NAVISTAR®

TMT121340

CLASS COURSE CODE: 8359

2013 Aftertreatment System with SCR
Overview for Technicians
Study Guide



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TABLE OF CONTENTS

Introduction

MODULE 1: DIESEL EXHAUST FLUID 5

MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS 7

MODULE 3: AFTERTREATMENT SYSTEM OPERATION 9

CONCLUSION

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INTRODUCTION

2013 Aftertreatment System with SCR Overview for Technicians

Welcome to the 2013 Aftertreatment System with SCR overview for technicians.

Course Navigation

Course Navigation:

To skip the navigation instructions and continue with the course, click on the “SKIP” button near the upper right-hand corner of the screen.

Navigation of this course may be performed in several ways. At the bottom of the screen are the “NEXT,” “PREVIOUS,” and “REPLAY” buttons. Clicking either the “NEXT” or “PREVIOUS” buttons will take you to the next or previously viewed course topic. After all information on a topic has been covered, the arrow on the “NEXT” button will pulse red to indicate you are ready to continue.

Clicking the “REPLAY” button will replay the topic you are currently viewing.

Near the bottom right-hand corner of the screen are the “PAUSE/PLAY” and “NOTES” buttons. Clicking the “PAUSE/PLAY” button allows you to pause the course and resume when you’re ready to continue.

Clicking the “NOTES” button will bring up a small window containing the narrated text for the currently viewed topic. Click the “NOTES” button again to hide this window.

That’s all for course navigation. Click the “NEXT” button to continue.

Course Overview

This course is intended to provide technicians with a description of Diesel Exhaust Fluid, or DEF, components of the Aftertreatment System, including the Selective Catalytic Reduction System, or SCR, and the Aftertreatment System operation on model year 2013 and newer vehicles.

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INTRODUCTION

Objectives

Upon completion of this course, you will be able to identify the characteristics of DEF, practice proper handling and storage of DEF, identify the Aftertreatment System components, and define the operation of the Aftertreatment System.

- ***Identify the characteristics of Diesel Exhaust Fluid (DEF)***
- ***Practice proper handling and storage of DEF***
- ***Identify Aftertreatment System components***
- ***Define the operation of the Aftertreatment System***

Modules

This course consists of this introduction and the following three modules: Diesel Exhaust Fluid, Aftertreatment System Components, and Aftertreatment System Operation.

Click the “NEXT” button to continue to module one.

Module 1: Diesel Exhaust Fluid

Module 2: Aftertreatment System Components

Module 3: Aftertreatment System Operation

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MODULE 1: DIESEL EXHAUST FLUID

Diesel Exhaust Fluid

Module one, diesel exhaust fluid.



DEF General Information

What is diesel exhaust fluid? Diesel exhaust fluid is a nontoxic, nonflammable, colorless liquid that delivers ammonia to the Selective Catalyst Reduction System, or SCR.

Nontoxic, nonflammable, and colorless

Used to deliver ammonia to the Selective Catalyst Reduction System (SCR)

SCR Catalyst



DEF has a mild ammonia smell and will evaporate if left open to the atmosphere. Leaks in the DEF Delivery System are easy to find because evaporated DEF leaves behind a noticeable residue.

Mild ammonia smell

Evaporated DEF leaves noticeable residue



For use with Navistar applications, only ISO+ 22241 or equivalent Diesel Exhaust Fluid is authorized.

ISO+ 22241 or equivalent

Proper Storage and Shelf Life of DEF

The following conditions are ideal for maintaining DEF quality and shelf life during storage: the recommended storage temperature of DEF is between 23°F and 77°F (-5°C and 25°C). The freezing point of DEF is 12°F (-11°C). DEF should be stored in a sealed container away from direct sunlight. Storage in a vehicle, in excess of 6 months, is not recommended.

Recommended storage temperature is between 23°F and 77°F (-5°C and 25°C)

Freezing point 12°F (-11°C)

Store in sealed containers to prevent contamination

Avoid direct sunlight

Prolonged in-vehicle storage is not recommended (excess of 6 months)



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MODULE 1: DIESEL EXHAUST FLUID

Proper Storage and Shelf Life of DEF (Continued)

If ideal storage conditions are met DEF has a minimum shelf life of 18 months, but for each 9°F (5°C) increment above the recommended temperature, shelf life is reduced by 6 months. If stored at 86°F (30°C) DEF will have a 12 month shelf life, 95°F (35°C) a 6 month shelf life.

77°F (25°C)

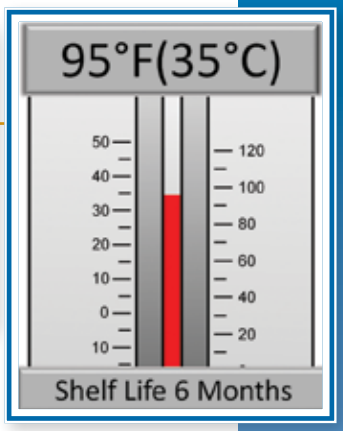
Shelf Life 18 Months

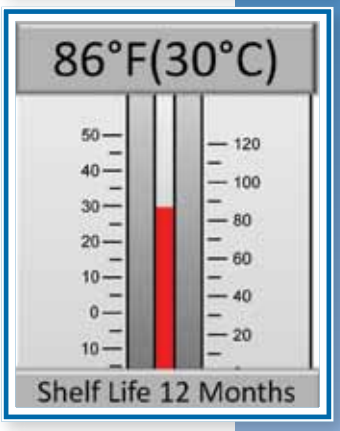
86°F (30°C)

Shelf Life 12 Months

95°F (35°C)

Shelf Life 6 Months







DEF Contamination

CAUTION

TAP WATER WILL CONTAMINATE DEF. WHEN CLEANING CONTAINERS OR FUNNELS INTENDED FOR DEF USE, RINSE WITH DISTILLED WATER. IF DISTILLED WATER IS NOT AVAILABLE, RINSE WITH TAP WATER AND THEN RINSE WITH DEF.



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MODULE 1: DIESEL EXHAUST FLUID

Disposal of DEF

CAUTION

DO NOT EMPTY DEF INTO THE DRAINAGE SYSTEM, OR RELEASE DEF INTO SURFACE WATER.



Cleanliness Practices

Prior to using any containers or funnels to dispense, handle, or store DEF, wash and rinse them thoroughly to remove any contaminants and then rinse with distilled water.



If spillage occurs, the DEF should be either transferred into a suitable, properly labeled container, or covered using an absorbent material and then disposed of according to local environmental regulations.



Concentration Specification

If the quality of DEF is in question, or you are instructed by service and/or diagnostic procedures to check the concentration of urea in DEF, the DEF Refractometer, special service tool #5025, must be used. The concentration of urea must be 32.5% +/- 1.5%.



Module 1 Summary

This concludes module one. To continue to module two and view the components of the Aftertreatment System, click the “NEXT” button.

Navistar DEF Refractometer service tool #5025

Urea concentration Spec: 32.5% +/- 1.5%.



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MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS

Module Overview

In this module we will identify the various components of the Aftertreatment System. The Aftertreatment System is comprised of the DEF Delivery and Selective Catalytic Reduction, or SCR, Systems.



DEF Tank and Mounting Brackets

The first component we'll discuss is the Diesel Exhaust Fluid Tank Assembly. The DEF Tank Assembly includes the tank, pickup assembly, and mounting bracket.

The tank is constructed of a composite material and uses a serviceable fill cap and drain.

The pickup assembly consists of a DEF level sensor, a urea quality sensor, a 40 micron pickup screen, and a coolant circuit for heating or thawing of DEF. The individual components of the pickup assembly are non-serviceable and can be replaced as an assembly only.





DEF Tank and Mounting Brackets



DEPENDING ON VEHICLE MODEL AND THE LOCATION OF THE DEF TANK, DEF TANK MOUNTING BRACKETS MAY DIFFER.



DEF Supply Module

The DEF Supply Module supplies and returns Diesel Exhaust Fluid between the DEF tank and DEF Doser. Within the DEF Supply Module is an internal filter that must be changed every 300,000 miles. The rest of the DEF Supply Module is non-servicable and must be replaced as an assembly.





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MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS

DEF Lines and Fittings

CAUTION

WHEN SERVICING NAVISTAR VEHICLES, IMPROPER OPERATION OF THE DEF SUPPLY SYSTEM MAY OCCUR IF THE SUCTION AND BACKFLOW LINES ARE INCORRECTLY INSTALLED.





There are three electronically heated DEF lines, the suction line, pressure line, and backflow line.

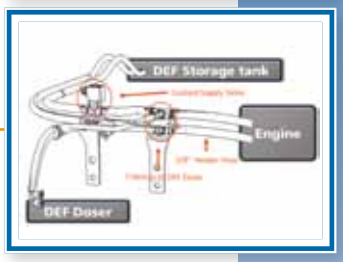
The DEF pressure line runs from the supply module and supplies DEF to the doser. The suction and backflow lines run between the DEF tank and the supply module.

Coolant Lines and Fittings

Engine coolant is routed from the engine to the DEF Doser and the coolant circuit in the DEF Storage Tank.

The Coolant Supply Valve regulates coolant flow to the DEF Tank based on the DEF Tank temperature sensor readings.

After flowing through the DEF Doser and the coolant circuit in the DEF Storage Tank, coolant is then returned to the engine.





MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS

DEF Electrical Components

Click on the Arrows in the upper right hand corner to learn about electrical harnesses and the Power Distribution Module for the DEF Supply System.

A. Power Distribution Module

The DEF Power Distribution Module, or PDM, contains fuses and relays used by the DEF Delivery System. This module may be mounted to the DEF supply module bracket or *directly to the bulkhead of the vehicle.* The DEF PDM may be powered directly by the battery or by the chassis PDM.

B. DEF Pick-up Pigtail

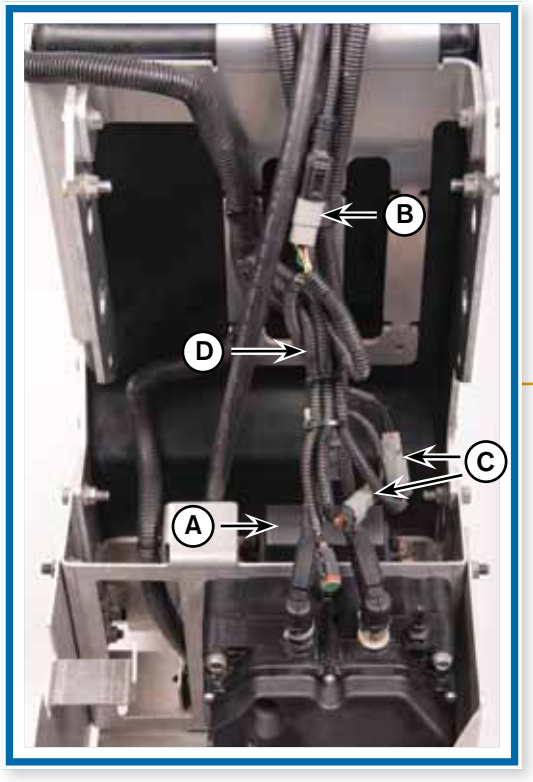
One electrical breakout connects to the harness from the DEF tank center unit or pick-up.

C. Heated Line Circuits

Three pigtails come from DEF lines and connect to DEF line heater circuits.

D. Tie Up Harness

The electrical harness should be bundled with the DEF pressure line to the doser and tied up to the DEF tank back support where necessary.

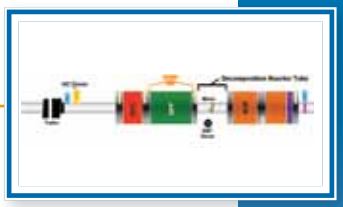


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MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS

SCR System Overview

The SCR system is made up of three main components: the DOC and DPF canister, the Decomposition Reactor tube, and the SCR canister. Spread throughout these main components are a series of sensors which facilitate proper operation of this system.



DOC and DPF

The first component in line of the exhaust system is the DOC and DPF canister. The DOC and DPF Canister is made up of a Diesel Oxidation Catalyst, or DOC, and a Diesel Particulate Filter, or DPF.



The DOC is constructed of a ceramic honeycomb and includes a series of small passages coated with precious metals. The DPF is located after the DOC and is also constructed of a ceramic honeycomb with a coating of precious metals.

Exhaust gas from the turbo outlet will enter the DOC inlet, pass through the DOC into the DPF, and finally exit through the DPF outlet.

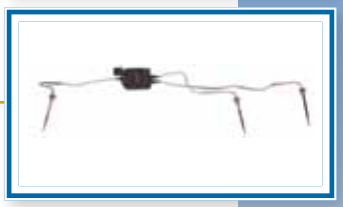


The DOC and DPF assembly is monitored by two modules, a Smart Temperature Sensor Module and the DPF Pressure Differential Module.

The Smart Temperature Sensor Module receives input from three temperature sensors, one at the DOC inlet, one between the DOC and the DPF, and one at the DPF outlet. This module broadcasts its temperature readings over the private CAN network.



The DPF Differential Pressure Module is used to measure exhaust restriction through the DPF by monitoring exhaust back pressure at the DPF inlet and outlet.







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MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS

DEF Doser and Decomposition Tube

The Decomposition Reactor Tube is located between the DPF outlet and the SCR inlet and contains an internal mixer. The Mixer ensures even vaporization of DEF into the exhaust stream.

The DEF Doser is mounted to the outside of the Decomposition Reactor Tube upstream from the Mixer. When commanded, the DEF Doser injects a precise amount of DEF into the exhaust stream. Engine coolant is routed through the Doser to keep the Doser cool and operable.



MODULE 2: AFTERTREATMENT SYSTEM COMPONENTS

SCR Canister

After exhaust gases pass through the Decomposition Reactor Tube they flow into the SCR Canister. The SCR Canister contains two SCR catalysts and one Ammonia Slip Catalyst or ASC.

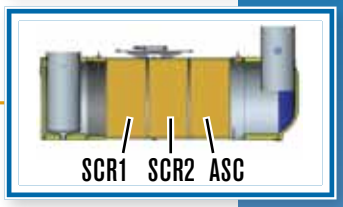
Mounted to the SCR Canister are three modules, a Smart Temperature Module, an Ammonia, or NH3, Module, and a Nitrogen Oxide, or NOx, Module.

The Smart Temperature Sensor Module receives input from two exhaust gas temperature sensors, one after the first SCR catalyst and one after the ASC.

An ammonia sensor located after the first SCR catalyst provides input to the NH3 Module.

The NOx Module receives input from a nitrogen oxide sensor at the outlet of the ASC.











Module 2 Summary

This concludes module two. To continue to module three and learn about Aftertreatment System operation , click the “NEXT” button.

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MODULE 3: AFTERTREATMENT SYSTEM OPERATION

Aftertreatment System Operation Overview

This module will identify the states of the DEF Delivery System, the methods of DPF regeneration, and the selective catalytic reduction process. First we will cover the states of the DEF Delivery System.

DEF Delivery System Operation

The DEF Delivery System is comprised of four main states: Heating, Priming, Dosing, and Purging.

Heating State

Heating State: If the engine is started in temperatures below 25°F (-4°C) the DEF Delivery System is commanded into the Heating state. The internal DEF Supply Module heater will be activated along with the heated DEF lines.

If the DEF tank temperature drops below 23°F (-5°C) the Coolant Supply Valve is commanded open allowing engine coolant to flow through the tank's coolant circuit to "heat or warm" the DEF.

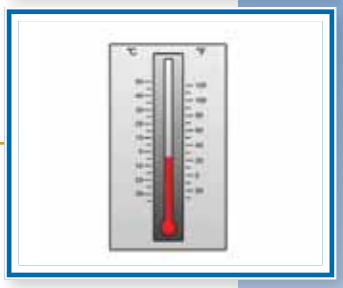




DEF Dosing System Operation

Heating
Priming
Dosing
Purging





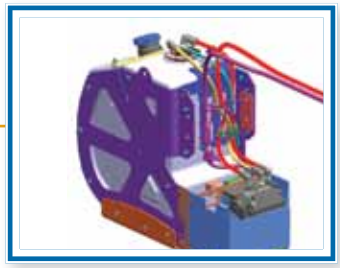


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MODULE 3: AFTERTREATMENT SYSTEM OPERATION

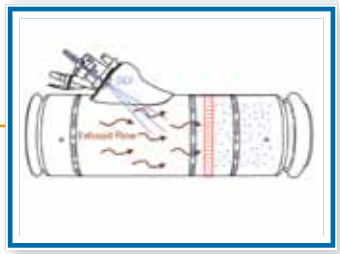
Priming State

Priming State: Once the SCR catalyst reaches a temperature of 302°F (150°C) the DEF Delivery System is commanded into the Priming state. During the Priming state the Supply Module will deliver DEF to the Doser. The DEF Doser will open and close to purge any air from the system.



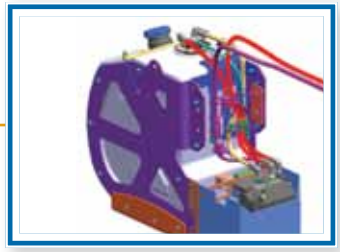
Dosing State

Dosing State: During the Dosing state the DEF Supply Module is activated. DEF is pulled from the tank, filtered, and pressurized to the DEF Doser by the Supply Module. The Doser is commanded open and sprays a precise amount of DEF into the exhaust stream as it passes through the Decomposition Reactor Tube.



Purging State

Purging State: To prevent freezing the DEF Delivery System performs a purge cycle when the key is turned to the OFF position. During this cycle the Supply Module positions its internal reverting valve to reverse the direction of DEF flow. All remaining DEF is then purged from the Doser and Pressure Line and returned to the Storage Tank.



DEF Level Monitoring

When the DEF level in the storage tank gets low the operator will be notified with visual and audible warnings. When the DEF level drops to approximately 20% of full, the DEF lamp on the instrument panel will illuminate.

As the DEF level continues to drop, the warnings will progress to flashing lights and audible chimes. If the vehicle is equipped with a digital display on the instrument panel, a warning message will appear.

If the DEF level falls below a critical threshold, the engine's performance will be de-rated and eventually vehicle speed will be limited.

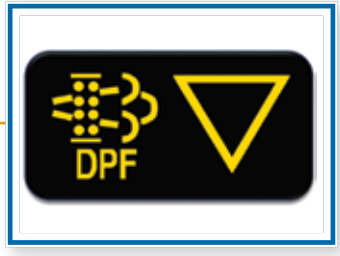
The specifications for the critical threshold, as well as the sequencing of the warning indicators, will vary depending on the application.



Conclusion of DEF Delivery System States

Now that we have covered the four states of the DEF Dosing System we will move on to learn more about Aftertreatment System operation and the methods of DPF Regeneration. Click "NEXT" to continue.





MODULE 3: AFTERTREATMENT SYSTEM OPERATION

DOC and DPF operation

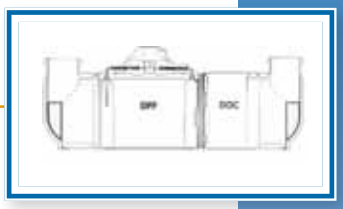
Exhaust gases entering the Aftertreatment System are directed to the DOC. As the exhaust flows through the passages of the DOC, unburned fuel is oxidized through a reaction with the precious metals of the catalyst and the remaining oxygen in the exhaust. This reaction increases the temperature of the exhaust system.

After exiting the DOC exhaust gases are forced to flow through small passages in the ceramic material of the DPF. The DPF collects the soot from the exhaust.



Regeneration

Regeneration is the process that removes accumulated soot from the Diesel Particulate Filter. During Regeneration the DPF is heated until the soot is oxidized and turned into carbon dioxide gas. There are three different Methods of Regeneration, Passive, Active, and Parked.



Passive Regeneration

Passive Regeneration, or Regen, happens anytime the exhaust system is hot enough to ignite the soot particles in the DOC and DPF during normal operation.



Active Regeneration

Active Regeneration occurs when exhaust temperatures are insufficient to ignite the soot particles collected in the DOC and DPF. During Active Regeneration the Aftertreatment Fuel Injector is commanded to inject extra fuel into the exhaust. A reaction between the fuel and precious metals in the DOC increases the temperature of the exhaust causing the soot particles in the DOC and DPF to oxidize.



Parked Regeneration Warning

WARNING

FAILURE TO PERFORM A PARKED REGENERATION WHEN DPF INDICATOR IS ON WILL CAUSE THE ENGINE TO LOSE POWER AND EVENTUALLY SHUT DOWN. WHEN PERFORMING PARKED REGENERATION, MAKE CERTAIN VEHICLE IS SAFELY OFF OF THE ROADWAY AND EXHAUST PIPE IS AWAY FROM PEOPLE, OR ANY FLAMMABLE MATERIALS OR STRUCTURES. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN A LOSS OF ENGINE POWER AND VEHICLE SPEED, INCREASED EXHAUST TEMPERATURES, AND AN ACCIDENT OR FIRE RESULTING IN PROPERTY DAMAGE, PERSONAL INJURY, OR DEATH.

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MODULE 3: AFTERTREATMENT SYSTEM OPERATION

Parked Regeneration

Parked Regeneration is required when soot levels are too high for Passive or Active methods and must be initiated by the operator. During Stationary Regen engine RPM is raised, fuel is injected into the exhaust, and the throttle valve is positioned to restrict intake airflow. If equipped with an exhaust back pressure valve, the valve is positioned to restrict exhaust flow. The purpose of these actions is to raise exhaust temperatures to oxidize and remove the soot captured in the DOC and DPF.



Regeneration Related Driver Warnings

When the soot load in the Diesel Particulate Filter becomes too great, the operator will be notified with visual and audible warnings.



During the initial warning the DPF lamp will illuminate and if the vehicle is equipped with a digital display on the instrument panel, a warning message will appear. This warning means the operator needs to apply load to the engine by driving at highway speeds. This high load level will aid the regeneration process of the DPF. If this action is not enough to reduce soot levels, the DPF lamp will begin to flash. This warning means the DPF is full of soot and Parked Regeneration is necessary. If these warnings are ignored an audible chime will activate and engine performance will be limited.

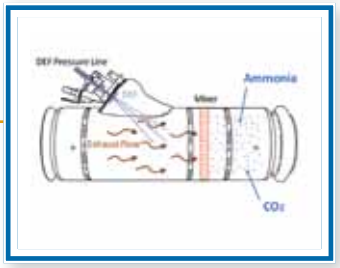
When Parked Regeneration is initiated a DPF temperature lamp on the instrument panel will be illuminated to warn the operator of increased exhaust temperatures.

Selective Catalytic Reduction

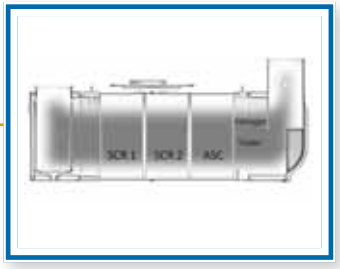
In addition to DOC and DPF regeneration, Selective Catalytic Reduction also takes place in the Exhaust Aftertreatment System. Selective Catalytic Reduction Is a process used to control the level of Nitrogen oxide, or Nox, being emitted by the engine through the vehicles exhaust.



The SCR system actively reduces NOx by injecting DEF through the Doser into the Decomposition Reactor Tube. The heat from the exhaust in the Decomposition Reactor Tube causes the DEF to break down and convert to ammonia and CO2.



After exiting the Decomposition Reactor Tube the ammonia and exhaust gases flow through the SCR Catalyst. The SCR1 Catalyst completes the break down of DEF into ammonia and CO2. The SCR2 Catalyst promotes a reaction between the ammonia and NOx in the exhaust. This reaction converts the ammonia and NOx to Nitrogen gas and water. Before the exhaust gasses exit the vehicle they pass through the ASC where any remaining ammonia is converted into Nitrogen gas and water. Once this reaction takes place the exhaust exits the Aftertreatment System and leaves the vehicle through the tailpipe.



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MODULE 3: AFTERTREATMENT SYSTEM OPERATION

Module 3 Summary

This concludes the basic operation of the Aftertreatment System. Click the “NEXT” button to continue.

For More Information

For further information on the Aftertreatment system, refer to the Master Service Information page located on the Navistar Service Portal.

This concludes the 2013 Aftertreatment System overview. Thank you for your participation. Close this window and return to the course grade book to take the final test.

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