



Diesel Exhaust Fluid (DEF) Pump Module 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. This standard provides a Component Technical Specification (CTS) for the Diesel Exhaust Fluid (DEF) Pump Module, which functions are:

- Filtering contaminants and supplying fluid at pressure to the injector location.
- Sensing fluid properties in tank and providing signals to the Engine Control Module (ECM).
- Heating the fluid in tank as required.

1.2 Applicability. This specification applies to the DEF Pump Module of Diesel fueled vehicles equipped with Selective Catalytic Reduction (SCR) system for the Nitric Oxide (NOx) emissions after treatment.

1.3 Remarks. This document provides standard technical requirements for DEF Pump Modules. This document shall be used in conjunction with program-specific technical specifications, CG4824. References to the program-specific technical specifications are included in this document where program-specific requirements are expected to exist.

Program-specific technical specifications may include additional requirements that are not referenced in this document and may supercede any requirements included in this document. In the case of any conflicts between this document and the program-specific technical specifications, the program-specific technical specifications take precedence.

This document establishes the component level requirements for the DEF Pump Module. This document shall be used in conjunction with and complement other requirements documents included in the Statement of Requirements (SOR).

1.4 Terminology. The DEF Pump Module specified in this document is part of the DEF system that has differing naming nomenclatures dependent on the market. The DEF system stores, handles and delivers an aqueous mixture of 32.5% urea (AUS32). For the purpose of this document it will be referred to as "DEF System". It is alternatively referred to as:

- Selective Catalytic Reduction System (SCR).
- AdBlue System (registered trademark of Verband der Automobilindustrie).
- Automotive Urea Solution (AUS32, ISO name).
- Urea System.
- Emission Reduction Fluid System.
- Agente Redutor Liquido Automotivo (ARLA 32).

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2 References

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

2.1 External Standards/Specifications.

ASTM D903	ISO 527-1/2	ISO 16750-5	SAE J1960
ASTM D4169	ISO 1431-1	ISO 19438	SAE J2044
ASTM D6653	ISO 3167	ISO 22241-1	SAE J2587
ISO 179	ISO 4020	SAE J400	

2.2 GM Standards/Specifications.

GMW3059	GMW3191	GMW14911	GMW15784
GMW3091	GMW14264	GMW15272	GMW15862
GMW3097	GMW14476	GMW15450	GMW15982
GMW3172	GMW14872	GMW15760	GMW16600

2.3 Additional References.

- CG4824 DEF Pump Module Program Specific Component Technical Specifications
- CG4825 Validation Cross Reference Index
- Component Technical Specification (CTS)
- Statement of Requirements (SOR), Appendix E

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. The visible (external-to-tank-shell) portions of the DEF Pump Module shall preferably be black in color.

3.1.2 Content.

3.1.2.1 Physical Content. The DEF Pump Module consists of (but is not limited to):

- Pump Module Housing.
- Filter.
- Pump.
- Pressure Sensor.
- Tank Heater.
- Level Sensor.
- Temperature Sensor.
- Urea Quality Sensor
- Electrical Connectors.
- DEF Dosing Line connector.

3.1.2.2 Functional Content. The DEF Pump Module shall provide the following primary functions while meeting specific requirements of the vehicle and powertrain electrical and hydraulic interfaces, while respecting the safety and emission standards:

- Seal the DEF system from water and dust intrusion to prevent contamination.
- Allow for DEF expansion due to cold weather and heat.
- Pump the DEF on request through the DEF Dosing Line to the injector at required pressure and flow rate.
- Filter the contaminants in the DEF.
- Heat and thaw the DEF on request, fulfilling the given cold weather startup times.

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- Measure the DEF outlet pressure and transmit the signal to the DEF Controller.
- Measure the DEF temperature and transmit the signal to the DEF Controller.
- Measure the DEF level and transmit the signal to the DEF Controller.
- Measure the DEF quality and transmit signals to the DEF Controller.
- Prevent the migration of DEF into the electrical interface in the event of an unintended internal leakage.

3.1.3 Ambient Environment. The following paragraphs specify the environmental conditions that the DEF Pump Module will be exposed to during its lifetime. The values in Table 1 should be used in the selection of materials and application of engineering judgment throughout the design process.

3.1.3.1 Operating Environment. The DEF Pump Module shall be capable of exposure to temperatures for their sales regions as defined in Table 1 and operating in the environments described in Table 2 without adverse effect to functional performance.

3.1.3.1.1 Continuous Temperature. The DEF Pump Module shall be designed to work without any performance or durability issues for 3020 h/30 000 cycles as per the temperatures in Table 2 during continuous vehicle operation, based on 321 900 km (200 000 mi) vehicle life. Component functionality and performance shall not be compromised under continuous thermal conditions.

3.1.3.1.2 Excursion Temperature. The DEF Pump Module shall be designed to work without any durability issues for 120 h/800 cycles at 110 °C underbody temperature during vehicle operation on an infrequent basis, based on 321 900 km (200 000 mi) vehicle life. If the vehicle Reliability Evaluation Point (REP) is other than 321 900 km (200 000 mi), then the required number of cycles shall be scaled accordingly. No single excursion event shall be longer than 20 minutes. Occupant safety shall not be compromised during excursion thermal conditions.

Table 1: Ambient Temperature

Region	Minimum Temperature	Maximum Temperature
Worldwide Default	-48 °C (-55 °F)	52 °C (125 °F)
Russia (Siberia)	-51 °C (-60 °F)	Not applicable
Middle East	Not applicable	55 °C (130 °F)

Table 2: Operating Environment

Underbody	-40 °C to 90 °C continuous
Relative Humidity (RH)	2% to 100%
Fluid Temperature in Tank (Bulk Fluid)	-40 °C to +65 °C continuous
Barometric Pressure	56.9 kPa to 106.3 kPa
Precipitation	≤ 4.6 mm/minute
Grade/Inclination	≤ 15%
Ozone	≤ 0.40 ppm
Altitude	-150 m to 4600 m
Operating Voltage	According to GMW3172

3.1.3.2 Non-Operating Environment. The DEF Pump Module shall meet all operating performance requirements, without loss of function or degradation of service life, after exposure to the conditions in Table 1, as well as to transport by airplane at altitudes up to 13 700 m (see Section 5).

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3.1.3.3 Ultraviolet Radiation. Ultraviolet radiation, accelerated weathering, applies for incomplete vehicles (i.e., cab chassis trucks, cutaway vans, etc.) and any exterior exposed components (i.e., fill caps in fill pocket, etc.) The exposed materials shall retain 75% of the original properties for Tensile Strength (ISO 527-1/2) and Notched Charpy Impact (ISO 179) after 2500 kJ/m² of accelerated exposure using Xenon arc weathering apparatus as described in SAE J1960. Tensile bars shall be prepared using ISO 3167, 4 mm thick Type A. Charpy Impact bars shall be 80 mm × 10 mm × 4 mm Machined V notch, r = 0.25 mm.

3.1.3.4 Robustness to Ozone. This requirement applies to parts made of highly unsaturated materials such as diene rubber (i.e., polyisoprene, styrene-butadiene rubber, etc.) that have exposure to the external ambient environment. The parts shall be checked for stabilization against ozone per ISO 1431-1 (100 pphm, test duration 336 h).

3.1.3.5 Type of Fluid and Material Compatibility. The DEF Pump Module shall work with the fluid as per ISO 22241-1 quality requirements. Materials used in the DEF Pump Module shall be compatible with this fluid, and shall work in the operating environment listed in Table 1 for the entire life.

The DEF Pump Module shall be compatible with the by-products formed during the degradation of DEF as it ages.

3.1.3.6 Corrosives - Chloride Exposure. Polymers exposed to the underbody and lower underhood atmosphere must be resistant to chloride exposure according to GMW16600.

3.1.3.7 Stone Impingement. In the case that the DEF Pump Module is not protected by a DEF Tank Protection Shield, the DEF Pump Module shall be capable of withstanding stone and gravel impact as tested per SAE J400 at an angle of attack of 45 degrees below the bottom surface of the DEF tank in the driving direction. After, the test components shall meet leak requirements and functional checks. Following a teardown and a detail analysis of every exposed component there shall be no indication of perforation and no damage that could impact the functionality of the components.

3.1.3.8 Automotive Fluids Compatibility. The DEF Pump Module shall be designed to withstand prolonged exposure to automotive fluids as outlined in ISO 16750-5 and exposure to DEF. Components must meet leak test requirements posttest and exhibit no visible cracking or crazing.

3.1.3.9 Thermal Integrity. The DEF Pump Module shall be designed to avoid auto-ignition conditions involving components of the DEF System as evaluated per GMW14911.

3.1.4 Interfaces. The interaction between the DEF Pump Module and other DEF System components is depicted at a high level in Figure 1. These interfaces may constrain or drive the design of the tank and, therefore, must be addressed during design and development. The entire DEF System implementation and operation in the vehicle must also successfully accommodate the identified interfaces. These physical interface requirements are further detailed in the program specific documents.

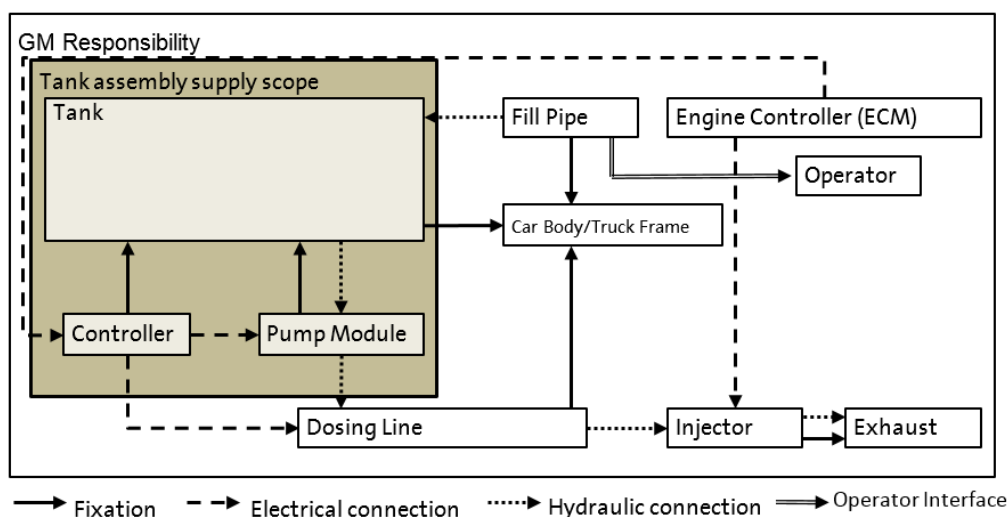


Figure 1: DEF System Components interaction with Other Subsystems

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3.1.4.1 Tank shell. The DEF Pump Module shall be mirror welded to the bottom of the tank, with both interfacing surfaces being molded in High Density Poly Ethylene (HDPE). The DEF Tank interface dimensions for the DEF Pump Module welding can be found in Appendix A, Figure A1.

3.1.4.2 DEF Dosing Line. DEF Dosing Line interface to DEF Pump Module shall be a 9.53 mm SAE J2044 quick connect design, unless otherwise indicated in the program specific CTS.

3.1.4.2.1 Quick connectors shall meet SAE J2044 requirements, with DEF fluid as the test medium.

3.1.4.2.2 Assembly effort, pull-apart effort and side load capability testing as per SAE J2044 shall be conducted at room temperature (23 °C), high temperature (50 °C) and low temperature (-30 °C).

3.1.4.2.3 The quick connector at pump end shall be heated to prevent freezing. The DEF Pump Module shall be capable of thawing the indicated region 'A' in Figure 2 independently (with DEF Dosing Line connected, but not energized) per the thaw times and conditions indicated in Table 4 (see 3.2.1.2.10). The DEF Dosing Line shall be capable of thawing the indicated region 'B' in Figure 2 independently (connected to DEF Pump Module but pump module not energized) per the thaw times and conditions indicated in Table 4.

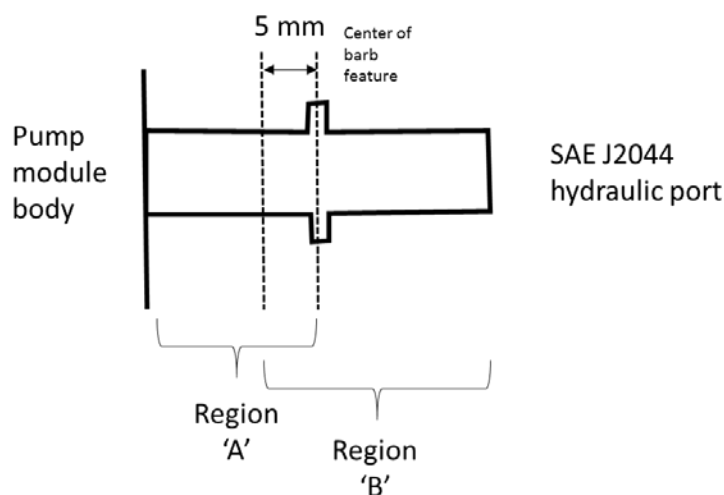


Figure 2: Thawing Performance Responsibility

3.1.4.3 Assembly Plant Tooling/Fixtures. The DEF Pump Module shall be designed such that it allows the required clearance for GM assembly plant tools, fixtures, handling and assembly clearances.

3.1.4.4 Electrical Connector Interface. The electrical connector of the DEF Pump Module to the DEF Tank or to the Vehicle Wiring Harness shall be resistant to all climatic and environmental conditions that can occur during vehicle use over lifetime. In order to demonstrate this, they shall meet GMW3191 and GMW3172 requirements:

- GMW3191 Temperature Class: 2.
- GMW3191 Vibration Class: 1.
- GMW3191 Sealing Class: 3.
- GMW3191 Mating Force Classification: 3.
- GMW3172 Classification: B-H-D-J-F-IP6K9K and IP6K8.

The electrical connector of the DEF Pump Module to the DEF Tank or to the Vehicle Wiring Harness shall have a capillary barrier (completely sealed male connector OR silicone blocking agent on the wires behind the female connector) to prevent fluid travel through connectors and wiring harness in case of leakage in the DEF Pump Module. This anti-capillarity barrier shall prevent the urea leakage for at least 18 months of worst case climate with the vehicle parked (no engine operation). The performance of this anti-capillarity barrier shall be demonstrated by 120 thermal cycles between 0 °C and 80 °C (5 h soak time at each temperature, 1 h transition

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time), with the tank filled with at least 5 L and at least 200 mm liquid height above the pump module, and a leakage on the pump module housing that will keep the dry side of the DEF pump module full of DEF fluid. After the test, no DEF fluid will leak out of a 200 mm length wiring harness with normal (not anti-capillarity) wires of 1 mm³ section.

Electrical Connectors of the DEF Pump Module shall include Connection Position Assurance (CPA) features unless otherwise agreed in writing from GM Engineering.

Only GM released connectors shall be used for the DEF Pump Module interface with the DEF Tank or to the Vehicle Wiring Harness.

3.1.5 Usage Definition. The DEF Pump Module is used on all Diesel vehicles which require active SCR in order to meet applicable emissions regulations.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Production Checks. The following tests must be performed, at a minimum, on all the DEF Pump Modules, before they are shipped to GM assembly plant or to DEF Tank Supplier assembly plant. The supplier shall submit the proposed production check sequence during the sourcing for approval by GM engineering.

The following tests shall also be used as pretest and posttest checks for functionality and sealing for all validation required.

3.2.1.1.1 Leak Test. The Pump Module shall be leak free and avoid any DEF contamination (or any contaminant from the environment) of internal "dry side" of the module. The Pump Module shall not leak any DEF fluid into the environment. Therefore, the DEF Pump Module shall be tested during the production per SAE J2587 section 4.1, showing a leakage rate lower than $2 \text{ mbar} \times \text{L/s} \times 10^{-4} \text{ mbar} \times \text{L/s}$ when tested with Helium at a differential pressure of 10 KPa.

3.2.1.1.2 Electrical Functionality Tests. For production: As developed for GMW3172 section 6.2.

For pretest and post-test checks: As developed for GMW3172 section 6.1.

3.2.1.2 DEF Pump Module performance requirements. Unless otherwise specified, the requirements in this section are valid for the whole product life. Unless otherwise specified the DEF Pump Module must meet the performance requirements in the static and dynamic (driving) states.

3.2.1.2.1 DEF System Operating Parameters. The following parameters are boundary conditions for the DEF Pump Module, with which the DEF Pump Module needs to be compatible, and which the DEF Pump Module needs to enable.

- Average flow rate in operation: 50 mL/h.
- Continuous Maximum Flow Rate 2.8 L/h.
- Excursion maximum flow rate 3.1 L/h (maximum 60 s every 10 minute).
- Re-fill flow rate (North America): 40 L/minute refill flow rate.
- Re-fill flow rate (Rest of the world): 10 L/minute.
- Plant first filling: Refer to SOR, Appendix E.
- Maximum fluid temperature in the tank: 65 °C.
- Maximum fluid temperature in the DEF Dosing Line: 100 °C.

3.2.1.2.2 Fluid Quantity Determination. The following requirements apply to the signal sent from the DEF Controller to the ECM and is not intended to represent only the performance of a single component of the DEF Pump Module used for the determination of DEF quantity.

- Measured signal: Useable fluid volume.
- Measurement range: 3% - 100% of tank volume.
- Measurement resolution: < 0.03 L.
- Measurement accuracy (incl. dynamics and filtering time impact): $\pm 0.5\%$ in the 0% - 50% quantity range.
- Measurement accuracy (incl. dynamics and filtering time impact): $\pm 1\%$ in the 50% - 100% quantity range.
- Response time after 5 L re-fill, to reach signal within accuracy: < 60 s.

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