



Full Chassis Frame for Body-on-Frame (BOF) Architectures

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 general requirements for the full frame subsystem. The functional, performance, reliability and validation requirements for the full frame are specified in this and other referenced documents. This is an incomplete document and must be combined with the Program-Specific document known as Statement of Requirement (SOR) Appendix C2. Specific full frame application and usage information, part number, and math data references are contained in Appendix B, of the SOR, Program Description.

1.2 Applicability. This specification applies to full frame assemblies for body-on-frame (BOF) vehicle architectures.

1.3 Remarks. The full frame subsystem provides support and structure to the vehicle. It serves as the main structural building platform interconnecting the various vehicle subsystems. The frame contributes to the following four (4) vehicle performance areas:

- Noise/Vibration/Harshness (NVH).
- Vehicle Dynamics.
- Crashworthiness.
- Durability.

2 References

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

2.1 External Standards/Specifications.

AWS A5.18	FMVSS 204	FMVSS 214	ISO/TS 16949
AWS A5.10M	FMVSS 208	FMVSS 301	SAE J2069

2.2 GM Standards/Specifications.

GMW3059	GMW14289	GMW15272	GMW15934 (ID)
GMW3116	GMW14375	GMW15708	GMW16057
GMW3224	GMW14573	GMW15718 (ID)	
GMW14058	GMW15005	GMW15727	
GMW14089	GMW15010	GMW15875	

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- Best Practice 110255: The supplier shall work with the General Motors (GM) responsible engineer to comprehend this requirement.
- CAE Guideline 60.02.063
- CAE Guideline 60.02.080
- CAE Guideline GMWA-20-02-017

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- Design Best Practices CSTRUCT-1, CSTRUCT-2, CSTRUCT-3, CSTRUCT-4, CSTRUCT-5, CSTRUCT-6, CSTRUCT-8, CSTRUCT-9, CSTRUCT-10, CSTRUCT-11, CSTRUCT-12, CSTRUCT-13, CSTRUCT-14, CSTRUCT-15, CSTRUCT-16, CSTRUCT-17, CSTRUCT-18, CSTRUCT-19, CSTRUCT-20, CSTRUCT-21, CSTRUCT-22, CSTRUCT-23, CSTRUCT-24, CSTRUCT-25, CSTRUCT-26, CSTRUCT-27, CSTRUCT-28, CSTRUCT-29, CSTRUCT-30, CSTRUCT-31, CSTRUCT-35, CSTRUCT-39, CSTRUCT-40, CSTRUCT-41, CSTRUCT-42, CSTRUCT-43, CSTRUCT-44, CSTRUCT-45, CSTRUCT-46, CSTRUCT-47, CSTRUCT-48, CSTRUCT-49, CSTRUCT-55, CSTRUCT-56, CSTRUCT-57, CSTRUCT-58, CSTRUCT-59, CSTRUCT-60, CSTRUCT-61, CSTRUCT-62, AECHS-6, BODYSTR-37, BRAKES-137, CHASSIS-1, CORRAVD-42, CORRAVD-44, CORRAVD-49, CORRAVD-56
- Engineering Library
- Enterprise Engineering Knowledge System (E2ks) Aftersales Engineering Overall Vehicle Towing and Recovery
- Fastener Application - Body Electrical Grounding using Screws and Weldnuts
- Geometric Dimensioning and Tolerancing (GD&T) Drawing
- GM North America Product Design
- GM Regional Fastener Catalog
- GM Serviceability Guidelines
- Key Product Characteristics (KPC)
- Master Process Document (MPD)
- Owner Manual
- Service Manual
- SOR Appendix A1
- SOR Appendix A3
- SOR Appendix A5
- SOR Appendix B
- SOR Appendix C2
- SOR Appendix D
- SOR Appendix E3
- SOR Appendix F10
- SSTS Appendix A5
- Subsystem Technical Specification (SSTS)
- Supply Power: www.gmsupplypower.com
- Vehicle Technical Specification (VTS) Template Program Specific

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The frame subsystem is defined in terms of required functions and performance characteristics in the following paragraphs (Section 3).

3.1.1 Appearance. The frame assembly is to be flat black coated.

3.1.2 Content.

3.1.2.1 Physical Content. Refer to Appendix B of SOR. A GM concept design is supplied with this SOR package in Unigraphics math data and the Part Breakdown Assumptions listed in Subsystem Technical Specification (SSTS) Appendix A5. Suppliers are encouraged to propose detailed refinement and improvement of this design in areas not designated to be carryover. Large-scale reconfiguration proposals are not encouraged, except as defined in SOR Appendix B or explicit written instructions from the GM Lead Engineer. Any alterations of or deviations from the GM Concept Design must be explicitly identified in writing by the supplier and approved

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in writing by the GM Lead Engineer in order to be eligible to include as a basis for any commercial quote. The interfaces are further detailed in 3.1.4.

3.1.2.2 Functional Content. The frame provides functions described in 3.1.2.2.1 through 3.1.2.2.3.

Note: Detailed performance requirements are shown in 3.2.1 of this document.

3.1.2.2.1 Support, isolate, and react load inputs from the various interfacing subsystems listed in Table 1.

3.1.2.2.2 Absorb energy in impacts.

3.1.2.2.3 Enable vehicle exterior attachment for trailer towing and vehicle recovery.

Table 1: Frame Interfacing Subsystems

Subsystem Interfaces	Support	Isolate	React Loads
Engine	X	X	X
Transmission	X	X	X
Transfer Case	X	X	X
Front/Rear Differential	X	X	X
Driveshaft	X	X	-
Steering Gear/Rack	X	X	X
Suspension Front/Rear	X	X	X
Front End Sheet Metal (FESM) Structure	X	X	-
Body/Cab/Box	X	X	X
Fuel Tank/Canister, etc.	X	-	-
Exhaust System	X	X	-
Lines Electrical/Fuel/Brake	X	-	-
Front/Rear Bumpers	X	-	X
Shields/Skid Plates	X	-	-

3.1.3 Ambient Environment. The frame shall be subject to an ambient environment as described in 3.1.3.1 and 3.1.3.2.

3.1.3.1 Temperatures. Refer to SOR Appendix C2.

3.1.3.2 Contaminants. The frame must withstand exposure to the environmental elements to the level specified in Table 2.

Table 2: Contaminant Exposure Level ^{Note 1}

Element	Prolonged	Intermittent	Not Applicable
Water/Snow/Ice	X		X
Engine Coolant		X	X
Windshield Fluid		X	X
Brake Fluid		X	-
Power Steering Fluid		X	X
Diesel Fuel		X	X
Gasoline		X	-
Engine Oil		X	X
Road Salt	X		-

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Element	Prolonged	Intermittent	Not Applicable
Battery Fluid		X	-
Dirt (Dust/Grit)	X		
Differential Fluid		X	
Ultraviolet Light			X Note 2-
Transmission Fluid		X	
Car Wash Chemicals and Detergents		X	
Tire Cleaners and Engine Cleaners		X	
Ammonia Glass Cleaner		X	
Fuel Additives			
Air Conditioning Refrigerant			
Deicers			
Acid Rain			
Sand/Gravel	X		
Mud	X		
Road Tar		X	
Road Oil		X	
Leaves		X	
Insects		X	
High Pressure Water Wash/Steam Cleaning		X	

Note 1: Due to material properties, specific materials selected may require protection from, as opposed to, resistance against the listed contaminants.

Note 2: Chassis structure will not be exposed to Ultraviolet in service. Exposure during shipping and storage must be limited to prevent degradation of coating performance below performance specification.

X = Required as specified in Columns "Prolonged" and "Intermittent".

3.1.3.3 Corrosion Resistance. The full frame subsystem shall meet the corrosion performance and validation requirements of GMW15272. Depending on the application, portions of the frame (e.g., the side rails) may be considered high visibility per GMW15272 with correspondingly higher performance requirements. Careful consideration must be given to the visibility of the frame to ensure that the corrosion performance requirements are properly understood.

3.1.4 Interfaces. The chassis full frame assembly interfaces with various entities that will affect or constrain its functionality and design. These interfaces are discussed in the following paragraphs.

3.1.4.1 External-To-Vehicle to Subsystem. Interface items that may affect the chassis full frame designs shall comply with the applicable requirements stated in GMW15010 Global Supplier Serviceability Requirements. Sections and Appendices as stated below:

3.1.4.1.1 Vehicle shipping (haulaway/ocean) and shipping attachments on the chassis frame (packaging envelope). For design requirements, reference the Shipping and Logistics (SHIPLOG) Community of Practice (CoP) in the Enterprise Engineering Knowledge System (E2ks System). Body or chassis lashing points are required for ocean shipment. For haulaway shipment, vehicles are restrained by soft tie securement (strap around circumference of each wheel). Chassis attachment points are not required for haulaway shipment.

3.1.4.1.2 Serviceability Requirements. Stakeholders Section 20.05 Chassis Structure.

3.1.4.1.3 Ground clearances (wash rack, parking blocks, etc.) See SOR Appendix D, Washability.

3.1.4.1.4 Towing and Recovery Devices. See SOR Appendix B for definition of program content relative to tow hooks and tie downs that interface directly with the frame structure.

3.1.4.1.5 Jacking and Lifting. See SOR Appendix C2, Jacking and Lifting.

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3.1.4.1.6 Trailering. The frame assembly is the subsystem which directly interfaces physically with trailers external to the vehicle. Interface includes trailer wiring harness as well as hitch. There are three (3) primary global trailer towing regions, each with its own load determination requirements. The specific load application path will be determined by the specific trailer hitch design and regional design practices and regulations. Definitions for the loads encountered during vehicle trailering which are input to the frame assembly subsystem are described in 3.1.4.1.6.1 through 3.1.4.1.7

3.1.4.1.6.1 North American Operation Trailer. Loads are based upon vehicle gross vehicle weight rating (GVWR), trailer weight rating (TWR) and aftermarket hitch dimensions and derived per GMW15875 alternatively; loads may be acquired via road load measurement.

3.1.4.1.6.2 European Operation Trailer. Loads are based upon vehicle GVWR and TWR and derived per GMW15934.

3.1.4.1.7 Vehicle Towing and Recovery. The frame shall provide interface for the necessary fittings and/or attachments that enable it to engage with standard automotive towing and vehicle recovery systems. A 40 mm minimum clearance envelope shall be provided around frame-mounted vehicle recovery features to allow attachment of recovery hardware.

3.1.4.2 Interfaces - Subsystems to Subsystem.

3.1.4.2.1 Interface items that may affect the chassis frame assembly design and must be considered in the design include:

3.1.4.2.1.1 Static packaging compatibility.

3.1.4.2.1.2 Static clearance between the chassis frame and the powertrain/drivetrain in design position shall be 25 mm unless explicitly authorized by the Buyer's designing engineer.

3.1.4.2.1.3 Dynamic clearance envelopes due to load deflection characteristics of powertrain/drivetrain and suspension: The dynamic clearance between powertrain/drivetrain, suspension and steering gear and the chassis frame shall be 10 mm.

3.1.4.2.1.4 Maintenance requirements of the drivetrain, suspension, and steering gear (must be able to detach from chassis frame and then reattach).

3.1.4.2.1.5 Local proximity to heat sources (conductive, radiant and convective). Minimum clearance between chassis frame and exhaust system components shall be 25 mm.

3.1.4.2.1.6 Body clearance shall be at least 10 mm dynamic, unless explicitly authorized by the buyer's designing engineer.

3.1.4.2.1.7 Fuel storage and handling.

3.1.4.2.1.8 Vehicle Tools. The frame assembly will need to accommodate stowage of spare tire and provide access to operate spare tire tools.

3.1.4.2.1.9 Bumpers and Fascias.

3.1.4.2.2 Physical Interface at Attachment Locations. The chassis frame assembly interfaces with vehicle subsystems listed in 3.1.2.2. For each of these, plus any other interface, the following must be addressed.

3.1.4.2.2.1 Contact area must be clean and free of weld slag and burrs.

3.1.4.2.2.2 Surface finish and flatness – see Geometric Dimensioning and Tolerancing (GD&T) drawing.

3.1.4.2.2.3 Tolerances, GD&T scheme – see GD&T drawing. Any deviations in the GD&T scheme must receive approval from the GM Dimensional Management Applications Group and the GM Design Release Engineer.

3.1.4.2.2.4 Attachment method.

3.1.4.2.2.5 Type, number, grade and finish of fasteners.

3.1.4.2.2.6 Joint integrity (service loading, fastener torque-tension and torque retention, etc.)

3.1.4.2.2.7 At interfaces where the potential for galvanic corrosion exists, proper protective coatings shall be used.

3.1.4.2.3 Assembly Interfaces.

3.1.4.2.3.1 Chassis full frame design shall allow clearance to be provided for assembly of all attachments with normal assembly plant tooling, processes and procedures, as specified in the Bill of Process.

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3.1.4.2.3.2 All assembly interfaces shall be properly error-proofed so that only correct assembly is possible (see 3.3.3).

3.2 Product Characteristics. The verifiable technical requirements for the chassis frame assembly are identified in 3.2.1 through 3.2.4.

3.2.1 Performance Requirements.

3.2.1.1 Static Stiffness Rates. (Stakeholders: 0B.02 Handling; 25 Chassis Structures): The static stiffness of all suspension attachment points shall be a multiple of the intended nominal value for the full tuning range of the isolator static stiffness. This stiffness will be measured, either analytically or physically, with the isolator inner metal bolted in place, with the load applied to the midpoint of the inner metal while the frame is constrained as specified in SOR Appendix A1 and SOR Appendix A3. The acceptability of frame structure isolated attachment stiffness to achieve customer pleasability for handling is as follows for stiffness in all three (3), X, Y, and Z directions. Refer Table 3.

Table 3: Suspension Interface Bracket Stiffness

Stiffness Acceptability	Customer Pleasability	Static Isolator Stiffness Multiple
Red	Does not meet customer expectations	< 2.0 times isolator stiffness
Yellow	Minimally meets customer expectations	2.0 to 4.0 times isolator stiffness
Green	Meets customer expectations	> 4.0 times isolator stiffness

3.2.1.1.1 Frame Ladder Static Stiffnesses. Refer to SOR Appendix C2.

3.2.1.1.2 Frame Local Attachment Static Stiffnesses. Refer to SOR Appendix C2.

3.2.1.2 Mobility. Refer to SOR Appendix C2.

3.2.1.3 Frame Structural Modes. Refer to SOR Appendix C2.

3.2.1.3.1 Component Frequency Separation. Refer to SOR Appendix C2.

3.2.1.3.2 Attachments Stiffness of Components/Systems of Significant Mass. The resonant frequency of the components/systems, as mounted on their attachments to the frame assembly, should be as in Table 4.

Note: These frequencies are to be determined analytically.

Table 4: Stiffness of Attached Large Masses

Component	Minimum	Preferred
Full fuel tank	Carryover	≥ 30 Hz
Full size spare tire	Carryover	≥ 30 Hz
Front and rear bumpers	Carryover	≥ 30 Hz

3.2.1.4 Crashworthiness. Requirements that enable the frame assembly to absorb impact energy follow. Frame geometry and section geometry contribute to the compliance of the total vehicle crash requirements. Specification of the frame crush requirements will be determined by the Crashworthiness group to support compliance with vehicle crash standard Federal Motor Vehicle Safety Standard (FMVSS) FMVSS 208, FMVSS 301, FMVSS 214 and all applicable FMVSS requirements.

3.2.1.4.1 Frame crush is a major contributor to compliance with FMVSS 208 Occupant Injury Standard, where applicable. When applicable, frame crush contribution to total vehicle crush must not allow the steering column to move rearward farther than allowed by FMVSS 204 Steering Column Penetration.

The frame should aid vehicle crashworthiness. It should buckle and thereby manage the loads into the body structure as well as absorb kinetic energy. The buckling locations, loads, and modes need to be determined by

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