



Answers to School Bus Fleet WebEx Questions  
June 1, 2009

**Questions**

**Answers**

<p>Does Cummins utilize EGR in their 2007 engines? Will this system differ on the 2010 Emissions Cummins engine?</p>	<p>Cummins does use EGR and DPF in current 2007 product, we will continue to use EGR + DPF and SCR in our 2010 solution. However, we will not use "extreme" or "massive" EGR for our solution for 2010 which is less fuel efficient due to reducing the combustion temperature in the cylinder. We will employ SCR to lower NOx in order to keep fuel efficiency at optimal levels for our end users.</p>
<p>What diagnostics are provided with the 2010 Emissions SCR system for the Cummins engine and the dosing?</p>	<p>Yes, there are 'new' fault codes that have been developed to support proper diagnosis and repair of the SCR system including the dosing system.</p>
<p>Is there a diagnostic system and software for the 2010 Emissions Cummins engine?</p>	<p>Yes, there are 'new' fault codes that have been developed to support proper diagnosis and repair of the SCR system including the dosing system.</p>
<p>How do the engine and emissions systems communicate?</p>	<p>Via datalink connection from the engine Electronic Control Module through the vehicle chassis wiring connecting to the doser control module and a few sensors located on the vehicle.</p>
<p>When will the 2010 Emissions Cummins engines begin in production and when will they begin to be provided in buses?</p>	<p>Cummins 2010 solutions will be available Jan 1, 2010 for all engine platforms and markets.</p>
<p>What will the warranty coverage be for the 2010 Emission Cummins engines and for the SCR system and are there any extended warranties available?</p>	<p>Warranty and Extended Warranty plans for Cummins Engines will be comparable to current offerings and terms.</p>
<p>Will the 2010 Emissions Cummins engines be compatible with BioDiesel?</p>	<p>Cummins products are compatible with up to B20. 2010 products will also maintain the ability to use up to B20.</p>
<p>Will the B50 life of 500,000 miles on the 2010 Emissions Cummins engine be affected with the use of BioDiesel?</p>	<p>Up to B20 is approved for Cummins 2010 products and will not affect engine life.</p>
<p>What training is required for the technician to service the 2010 Emissions Cummins engines &amp; when will it be provided?</p>	<p>The Cummins service training plan/program will be very similar to the approach taken with the launch of our '07 products. Technicians will be offered both self study as well as hands-on training at Cummins distributors. The role out of Cummins training plan/schedule will begin late in 2009.</p>
<p>Fuel Economy was identified as 5 to 9 percent over that for Extreme EGR. Does this include the added cost of DEF?</p>	<p>No...it does not include the cost of diesel exhaust fluid, this is strictly fuel economy advantage. Refer to the WebEx for cost advantages.</p>
<p>Stating a 5 to 9 percent fuel economy advantage over Extreme EGR, what Extreme EGR engine is that compared to?</p>	<p>This is related to Cummins own engine development experience comparing an EGR-only solution to our current SCR approach.</p>
<p>What location and routing were used to determine the fuel economy ratings of the engines?</p>	<p>This is a combination of Cummins own test cell evaluations and engineering vehicle development as well as actual customer field test experiences.</p>



Is there a fuel economy difference from the 2007 Emission Cummins engine and the new 2010 Emission Cummins engine?	2007 and 2010 midrange Cummins products will be comparable in fuel economy, however if Cummins would have gone to 'in-cylinder' we would have lost 5-9% in fuel economy.
Will the SCR system provide for cooler exhaust?	Yes, but it is dependent on actual duty cycle and actual load factor.
Will the 2010 Emissions Cummins engines be used in Canada?	Yes, the 2010 emissions engines will be used in both the US and Canada.
What is the added weight to the bus with addition of the SCR system? Will buses be overweight in some states and provinces?	The expected weight gain on a school bus including a full tank of Diesel Exhaust Fluid will be approximately 200 to 250 pounds dependent upon the size of the DEF tank.
What are all the components that are added to the bus for the SCR system?	SCR reactor, decomposition pipe, DEF Doser, Doser Control Unit, DEF tank, DEF fluid lines, NOx sensors, a coolant circuit for the SCR system, wire harnesses and related parts to attach and support the system.
Will the amount of Nitrogen exhaust be enough to ignite to flame?	No. Nitrogen is not flammable.
Is there an SCR kit for older buses to retrofit to the 2010 Emissions and do older buses need to be retrofitted to meet these 2010 emission requirements?	Not at the present time. It is possible that a system might be available at a later date.
Are the components for the 2010 Emissions Cummins engines/SCR protected from rust and corrosion?	Generally speaking, yes. Much of the SCR system is stainless steel and impact resistant polymer.
What is the life of the SCR system and its components?	The SCR system is designed to last the life of the engine.
Does the 'stop and go' environment that we use in school buses have any affect on the 2010 Emissions system/SCR?	No. Duty cycle does affect the amount of diesel exhaust fluid used, but the system is designed with this in mind.
What are the preventive maintenance requirements on the SCR system on the 2010 Emissions Cummins engine?	There are no preventive maintenance requirements other than a DEF filter that will need to be serviced at 200,000 miles.
How many sensors are there on the 2010 Emissions SCR System for the Cummins Engine and a Thomas Built Bus?	2 NOx sensors, 2 temperature sensors and a diesel exhaust fluid level sensor.
Do the 'Regenerations' on the 2010 Emission Cummins engines differ from the 2007 Emission Cummins engines?	There will be fewer regenerations in the 2010 engines vs. 2007 engines.
Is there more or less carbon dioxide emitted from a 2010 Emission Cummins engine as compared to the 2007 Emission Cummins engine?	The amount of Carbon Dioxide emitted is based upon the amount of fuel burned. Because the fuel economy will be similar to 2007 Emissions engines, the Carbon Dioxides emitted will be comparable to slightly less.
Why would Cummins not increase the compression ratio for 'in-cylinder' emission advantage versus an 'add-on' system with SCR?	This is because of design constraints for the engine. Increasing compression ratio alone cannot reduce the NOx level down to 2010 emission requirements.



With the addition of the Selective Catalyst Reduction system will the bus be approved for operation in all states and provinces?	Cummins will submit to both EPA and CARB and through testing is planning on achieving certification in all 50 states.
Where has testing been performed with engines in operation and in what conditions?	Cummins conducts field tests through many conditions and types of applications, from extreme cold in Northern Canada, mountainous duty cycles, and extreme heat in the deserts of the west. Cummins tests a variety of applications from stop and go applications such as bus and "Manhattan" duty cycle delivery vehicles; Cummins tests linehaul, yardspotters, and many different normal and extreme operating type scenarios. Winter Test in Bemidji was completed in 01/2009. Functional testing of prototypes, EMI testing, and durability testing will be conducted throughout the year.
What is the added cost to the operator with the requirement to use stainless steel components?	Stainless Steel is currently used on all buses equipped with 2007 Emissions engines so there will not be a significant increase for stainless steel on 2010 Emission engines over 2007 engines.
What is the difference in emissions exhausted from a 2010 Emission Cummins diesel engine versus a CNG fueled bus?	In 2010 the Diesel engines will be similar in emissions to what CNG is currently.
Is the 2010 Emissions Cummins engine equipped on vehicles today and where can someone view any photographs of the exhaust system?	<a href="http://www.everytime.cummins.com">www.everytime.cummins.com</a>
Explain why the 'in-cylinder' solution caused condensation in the engine.	EGR must be cooled to a lower temperature to reach the needed emission levels. This causes condensation of the EGR gas before it goes into the cylinder.
Can we have a shortened presentation/brochure illustrating the SCR solution benefits?	<a href="http://www.truthaboutscr.com">www.truthaboutscr.com</a> and <a href="http://www.thomasbus.com">www.thomasbus.com</a> have downloadable .pdf files that are very good.
Why are Scania and Mann in Europe changing from SCR to Extreme EGR if SCR is the system that has been used in Europe for years?	North American and European markets took 2 different routes to attain reduced emissions. North America first approached particulate matter reduction with the use of EGR, and the European market addressed the reduction of NOx with the use of SCR. North American manufacturers for the 2010 emissions requirements will be affecting the reduction of NOx while Europe utilizes EGR to reduce their particulate matter emissions. Additionally, the EPA regulations are stricter than current Euro standards and new sources are now saying that Scania and Mann may need SCR to meet Euro requirements in 2013, which almost matches the EPA requirements.
Has the Cummins engines that Thomas Built Buses to meet the 2010 Emissions requirements been certified to those 2010 Emissions standards?	Certification will be applied for in October. The certification will be available for viewing on the EPA website.



<p>Is it true that Europeans are moving away from SCR and toward Extreme EGR?</p>	<p>North American and European markets took 2 different routes to attain reduced emissions. North America first approached particulate matter reduction with the use of EGR, and the European market addressed the reduction of NOx with the use of SCR. North American manufacturers for the 2010 emissions requirements will be affecting the reduction of NOx while Europe utilizes EGR to reduce their particulate matter emissions. Additionally, the EPA regulations are stricter than current Euro standards and new sources are now saying that Scania and Mann may need SCR to meet Euro requirements in 2013, which almost matches the EPA requirements.</p>
<p>There are concerns expressed that the copper zeolite used in the catalyst for the Cummins SCR system is a carcinogenic. Is this true and what is Cummins and Thomas Built Buses using in their exhaust system?</p>	<p>Cummins is confident that EPA will approve the copper zeolite for certification. All testing is showing 0 level carcinogens and the EPA has reviewed the data and is in agreement with Cummins testing processes and results.</p>
<p>The warning and light system for the SCR and emissions system is concerning that it is complicated and confusing for a driver.</p>	<p>Today on an electronically equipped vehicle there are warnings and indicators that provide notification to the driver and/or technician. That is the case whether an operator is driving a car, a school bus, a truck or farm equipment. As our drivers of today have greater training provided to them on the part of fleets this notification process that was introduced would be a part of the driver training program. As introduced in the presentation, if the bus is serviced or inspected on a regular basis the refill of the Diesel Exhaust Fluid would become a part of that inspection process. Following this recommendation the number or necessity for notification indicators would be reduced compared to 'waiting for a low level warning' prior to refill.</p>

## Diesel Exhaust Fluid

### Questions

### Answers

<p>What exactly is Diesel Exhaust Fluid?</p>	<p>Diesel Exhaust fluid is comprised of 67.5% purified water and 32.5% Urea. Urea is a compound that is found in many consumer products that are used today such as in toothpaste, hand softener, pretzels and soap. <math>(\text{NH}_2)_2\text{CO}</math> is most commonly used as a fertilizer.</p>
<p>How was it determined that Diesel Exhaust Fluid was to be used in order to meet the 2010 Diesel engine emissions requirement?</p>	<p>Diesel Exhaust fluid is used successfully today to reduce emissions with coal-powered hydro-electric plants and is currently used in Europe in on-highway vehicles, so there has been a precedent set for its effectiveness. SCR has been used effectively for 50 years.</p>
<p>Who manufactures Diesel Exhaust Fluid and how is it formulated?</p>	<p>There are a number of companies that develop and provide Diesel Exhaust Fluid and it is a combination of purified water and urea as identified in the question above. It is available through engine manufacturers such as Cummins Engine &amp; Detroit Diesel, fuel suppliers and Thomas Built Buses dealers. Manufacturers of Diesel Exhaust Fluid; Agrium Inc. - Calgary, AB; CF Industries - Deerfield, IL; Dyno Nobel - Salt Lake City, UT; Koch Nitrogen - Wichita, KS; Potash Corp - Geismar, LA; Terra Environmental - Courtright, ON; Yara North America - Tampa, FL</p>
<p>How is the Diesel Exhaust Fluid level monitored?</p>	<p>The Diesel Exhaust Fluid level is monitored with the use of a gauge that is on the dash, incorporated into the fuel gauge, along with a sending unit &amp; sensor mounted in the Diesel Exhaust Fluid tank.</p>
<p>Is Diesel Exhaust Fluid corrosive?</p>	<p>Diesel Exhaust Fluid is corrosive to aluminum. There are no aluminum components that DEF comes in contact with on a school bus. The Diesel Exhaust Fluid tank is made of polyethylene and the remainder of the system (exhaust and dosing) is made of stainless steel. Our testing has shown that it takes a long period of time with an aluminum component soaking in DEF to create corrosion.</p>
<p>Approximately, how much Diesel Exhaust Fluid would be used for 100 gallons of diesel fuel?</p>	<p>The operational testing has shown that a 2% dosing of Diesel Exhaust Fluid in the exhaust stream provides for a measure that is acceptable for 2010 emissions requirements. That would mean that you would use approximately 2 gallons of Diesel Exhaust Fluid for every 100 gallons of diesel fuel used.</p>

<p>What is the concentration of urea in Diesel Exhaust Fluid and is this the same as agricultural fertilizer?</p>	<p>DEF is a 32.5% aqueous solution of urea per ISO 22241. Agricultural formulations have higher urea concentrations and lower purity requirements. The formulation process for agricultural fertilizer and that for Diesel Exhaust Fluid are different processes with different compounds and additives used so it's not possible to directly compare the two. Agricultural fertilizer cannot be used as a Diesel Exhaust Fluid.</p>
<p>Will Diesel Exhaust Fluid degrade at higher temperatures (above 85° F) if it is stored in a sealed container?</p>	<p>In order for Diesel Exhaust Fluid to degrade while stored at higher temperatures it must be stored at over 85°F for over 6 months. If the temperature decreases during that time of storage then the storing timeline is increased. DEF stored at below 85°F will provide for a 12 to 18 month shelf life.</p>
<p>Is Diesel Exhaust Fluid compatible with BioDiesel?</p>	<p>Yes</p>
<p>Does Diesel Exhaust Fluid freeze and at what temperature?</p>	<p>Diesel Exhaust Fluid freezes at 11°F/-11°C. It does not freeze as a solid block at that temperature, but it has a 'slushy' consistency. To freeze to a solid mass requires temperatures below -20°F/-25°C for 48 hours. From a solid frozen mass the system will take approximately 40 minutes to thaw the Diesel Exhaust Fluid, which is faster than required by the EPA.</p>
<p>How does the system operate if the Diesel Exhaust Fluid is frozen? Is the engine still compliant when the Diesel Exhaust Fluid is frozen?</p>	<p>The system will continue to operate when the Diesel Exhaust Fluid is frozen. EPA has approved 70 minutes of operating time in order for the dosing process to be operational when the DEF is frozen. A heating element is located in the DEF tank to provide for thawing when the DEF is frozen. Additionally, when a diesel engine is cold at start up and is combined with cold air at the engine intake, fewer emissions are emitted from the engine.</p>
<p>With the Diesel Exhaust Fluid freezing will it affect components of the SCR system? For example, the doser injector?</p>	<p>Diesel Exhaust Fluid being frozen will not affect the system. As indicated in the above responses the system will operate. Regarding the other components, the lines are heated during operation and when the bus is shut down the doser pump purges the DEF lines so that there is no DEF remaining in the DEF lines or in the injector.</p>
<p>Why not use heating elements in the Diesel Exhaust Fluid tank as opposed to engine coolant lines?</p>	<p>To avoid excessive electrical current draw, only the DEF pump and DEF lines are electrically heated.</p>
<p>Does the driver have any awareness (notification) for the heating process of the Diesel Exhaust Fluid?</p>	<p>No</p>
<p>During the summer months when temperatures are higher, will the coolant be flowing through the coolant lines in the Diesel Exhaust Fluid tank?</p>	<p>No. The system will identify when the Diesel Exhaust Fluid is frozen or at a temperature that requires heating. Above those temperatures the valve that releases coolant into the heating element will remain closed so coolant will not flow through the element in these situations.</p>

<p>What are concerns regarding the coolant lines that go into the Diesel Exhaust Fluid tank begin to leak into the Diesel Exhaust Fluid?</p>	<p>The SCR system will have sensors that will identify that the Diesel Exhaust Fluid is not at a standard to provide for the necessary dosing of the exhaust system so it will have a 'DEF Quality' notification on the dash to warn of the issue. Also, the engine electronics will identify a loss of coolant and a technician performing a system analysis will identify where the coolant is leaking.</p>
<p>What are the sizes of the Diesel Exhaust Fluid tanks?</p>	<p>Currently, the plan for the Saf-T-Liner® C2 is to provide an 11 gallon tank which should provide an approximately 5,000 mile/8,000 kilometer range and for the Saf-T-Liner® EF &amp; Saf-T-Liner® HDX to provide a 13 gallon tank which should provide an estimated mileage similar to that of the Saf-T-Liner® C2. These mileages may differ based on operation environment and driver tendencies.</p>
<p>Where can Diesel Exhaust Fluid be purchased in bulk or by the gallon?</p>	<p>Today Diesel Exhaust Fluid can be ordered from --- Cummins Engine Distributors; Detroit Diesel Dealers; Truck dealers; Air Blue Fluids - Brea, CA; Brenntag NA - Charlotte, NC; CDI (Cervantes-Delgado Inc) - Brea, CA; Colonia Chemical - Tabernacle, NJ; Cummins Filtration - Nashville, TN; Excelda - Brighton, MI</p>
<p>What occurs when the coolant line sensors fail?</p>	<p>The sensors that are provided in the SCR system are designed to last the life of the engine. With a B50 life of 500,000 miles on the Cummins ISB the chance for sensor failure is limited. However, should there be a sensor failure there will be a warning notification and upon electronic diagnosing of the engine there would be a notification as to the root cause for the warning. This system warning is the same today with an '07 Emission engine.</p>
<p>What are the chances that any of the sensors in the SCR system would fail and what would occur?</p>	<p>The sensors that are provided in the SCR system are designed to last the life of the engine. With a B50 life of 500,000 miles on the Cummins ISB the chance for sensor failure is limited. However, should there be a sensor failure there will be a warning notification and upon electronic diagnosing of the engine there would be a notification as to the root cause for the warning. This system warning is the same today with an '07 Emission engine.</p>
<p>Where will the Diesel Exhaust Fluid tanks be located and what protection is provided from road debris?</p>	<p>The location, surrounding geometry and support bracketry of the Diesel Exhaust Fluid tank is such that there is protection for the tank. In each bus model the tank is mounted to the frame and located where it is not exposed to severe road debris.</p>
<p>What is the cost of Diesel Exhaust Fluid &amp; what has an affect on that pricing?</p>	<p>The anticipated retail price of Diesel Exhaust Fluid in bulk containers is anticipated to be approximately the same as diesel fuel today. The market conditions that affect the pricing of diesel fuel do not affect the pricing of Diesel Exhaust Fluid and therefore the pricing differential can change, however, Diesel Exhaust fluid is projected to remain at or below the diesel fuel pricing levels. The Diesel Exhaust fluid demand will also aid in maintaining a low cost for the fluid.</p>

<p>Why do we need to use rubber gloves for the handling of Diesel Exhaust Fluid?</p>	<p>As with most shop chemicals and fluids, rubber gloves are a recommendation from the supplier of Diesel Exhaust Fluid. It is more a precaution than a necessity. Not everyone responds the same when exposed to different elements. Where someone may experience minor skin irritation with DEF, another may not have the same affect.</p>
<p>Doesn't the cost of Diesel Exhaust Fluid offset the fuel economy advantage you've expressed?</p>	<p>2007 and 2010 midrange Cummins products will be comparable in fuel economy, however if Cummins would have gone to 'in-cylinder' we would have lost 5-9% in fuel economy. We use this as our base line and as we discussed in the SBF WebEx, we estimate a 2% dosing rate with Diesel Exhaust Fluid estimated to be the same price as diesel fuel. Overall that would equate to a 3 to 6 percent fuel economy cost advantage over an Extreme EGR Emissions engine similar to the one used in Cummins testing.</p>
<p>What infrastructure is in place today and for the future to accommodate the introduction of Diesel Exhaust Fluid as part of Cummins' 2010 Emissions strategy?</p>	<p>Today there are a number of suppliers providing support for the SCR-equipped engines with Diesel Exhaust Fluid. Detroit Diesel dealers and Cummins Engine dealers are already preparing for the supply of their products - AdBlue from Detroit Diesel &amp; a Fleetguard product from Cummins. Additionally, there are bulk suppliers, such as Colonial Chemical, who have an infrastructure already in place. Remember that this product is not something that has to be introduced to the world. It is currently utilized in non-transportation industries today, as well as automobiles in the US and on-highway vehicles in Europe. TravelCenters of America and Pilot will have DEF in bulk and available in containers.</p>
<p>Are there any biohazard requirements of concerns for Diesel Exhaust Fluid? Any clean up requirements?</p>	<p>No. Diesel Exhaust Fluid does not have a bio-hazard clean up requirement.</p>
<p>How does the system operate if the Diesel Exhaust fluid is low or empty?</p>	<p>The system will continue to operate on a 'low' or an 'empty' basis. In a 'low' situation there will be notifications provided on the dash and in an 'empty' basis these notifications will include a flashing red level indicator. When the system is empty the bus will continue to operate with a reduction in engine torque of approximately 12 to 17 percent. Upon shutting down the engine and restarting without refilling the Diesel Exhaust Fluid the bus will then operate at 5 mph to allow the operator to drive to a location to refill the fluid. Once the fluid is refilled the bus will then continue to operate in a normal manner and there will not be a requirement for a 'reset' of the system. It automatically resets once the system is refilled.</p>
<p>Can there be an algae problem with the use of Diesel Exhaust Fluid?</p>	<p>The manufacturers of Diesel Exhaust Fluid have found through their testing and analysis that DEF does not provide for or sustain Algae growth.</p>

<p><b>What are the notifications of low Diesel Exhaust Fluid and will the bus continue to operate will low or 'no' Diesel Exhaust Fluid?</b></p>	<p>The system will continue to operate on a 'low' or an 'empty' basis. In a 'low' situation there will be notifications provided on the dash and in an 'empty' basis these notifications will include a flashing red level indicator. When the system is empty the bus will continue to operate with a reduction in engine torque of approximately 12 to 17 percent. Upon shutting down of the engine and restarting without refilling the Diesel Exhaust Fluid the bus will then operate at 5 mph to allow the operator to drive to a location to refill the fluid. Once the fluid is refilled the bus will then continue to operate in a normal manner and there will not be a requirement for a 'reset' of the system. It automatically resets once the system is refilled.</p>
<p><b>Are there any storage requirements for the storage of Diesel Exhaust Fluid that would be more stringent than for Windshield Washer Fluid or diesel fuel?</b></p>	<p>No. There is not a bio-hazard with Diesel Exhaust Fluid. DEF is less toxic than diesel fuel or windshield washer antifreeze.</p>
<p><b>What is the shelf life of Diesel Exhaust Fluid?</b></p>	<p>With Diesel Exhaust Fluid stored in a service facility similar to oil or windshield antifreeze the anticipated shelf life is 12 to 18 months. ISO 22241-3 sets minimum storage life standards.</p>
<p><b>Does Diesel Exhaust Fluid stored at high temperatures or operate at high temperatures change? Does it convert to ammonia?</b></p>	<p>Diesel Exhaust Fluid when heated, will very slowly hydrolyze to form small amounts of ammonia in solutions. Storage stability studies that have been conducted show that at 122°F/50°C DEF will still meet the ISO specifications of less than .2% ammonia for at least 35 days. At that rate, it would take more than 2 years to reach the ammonia level of household ammonia which is still not classified as a toxic material.</p>
<p><b>What is the recommendation of Diesel Exhaust Fluid in the tank for an operator over the summer months during school operations shut down and during the shut downs throughout the school year?</b></p>	<p>The operator can either 'drop' the remaining fluid from the tank and store it in bulk storage through the summer months and refill the bus upon the school year start up or the fluid can remain in the tank through the summer. At start up the fluid quality could have diminished, however, the bus will operate and the dosing rate may increase until the remaining fluid is used.</p>
<p><b>What type of filtration if provided or required for the Diesel Exhaust Fluid and what is the maintenance cycle on a filtration system?</b></p>	<p>There is a Diesel Exhaust Fluid filter integrated into the system and the filter requires replacement at 200,000 miles/300,000 kilometers.</p>