

NAVISTAR, INC.		
TMS (TRUCK MATERIAL SPECIFICATION)		NUMBER: TMS-9547
TITLE: Quality Requirements For Mufflers and Exhaust Aftertreatment Modules		CURRENT REV. No: 1312 DATE: December 2013
WRITTEN/EDITED BY: Materials Engineering	APPROVED BY: Materials Engineering	SUPERSEDES: Rev 1104 – April 2011
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<i>This specification may involve hazardous materials, equipment, and procedures. This specification does not purport to address all of the safety issues associated with its use. The user is responsible to consult appropriate safety and health practices and to determine the applicability of regulatory limits prior to use.</i>		
Change Notice: Revised Section 4.3.1 related to rate of draining the water trap; added chart in Section 4.3.1 for drain rate; editorial changes.		
Reference: File 650-8	Keywords: Exhaust Quality, Mufflers, Noise Emissions, Aftertreatment	

1.0 APPLICATION

This specification is divided into two sections as follows:

Part I – Quality Requirements for Mufflers and Muffler Assemblies

Part II – Quality Requirements for Exhaust Aftertreatment Modules

Application of TMS-9547 Specification Based on Emissions Regulations

	EURO 0	EURO I-VI	US EPA pre-'04	US EPA 2004	US EPA 2007	US EPA 2010
Mufflers & Pipes	Pt. I		Pt. I			
PIPES POST ATD		Pt. II		Pt. II	Pt. II	
ATD		Pt. II		Pt. II	Pt. II	
PIPES POST REDUCTANT		Pt. II			Pt. II	Pt. II
REDUCTANT COMPONENTS		Pt. II			Pt. II	Pt. II

Part I of this specification covers engineering quality and quality control requirements for purchased mufflers and muffler assemblies supplied to Navistar plants. Part II covers engineering quality and quality control requirements for aftertreatment exhaust modules associated with 2007 emissions compliant diesel engines supplied to Navistar, Inc.

NOTE: The engine manufacturer is responsible to insure that the engine, including aftertreatment module, meets all 2007 emissions requirements.

2.0 SCOPE

This specification covers general requirements (including corrosion resistance, leakage testing, noise requirements, and structural integrity), quality control, source approval, designation on drawings, and shipping and identification requirements.

2.1 Restricted Chemical Substances

Effective January 1, 2007, all product supplied to the requirements of this specification must comply with the requirements of the CEMS B-50 specification.

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3.0 REFERENCE DOCUMENTS

Unless otherwise specified the latest issue of all referenced standards shall apply. The following specifications, standards, and regulations are referenced in this specification:

Quality System Standard ISO 9001 or TS-16949	CFR Title 40, Part 205, Subpart B, VA-PR-001 <i>Test Lab Procedure -- Noise Emissions</i>
NAVISTAR Eng. Design STD. A-16	CFR Title 29, Part 1910
NAVISTAR Manufacturing Std MS-D-13	ASTM B117
NAVISTAR TMS-9543	NAVISTAR CEMS G-7
40 CFR 86.004-2	SAE J366
NAVISTAR CEMS B-50	SAE J1060
AWS A2.4	AWS D1.6
	ECE 51-02

PART I. MUFFLERS AND MUFFLER ASSEMBLIES

4.0 GENERAL REQUIREMENTS (MUFFLERS/MUFFLER ASSEMBLIES)

4.1 Corrosion Resistance

Mufflers and muffler assemblies shall withstand 250 hours salt spray testing as per ASTM B117 without evidence of significant red rust. Weld heat affected zones (HAZ) and sharp radii may show some red rust appearance but will not develop loose rust scale. Mufflers and muffler assemblies shall be free of perforation, due to corrosion in service, for a period of 36 months or 350,000 miles in service, whichever occurs first.

4.2. Water Ingestion

When placed in a vertical position with outlet at the top and inlet at the bottom, and with the inlet pipe installed, vertical/round mufflers shall be capable of storing a minimum quantity of one gallon of water, poured in from the top, through the muffler, without visible evidence of leakage from the inlet tube joint or from the bottom of muffler.

4.3 Air Leakage Rate

Maximum allowable leakage rate in the Muffler is four (4) standard cubic feet of air per minute @ 4 psig. Maximum allowable leakage of the exhaust piping between the turbocharger and inlet to the muffler is limited to a maximum of one (1) standard cubic foot of air per minute @ 4 psig.

4.4 Noise Requirement

The muffler is a major component in the truck noise control system which enables a vehicle to comply with the 80 dB(A) requirement of the Federal Noise Regulation (CFR Title 40, Part 205, Subpart B). The equivalent NAVISTAR test lab procedure is VA-PR-001. All vehicles for sale/use in the global market shall meet the E.C.E. Regulation (ECE 51-02). All muffler and muffler assemblies used on Navistar trucks require approval by NAVISTAR for each truck model and engine combination. In general, total noise contribution from the tailpipe outlet(s) and muffler shell body is limited to 70 dB(A). Deviations from this limit are not acceptable without prior approval from the Vehicle Acoustics Group. After review and approval of supplier test data (and final vehicle validation, if applicable), noise control may not be modified on production units without prior consideration by the NAVISTAR Vehicle Acoustics Group.

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PART I. MUFFLERS AND MUFFLER ASSEMBLIES (cont'd)

4.4.1 Vehicle Noise Test Methodology

To determine noise contribution of the proposed exhaust system, compare vehicle pass-by noise levels with the proposed system to levels with a baseline-attenuated exhaust. The baseline condition represents a configuration where, at a minimum, exhaust noise contribution from the tailpipe outlet is attenuated by adding a silencer to the tailpipe outlet(s) of a production-approved exhaust system. If applicable, additional pipe and/or muffler noise control must be applied if shell noise or leakage is significant. As a result, contributed exhaust noise from the baseline-attenuated configuration must be less than 60 dB(A). Record 1/3-octave band and over-all noise level as a function of time or displacement through the measurement zone. Report the highest level from the right and left side of the vehicle for each test gear.

4.4.2 Lab Noise Measurement

If a lab measurement is used in lieu of vehicle tests, NAVISTAR must approve of equivalency, targets, and scope of application.

4.4.3 Data Analysis

Exhaust noise contribution level determined by:

$$C_{pA}^{exhaust} = 10 \log_{10} \left[10^{(SPL1/10)} - 10^{(SPL2/10)} \right]$$

where: SPL1 = vehicle sound level with proposed exhaust system, normalized to 30°F.

SPL2 = vehicle sound level with attenuated exhaust noise, normalized to 30°F.

4.4.3.1 Test Lab Procedure VA-PR-001 provides the method to normalize emission noise levels to 30°F ambient test temperature. The 70 dB(A) contributed noise limit applies to a reference vehicle with a nominal, total-vehicle emission level of 78.5 dB(A). The exhaust noise contribution must be normalized to account for differences between the actual production-equivalent truck noise level as compared to 78.5 dB(A).

4.4.3.2 Hence, the normalized exhaust noise contribution is determined by:

$$C_{pA}^{exhaust} = \left[78.5 \text{ dB(A)} - L_{pA} \right] + C_{pA}^{exhaust}$$

where: all noise levels are corrected to an ambient temperature of 30°F as described in VA-PR-001, and L_{pA} is the vehicle noise level with a production-approved exhaust system.

4.5 Structural Integrity

Muffler and/or muffler assemblies shall be capable of withstanding the normal static and dynamic loading anticipated in service. When requested by NAVISTAR, the supplier shall provide test data indicating capability of the muffler to withstand the defined load conditions.

4.6 Test Reports

When the supplier is assigned responsibility to provide test data in support of NAVISTAR engineering design programs, test reports submitted will follow the format described in TMS-9543. The use of this format enables test reports to be filed and permanently stored in the NAVISTAR Project Tracking, Reporting, and Retrieval System.

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PART II. EXHAUST AFTERTREATMENT MODULES

4.0 GENERAL REQUIREMENTS (EXHAUST AFTERTREATMENT MODULES)

4.1 Cosmetic Corrosion Resistance

The aftertreatment exhaust module shall withstand 250 hours salt spray testing as per ASTM B 117 without evidence of significant red rust. Weld heat affected zones (HAZ) and sharp radii may show some red rust appearance but will not develop loose rust scale.

4.1.1 Perforation Corrosion Resistance

The aftertreatment exhaust module shall be free of perforation, due to corrosion in service, for a period of **10 years** or **185,000 miles** in service, whichever occurs first, for medium duty diesel engines; or **10 years** or **485,000 miles** in service or for **22,000 engine hours**, whichever occurs first, for heavy duty diesel engines as per 40 CFR 86.004-2.

4.2 Back Pressure

The aftertreatment exhaust modules, when tested in combination with the rest of the exhaust piping, must not exceed the max exhaust back pressure allowance determined by the engine manufacturer.

4.3 Leakage Testing

4.3.1 Water Ingestion

The catalyst and filter substrates used in the aftertreatment modules are mounted to their stainless steel housings using a ceramic fiber mat. This ceramic material must be protected from contact with water. Vertically mounted modules must include a water trap that prevents water from entering the substrate section(s) or equivalent drainage provision to ensure the fiber mat is not wetted. Horizontally mounted modules should include vertically aligned ($\pm 10^\circ$) drain holes in the outlet section or equivalent drainage method to ensure the fiber mat will not be wetted. Drainage holes must not be covered by mounting straps or otherwise become plugged. The module shall be capable of storing a minimum quantity of one (1) gallon of water without leakage into the catalyst and filter. The module shall also be capable of draining the water trap at a rate as shown in the chart below. See Appendix A for test procedure.

	0 Degree Incline	15 Degree Incline	Efficiency
Steady Flow	0.475 GPM	0.3 GPM	100%
Flow Surge	3 GPM for 10.6 seconds	3 GPM for 10.6 seconds	100%

4.3.2 Exhaust Gas Leakage

Maximum allowable leakage rate in the aftertreatment module is one (1) standard cubic foot of air per minute @ 4 psig. Maximum allowable leakage of the exhaust piping between the turbocharger and inlet to the DOC is limited to a maximum of one (1) standard cubic foot of air per minute @ 4 psig.

4.4 Noise Requirement

4.4.1 Pass-By Noise Requirement

The aftertreatment exhaust module is a part of the truck noise control system which enables a vehicle to comply with the 80 dB(A) requirement of the Federal Noise Regulation (CFR Title 40, Part 205, Subpart B). The equivalent NAVISTAR test lab procedure is VA-PR-001.

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PART II. EXHAUST AFTERTREATMENT MODULES (cont'd)

All vehicles for sale/use in the global market shall meet the E.C.E. Regulation (ECE 51-02). All aftertreatment exhaust modules used on Navistar trucks require approval for noise compliance by NAVISTAR for each truck model and engine combination. In general, total noise contribution from the tailpipe outlet(s) and the aftertreatment exhaust module shell body/bodies is limited to 70 dB(A). Deviations from this limit are not acceptable without prior approval from the NAVISTAR Vehicle Acoustics Group. After review and approval of supplier test data (and final vehicle validation, if applicable), noise control may not be modified on production units without prior consideration by the Vehicle Acoustics Group.

4.4.2 Deceleration Noise Requirement

The aftertreatment exhaust module is a part of the truck noise control system enabling a vehicle to comply with Federal Noise Regulations. All aftertreatment exhaust modules used on Navistar trucks require approval for noise compliance by NAVISTAR for each truck model and engine combination. The noise level contributed by the aftertreatment exhaust module during a deceleration pass-by test shall not exceed 78 dBA when used on an engine with an engine compression brake. The engine compression brake shall be full on. The test method shall be the deceleration portion of SAE J366. This requirement does not apply if the application of the aftertreatment exhaust module is on an engine that does not offer an engine compression brake.

4.4.3 Interior Noise Requirement

The aftertreatment exhaust module is a part of the truck noise control system enabling a vehicle to comply with Federal Noise Regulations. All aftertreatment exhaust modules used on Navistar trucks require approval for noise compliance by NAVISTAR for each truck model and engine combination. The exhaust outlet noise shall be measured for all aftertreatment exhaust modules and engine combinations. For vertical tailpipe systems, position the microphone at 2 feet from the center of the tailpipe outlet and 110 degrees down from the axis of the vertical tailpipe outlet. For horizontal tailpipe systems, position the microphone at the 2 foot radius from the center of the tailpipe outlet, ½ meter laterally from the DPF in the direction where the centerline of the truck would be, and vertically at the same height from the floor as the DPF centerline. The microphone shall be pointed at the tailpipe outlet. Measure overall and 1/3 octave band sound pressure levels in dBA, fast response versus engine speed. The engine speed shall sweep the full range, at full load, up to maximum governed engine speed, under quasi-steady state conditions. Add the 1/3 octave bands of 50 through 250 hertz center frequency together to obtain a band-pass sound pressure level. The band-pass sound pressure level shall be plotted versus engine speed. The maximum band-pass sound pressure level over the engine speed range shall not exceed 85 dBA for a vertical tailpipe or 88 dBA for a horizontal tailpipe.

4.4.4 Interior Noise during Regeneration

The aftertreatment exhaust module is a part of the truck noise control system enabling a vehicle to comply with Federal Noise Regulations. All aftertreatment exhaust modules used on Navistar trucks require approval for noise compliance by NAVISTAR for each truck model and engine combination. The sound quality of the noise from the aftertreatment exhaust system shall not be objectionable at the side of the truck or at the driver's location in the cab during a regeneration cycle. The sound quality of the regeneration noise can be evaluated using the 1 to 10 rating scale in SAE J1060. The average rating must be 7 or above to be acceptable.

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PART II. EXHAUST AFTERTREATMENT MODULES (cont'd)

4.5 Structural Integrity

Exhaust aftertreatment modules shall be capable of withstanding the normal static and dynamic loading anticipated in service. When requested by NAVISTAR, the supplier shall provide test data indicating capability of the module to withstand the defined load conditions.

4.6 Test Reports

When the supplier is assigned responsibility to provide test data in support of NAVISTAR engineering design programs, test reports submitted will follow the format described in TMS-9543. The use of this format enables test reports to be filed and permanently stored in the NAVISTAR Project Tracking, Reporting, and Retrieval System.

4.7 Aftertreatment Module Tracking and Identification Requirements

Federal EPA tracking and identification requirements for aftertreatment components/modules are described in the ADDENDUM to this specification. The ADDENDUM is a part of this specification and requirements shown in the ADDENDUM are a part of the Engineering requirements of this specification. The first part of the addendum describes the regulatory language of EPA rule. The second part of the addendum describes the Engine manufacturer's requirements and responsibility for tracking and identification. The third part of the addendum describes the Assembly plant's requirements and responsibility for maintaining identification during the assembly procedure.

(THE FOLLOWING IS APPLICABLE TO BOTH PARTS I and II)

5.0 QUALITY

All muffler and muffler assemblies or exhaust aftertreatment modules shall be delivered in a clean and dry condition. All inlet and outlet tubes and all electronic sensors shall be protected from damage and/or deformation in shipping and handling.

5.1 Weld Quality

5.1.1 Weld Requirements

Required welding will be specified on the applicable engineering drawings using weld symbols per American Welding Society standard ANSI/AWS A2.4. Welds will meet the requirements of AWS D1.6, Structural Welding Code for Stainless Steel. Weld filler metal will be as described in CEMS A-37 Appendix, Table XV, unless otherwise agreed upon between the supplier and Navistar Engineering.

5.1.2 Weld Qualification

To determine and monitor quality of welds, macroetch samples will be prepared for each weld joint for purposes of weld setup and for PPAP. The test specimens will be prepared with a surface finish sufficient for macroetch examination. A suitable macro etchant solution (see Annex G in AWS D1.6 for suggestions) will be applied to the samples to provide a clear definition of the weld. For acceptance qualification of the welds, visual examination of the test samples shall show complete fusion and absence of cracks or other weld defects. In addition, the actual weld size shall be at least equal to the specified weld size, and shall not have any concavity or convexity greater than 2 mm (1/16 in).

5.1.2.1 Test Frequency

In addition to the required testing for weld setup and PPAP, the supplier will provide a test plan and schedule to Navistar Engineering for regular monitoring of weld quality. Supplier will provide test samples to Navistar, and must furnish records of ongoing weld quality testing to Navistar upon request.

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