles (Family 3).

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For structural durability testing, consideration must be given to test at the Gross Vehicle Mass Rating (GVMR) of the architectural limit or whatever is considered to be worst case.

4.1.2 Specification of Pressures. Tire pressures and/or any load leveling device pressures for various ballast conditions should be specified by test responsible personnel. The tires shall be set to the specified tire pressure when the vehicle is ballasted.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

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.

Vehicle ballast is not dependent on the curb condition of the vehicle after the test has begun. Do not consider mud or snow/ice accumulation.

4.3 Instructions.

4.3.1 Placement of Ballast. Simulate cargo and luggage loading by distributing the required mass evenly over the cargo floor.

4.3.2 Roof Carrier Ballast. The ballast for the roof carrier should be removed from the ballast located in the cargo area and secured on the roof carrier such that the total vehicle mass does not change. The amount of mass should be equal to specified load capacity of the roof carrier unless otherwise indicated. The placement of the roof carrier ballast should be the standard cargo test box and be attached to the cross bows as defined in Appendices K and L. No interference of the ballast and cross bars is permissible, and there must be no loss of function on cross bar components.

- Appendix K: Roof Carrier Ballast – Standard Cargo Test Box Dimensions.
- Appendix L: Roof Carrier Ballast – Placement of Test Box.

5 Data

5.1 Calculations. Use data sheets in Appendices A to J for calculations.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation. Refer to worksheets in appendices of this document.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary. Refer to GMW15444 for definitions of terms used throughout the Durability Events.

The following are definitions of common terms related to ballast:

Curb Mass: The as-manufactured mass of the motor vehicle including standard equipment, options, and the maximum fill capacity of fuel, lubricants, and coolant. The curb mass does not include driver or occupant mass. In the case of a vehicle that was originally built as an Incomplete Vehicle, curb mass also includes the mass of any subsequently installed body. Similarly it may be necessary to add ballast to early build vehicles in order to represent the intended curb mass of the production vehicle.

For Computer Aided Engineering (CAE) analyses and other instances where an actual test vehicle does not exist, the curb mass of a model of vehicle should be determined by using the average of the maximum and minimum curb mass for a given engine/transmission/driveline combination. (EPA curb mass should no longer be used for durability testing since this is not a global mass definition.)

For durability testing, only 100% fuel level should be used to determine curb mass.

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Designated Seating Capacity: The maximum number of seating locations as specified by the manufacturer for a given vehicle model type. Seating locations are those occupant locations in which seatbelts are provided, e.g., small rear seats, jump seats, etc. For school bus applications seat locations are not defined by seatbelt locations.

Gross Axle Mass Rating (GAMR)/Gross Axle Weight Rating (GAWR): The value specified by the manufacturer as the load-carrying capacity of a single-axle system, front or rear. GAMR/GAWR is derived by the lowest component rating of tires, wheels, springs or the axle itself.

Gross Combined Mass Rating (GCMR)/Gross Combined Weight Rating (GCWR): The value specified by the manufacturer as the loaded mass of the vehicle and trailer combination.

Gross Vehicle Mass (GVM)/Gross Vehicle Weight (GVW) Cargo Carrying Configuration: The GVM/GVW Cargo Carrying Configuration applies only to vehicles that have a configurable cargo area. This does not apply to passenger cars with fold down seatbacks used to access the trunk or hatchbacks. In the GVM/GVW Cargo Carrying Configuration, seats should be folded down or removed to completely expand the cargo area as shown in the owner's manual. This configuration is defined as the driver + 70 kg (154 lb) in each remaining passenger seat position after the cargo capacity has been expanded + mass in the expanded cargo area.

Gross Vehicle Mass (GVM)/Gross Vehicle Weight (GVW) Ballast Condition: The GVM/GVW ballast condition is defined as loading the vehicle to its listed Gross Vehicle Mass Rating GVMR/GVWR.

Gross Vehicle Mass (GVM)/Gross Vehicle Weight (GVW) Passenger Carrying Configuration: In the GVM/GVW Passenger Carrying Configuration, the number of driver/passenger seat positions is equal to the Designated Seating Capacity of the vehicle. This configuration is defined as the driver + 70 kg (154 lb) in each passenger seat position + mass in the cargo area. For school bus applications each seat position should be ballasted to 57 kg (125 lb).

The GVM Passenger Carrying Configuration may result in a total vehicle mass less than GVM for some vehicles (e.g., crossovers). If the total vehicle mass for the GVM Passenger Carrying configuration is close to the total vehicle mass for the GVM Cargo Carrying Configuration then the greater of these two values can be used for both configurations. As a general rule, a difference of about 2% of GVM is acceptable. Using the same total vehicle mass value for both configurations may reduce the amount of effort for RLDA, vRLDA, drive file creation, etc.

Note: The axle masses are not to exceed 105% of GAMR. If this occurs then the ballast should be placed inside the vehicle in such a way that neither the front nor rear axle mass is greater than 105% of GAMR.

Figure 1 through Figure 3 show the ballast conditions specified in the structural and general durability tests for different vehicles. Refer to the appropriate ballast worksheet in the appendices for more information.

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Structural Durability Test Ballast Condition for Sedans, Coupes, Hatchbacks, Notchbacks and Station Wagons

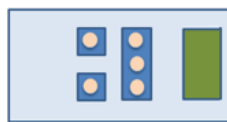
STRUCTURAL VEHICLE MASS (SVM)

General Durability Test Ballast Conditions for Sedans, Coupes, Hatchbacks and Notchbacks (excluding Station Wagons)

LIGHT VEHICLE MASS (LVM)

GROSS VEHICLE MASS (GVM)

Passenger Carrying Configuration



- 70 kg in all seat positions
- Cargo mass determined based on GVM for vehicle

Cargo Carrying Configuration – Not used

The GVM Cargo Carrying Configuration applies only to vehicles that have a configurable cargo area. This does not apply to passenger cars with fold down seatbacks used to access the trunk.

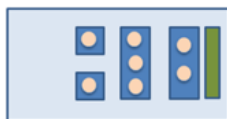
Figure 1: Ballast Conditions for Sedans, Coupes, Hatchbacks, Notchbacks and Station Wagons

Structural and General Durability Test Ballast Conditions for Body Frame Integral (BFI) Crossovers, BFI SUVs and BFI Vans

LIGHT VEHICLE MASS (LVM)

GROSS VEHICLE MASS (GVM)

Passenger Carrying Configuration



- 70 kg in all seat positions
- Cargo mass determined based on VOLUME of cargo area
- Test vehicle mass may be less than GVM for vehicle
- Used during phases 1, 2 and 5 of test

Cargo Carrying Configuration



- 70 kg in some seat positions
- Vehicle is configured to carry cargo (seats folded down or removed)
- Cargo mass determined based on GVM for vehicle
- Used during phases 3 and 4 of test

Figure 2: Ballast Conditions for Crossovers, BFI SUVs and BFI Vans

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General Durability Test Ballast Conditions for Station Wagons

Structural and General Durability Test Ballast Conditions for Body On Frame (BOF) SUVs and BOF Passenger Vans

LIGHT VEHICLE MASS (LVM)

GROSS VEHICLE MASS (GVM)

Passenger Carrying Configuration



- 70 kg in all seat positions
- Cargo mass determined based on GVM for vehicle
- Used during phases 1, 2 and 5 of test

Cargo Carrying Configuration



- 70 kg in some seat positions
- Vehicle is configured to carry cargo (seats folded down or removed)
- Cargo mass determined based on GVM for vehicle
- Used during phases 3 and 4 of test

Figure 3: Ballast Conditions for BOF SUVs, BOF Vans and Station Wagons

Gross Vehicle Mass Rating (GVMR)/Gross Vehicle Weight Rating (GVWR): The value specified by the manufacturer as the gross mass capacity of the test vehicle as measured at the tire-ground interfaces. GVMR/GVWR includes the mass of the vehicle, all occupants, fuel, cargo and trailer tongue load.

Heavy Cargo Mass (HCM)/Heavy Cargo Weight (HCW) Ballast Condition: For light duty trucks, the HCM/HCW ballast condition is defined as loading the vehicle to 130% of its listed GVM/GVW rating. For Cab Chassis Trucks and family 2 medium duty trucks, the HCM/HCW ballast condition is defined as loading the vehicle to 125% of its listed GVM/GVW rating. Only trucks whose primary use is to carry cargo, e.g., pickup trucks and cargo vans, should use this overload condition.

Note: Ballast is not to exceed 135% of either front or rear GAMR. Remove ballast as necessary.

Light Vehicle Mass (LVM)/Light Vehicle Weight (LVW) Ballast Condition: The LVM/LVW ballast condition is defined as curb mass + driver + test equipment. This is the same as driver + test curb mass. Driver mass is estimated at 70 kg (154 lb). The test equipment mass is estimated at 45 kg (100 lb). Actual mass should be used whenever possible. This is not possible when multiple drivers are to be used.

For police vehicles the LVM/LVW ballast condition is defined as curb mass + driver + right front passenger mass of 70 kg (154 lb) +91 kg (200 lb) in the trunk/cargo area. The additional ballast is intended to represent additional special equipment typically located in police vehicles such as the light bar, special bumpers, radio equipment and other routinely carried emergency equipment.

Overload Vehicle Mass (OVM)/Overload Vehicle Weight (OVW) Ballast Condition: The OVM/OVW ballast condition is defined as loading the vehicle to 112.5% of its listed GVM/GVW rating. Only trucks whose primary use is to carry cargo (e.g., pickup trucks and cargo vans) should use this overload condition.

Payload Rating: The resulting calculated value obtained by subtracting the Curb Mass of a vehicle from its Gross Vehicle Mass Rating.

Roof Carrier Mass Rating: The value specified by the manufacturer as the maximum mass capacity of the roof carrier.

Standard Equipment: That equipment which the manufacturer designates as mandatory on the vehicle. Standard equipment cannot be deleted by the purchaser without replacement by an option.

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Structural Vehicle Mass (SVM)/Structural Vehicle Weight (SVW) Ballast Condition: The SVM/SVW ballast condition is defined as two occupants per row of seats and 50% of the rated cargo ballast. Driver and passenger ballast should be placed in the outside seating positions of each seating row.

Test Curb Mass: The curb mass of the vehicle plus all required test equipment including ballast bottles, driver's aid, tachograph, Road Load Data Acquisition (RLDA) instrumentation, etc.

7.2 Acronyms, Abbreviations, and Symbols.

BFI	Body Frame Integral
BOF	Body On Frame
CAE	Computer Aided Engineering
GAMR	Gross Axle Mass Rating
GAWR	Gross Axle Weight Rating
GCMR	Gross Combined Mass Rating
GCWR	Gross Combined Weight Rating
GVM	Gross Vehicle Mass
GVMR	Gross Vehicle Mass Rating
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating
HCM	Heavy Cargo Mass
HCW	Heavy Cargo Weight
LVM	Light Vehicle Mass
LVW	Light Vehicle Weight
OVM	Overload Vehicle Mass
OVW	Overload Vehicle Weight
PT	Powertrain
RLDA	Road Load Data Acquisition
SUV	Sport Utility Vehicle
SVM	Structural Vehicle Mass
SVW	Structural Vehicle Weight

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW15445

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9 Release and Revisions

This standard was originated in October 2006. It was first approved by the Global Proving Ground Durability Test Correlation Team in January 2007. It was first published in February 2007.

Issue	Publication Date	Description (Organization)
1	FEB 2007	Initial publication.
2	JUN 2007	Added Cab Chassis reference to the Medium Duty Family 2 sections and worksheets. (Global Proving Ground Durability Test Correlation Team)
3	DEC 2009	Updated GVM with 105% axle restrictions for Ballast Data Sheets A1 and A2. Updated Structural Ballast Data Sheets B1 and B2. Included Ballast Data Sheets for Midsize truck with a payload greater than 700 kg. Added luggage rack ballast cargo box and attachment requirements. (Global Proving Ground Durability Test Correlation Team)
4	JUN 2010	Corrected passenger mass error in Appendix F. (Global Proving Ground Durability Test Correlation Team)
5	APR 2013	Changed Distribution Type Permitted to External Highly Restricted. (Global Proving Ground Durability Test Development Team)
6	APR 2017	Changed "Luggage Rack" to "Roof Carrier." Changed "module" to "event." Separated the data sheets for Cars, Crossovers, SUVs, and Passenger Vans into different data sheets based on 1. BFI vs. BFO architecture and 2. Vehicle types with vs. without expandable cargo areas. Changed Distribution Type Permitted to External Restricted. (QRD - Global Proving Ground Durability Test Development Team)

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Appendix A

Data Sheet A1: Ballast Mass Worksheet for BFI Architectures without Configurable Cargo Area – Sedans/Coupes/Hatchbacks (Excludes Police Vehicles) ^{Note 1}

Cargo ballast, representative of cargo mass, should be uniformly distributed in the cargo area.

The axle masses are not to exceed 105% of GAMR. If this occurs, then the ballast should be placed inside the vehicle in such a way that neither the front nor rear axle mass is greater than 105% of GAMR. The test responsible personnel (or equivalent) should notify the Program Team of the condition.

See Section 7.1 for definitions of the terms used in the following data sheet.

VEHICLE/PASSENGER MASS INFORMATION

GVM of the specific test vehicle	_____ (Line 1)
Designated Seating Capacity	_____ (Line 2)
Curb Mass of the specific test vehicle	_____ (Line 3)
Test Curb Mass = Curb Mass (Line 3) + Test equipment mass (45 kg) ^{Note 2}	_____ (Line 4)
Maximum number of passengers = Designated Seating Capacity (Line 2) – 1 (driver)	_____ (Line 5)
Maximum passenger mass = Max number of passengers (Line 5) x 70 kg	_____ (Line 6)
Roof Carrier Mass Rating (if applicable)	_____ (Line 7)

TOTAL VEHICLE MASS CALCULATIONS

Ballast Condition	Description	Ballast Calculation	Total Vehicle Mass
LVM	Driver + Test Equipment	Test Curb Mass (Line 4) + Driver (70 kg) ^{Note 2}	_____ (Line 8)
GVM	GVM	GVM (Line 1) (Limit to 105% GAMR)	_____ (Line 9)

CARGO AREA BALLAST CALCULATIONS

Ballast Condition	Total Vehicle Mass	- Test Curb Mass (Line 4)	- Driver Mass	- Appropriate Passenger Mass	= Cargo Ballast
LVM	_____ (from Line 8)	- _____ kg	70 kg ^{Note 2}	- _____ kg	= _____ kg
GVM	_____ (from Line 9)	- _____ kg	70 kg ^{Note 2}	- _____ kg (from Line 6)	= _____ kg

ROOF CARRIER BALLAST: See 4.3.2 for instructions on roof carrier ballast. Typically ballast is placed on the roof carrier for only a portion of the durability test. Refer to the appropriate test procedure for details.

Note 1: The GVM (GVW) Cargo Carrying Configuration applies only to vehicles that have a configurable cargo area. This does not apply to passenger cars with fold down seatbacks used to access the trunk. See 7.1 GVM (GVW) Cargo Carrying Configuration for more information.

Note 2: Driver mass is estimated at 70 kg and test equipment mass is estimated at 45 kg. Actual masses should be used whenever possible. (This is not possible when multiple drivers are to be used.)

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