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Executive Summary

Fleets, diesel vehicle owners and truckstops are soon going to be introduced to a product that aims to help clean the air of harmful pollutants and may hold the promise of increasing fuel mileage. Beginning in 2010, most new diesel-burning vehicles will be outfitted with a pre-exhaust treatment system that requires regular replenishment by a specially prepared liquid called Diesel Exhaust Fluid (DEF).

As this informational paper will describe, DEF is derived from urea and requires special dispensing equipment, employee training and certification processes to maintain purity. A full discussion of these handling requirements will be accompanied by details on how DEF will make its way to market and projections of its future demand.

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Successful Urea/Diesel Exhaust Fluid Handling, Storage & Dispensing

Although urea is a widely produced chemical compound used for years by the agriculture industry to infuse nitrogen into soil, the term “diesel exhaust fluid” (DEF), a specific composition of urea for application in transportation, only recently entered the lexicon of the U.S. fleet industry with the advent of a particular type of clean exhaust system called Selective Catalytic Reduction (SCR).

Since 2006, DEF (known as AdBlue in Europe) has been a familiar product in Europe where strict limits on the amount of air pollutants permitted from diesel exhaust have been in place longer than in the U.S.

DEF will be required in most 2010 diesel vehicles in order to replenish the clean exhaust systems using SCR. Because these systems are sensitive and the material must remain pure, quality and training are key concerns for anyone marketing or handling DEF.

Distribution networks and certification systems are being established to meet the anticipated need for quality DEF through truckstops and retail outlets and to accommodate a wide variety of dispensing options.

This White Paper will provide a complete picture of DEF’s history, the political background that’s driving demand, how it is produced, distributed, safely handled, stored, dispensed and likely to be priced. And it’ll indicate the future of DEF in the U.S., projecting future demand for the product and characterizing its role in improving fuel mileage in fleets and helping to clean the air.

Chapter 1-Policy Drivers

In 1990, Congress passed and President George H.W. Bush signed amendments to the Clean Air Act that directed the U.S. Environmental Protection Agency (EPA) to regulate air pollutants from a variety of industrial and commercial sources including motor vehicles.

Among the air pollutants EPA regulates under the authority of the Clean Air Act are particulate matter (PM) and nitrogen oxides (NOx), byproducts of diesel exhaust that are precursors to smog. PM has been linked to higher incidences of childhood asthma, among other health hazards. The more sulfur motor fuel contains, the more PM it produces when burned. NOx is produced during the process of high-temperature combustion such as is present in a motor vehicle engine, and can react with sunlight along with volatile organic compounds to form smog.

The regulatory instrument by which EPA regulates PM under CAA authority is the National Ambient Air Quality Standard (NAAQS). It sets a PM maximum limit of 10 micrometers in air samples taken over a 24-hour period (PM10). Five other criteria air contaminants are regulated under NAAQS: lead, nitrogen oxide (NOx), sulfur dioxide, carbon monoxide and ozone. The agency set its Tier 2 tailpipe emissions limits on these six criteria contaminants.

In order to meet the PM10 and NOx limits on diesel exhaust under Tier 2, EPA gave engine manufacturers the choice of which technology platform they'd like to adopt in order to cut emissions of PM and NOx from their vehicle exhaust systems. The three technologies that emerged were SCR, Exhaust Gas Recirculation (EGR) and Lean NOx Trap. By fall of 2008, most had chosen SCR. Navistar/International was the notable exception, choosing to instead deploy EGR throughout its 2010 model trucks.

Clean Air Act

EPA's mission is to protect human health and the environment. To achieve this mission, EPA implements a variety of programs under the Clean Air Act that focus on:

* *reducing outdoor, or ambient, concentrations of air pollutants that cause smog, haze, acid rain, and other problems;*
* *reducing emissions of toxic air pollutants that are known to, or are suspected of, causing cancer or other serious health effects; and*
* *phasing out production and use of chemicals that destroy stratospheric ozone.*

These pollutants come from stationary sources (like chemical plants, gas stations, and powerplants) and mobile sources (like cars, trucks, and planes).

Key Acronyms

DEF	*Diesel Exhaust Fluid*
SCR	*Selective Catalytic Reduction*
EPA	*Environmental Protection Agency*
CAA	*Clean Air Act*
PM	*particulate matter*
NOx	*Nitrogen Oxides*
NAAQS	*National Ambient Air Quality Standards*
EGR	*Exhaust Gas Recirculation*
PPM	*parts per million*
ULSD	*Ultra-Low Sulfur Diesel*
ISO	*International Organization of Standardization*
AUS	*aqueous urea solution*
COA	*Certificate of Assurance*
API	*American Petroleum Institute*

Companies that have adopted SCR and EGR.

SCR

Volvo
Detroit Diesel
Cummins
PACCAR
Mack
Daimler
Mercedes Benz

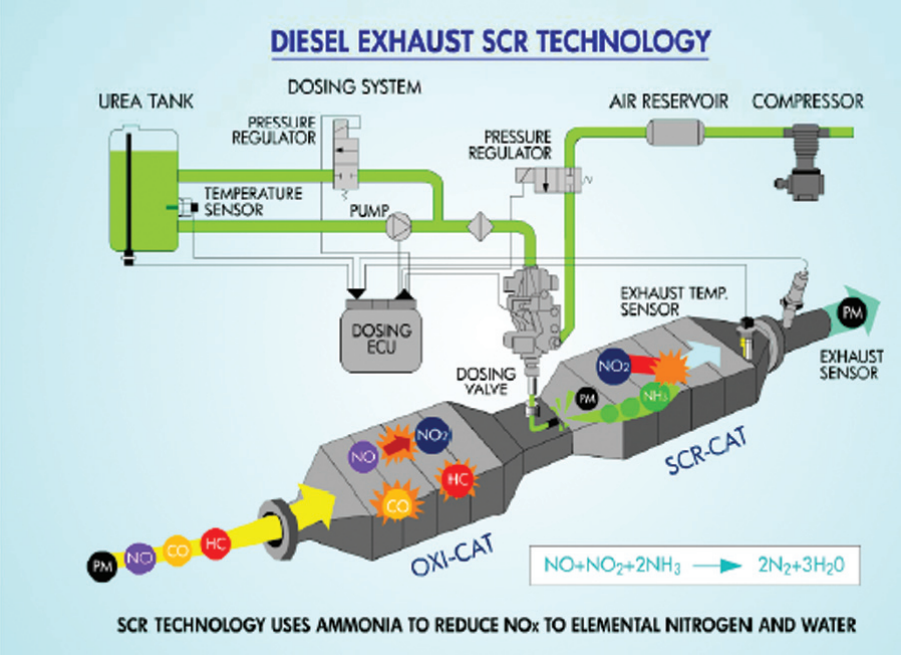
EGR

Navistar/International

Chapter 1-Policy Drivers (cont.)

Exhaust treatment systems work hand in hand with reductions in the amount of sulfur in diesel fuel to reduce PM and NOx. As of 2006, all diesel fuel for on-road use in the U.S. must contain no more than 15 parts-per-million (ppm) of sulfur. This super-clean diesel fuel is known as Ultra-Low-Sulfur Diesel (ULSD).

Large-scale SCR systems are used at some coal-fired power generation plants to reduce NOx emissions.



Chapter 2-The European Experience

Starting in the early 1990s, the European Union (EU) member states began to ratchet down the amount of sulfur allowed in motor fuel and the amount of NOx that could be emitted from exhaust systems. Adoption of pre-exhaust treatment systems such as SCR began in 2006. As a result, operators of EU fleets have had a two-year head-start using DEF to replenish their SCR systems.

In Europe, original equipment manufacturers use the trademark term AdBlue to describe automotive-grade DEF.

Although initially AdBlue supply chain integration costs were high, operational efficiencies quickly came into play and prices became more economical.

Chapter 3-Production

The U.S. and Canada are net importers of agricultural grade urea, largely distributed by barge. However, DEF will largely be sourced from domestic facilities which are already established in North America. A single Anhydrous Ammonia/urea/DEF plant costs approximately $2 billion to build from the ground up so it is unlikely that new plants will be coming on line to supply the U.S. truck fleet.

Since product quality is paramount for DEF, production needs to be close to its target market to cut down on aging and/or contamination concerns.

To make DEF:

Step 1 - Producers start with natural gas as a feedstock.

Step 2 - They then synthesize that into ammonia and CO2, “cracking” and reforming it just as refiners would gasoline or diesel out of crude oil.

Step 3 - Ammonia is coupled with CO2 to form urea.

Step 4 - The urea is then blended with very pure, deionized water to make a 32.5% solution of urea (the remainder is water).

Chapter 4-Quality

The DEF production process is done to ISO-22241 standards and best produced under very strict protocols, such that automotive-grade DEF certified product meets or exceeds the ISO-22241 standard.

Producers then issue a Certificate of Analysis (COA) that guarantees the quality of the DEF down to the minutest detail. Without the COA, the solution is only industrial-grade urea.

Certified laboratories will check for the DEF's purity and concentration and monitor all of the specific elements within the product needed to maintain quality.

Two specific quality issues can arise unless the strictest guidelines are adhered to:

- Purity – product impurities can detrimentally affect the after-treatment systems' performance and void vehicle warranty guarantees due to premature catalyst deactivation and/or fouling of prefilters and injector nozzles, to identify a few.

- Concentration – delivering the right amount of urea to the exhaust stream is critical to ensure the vehicle meets the tailpipe emissions target required by EPA's Tier 2 standards.

Characteristics	Unit	Limits		Test methods
		min	max	
Urea content [a]	% (m/m) [d]	31,8	33,2	ISO 22241-2 Annex B [e] ISO 22241-2 Annex C [e]
Density at 20 °C [b]	kg/m³	1087,0	1093,0	ISO 3675 or ISO 12185
Refractive index at 20 °C [c]	------	1,3814	1,3843	ISO 22241-2 Annex C
Alkalinity as NH_3	% (m/m) [d]	--	0,2	ISO 22241-2 Annex D
Biuret	% (m/m) [d]	--	0,3	ISO 22241-2 Annex E
Aldehydes	mg/kg	--	5	ISO 22241-2 Annex F
Insoluble matter	mg/kg	--	20	ISO 22241-2 Annex G
Phosphate (PO_4)	mg/kg	--	0,5	ISO 22241-2 Annex H
Calcium	mg/kg	--	0,5	ISO 22241-2 Annex I
Iron	mg/kg	--	0,5	
Copper	mg/kg	--	0,2	
Zinc	mg/kg	--	0,2	
Chromium	mg/kg	--	0,2	
Nickel	mg/kg	--	0,2	
Aluminium	mg/kg	--	0,5	
Magnesium	mg/kg	--	0,5	
Sodium	mg/kg	--	0,5	
Potassium	mg/kg	--	0,5	
Identity	--	identical to reference		ISO 22241-2 Annex J

Chapter 4-Quality (cont.)

The ISO-22241 specification is very strict and rules out the use of agricultural and industrial grade urea as a substitute for DEF. Also, the presence of formaldehyde found in most urea renders it unfit for DEF production.

ISO-22241 also governs the integrity of DEF through the supply chain. Purity and concentration must be maintained to the vehicle and through the dispensing equipment, storage and handling, including any small packaging for DEF. Supply-chain partners must undergo a rigorous process to handle the fluid properly.

The American Petroleum Institute (API) will certify DEF and will provide labels for DEF containers indicating the product is certified. Those labels are being drafted by the SCR Stakeholders Group. Certification is likely to include some quality assurance training for supply chain partners including retailers. Samples can be pulled anywhere in the supply chain to ensure DEF with the API label meets the stringent quality requirements.

Contrary to some beliefs, DEF is not an additive, and is not mixed with diesel fuel. In a vehicle outfitted with an SCR system, DEF has a separate on-board tank (6-10 gallons on light-duty vehicles; 10-30 gallons on heavy-duty vehicles).

From its storage tank, DEF is pumped through a filter and injector and then, into the exhaust stream. Injectors are very sensitive, making purity extremely important, as any un-dissolved material may clog filters or injectors. Additionally, dissolved material can result in premature SCR catalyst failure.

Filters in the SCR system must function for at least a minimum amount of time in order to meet EPA's Tier 2 specifications. Premature failure will activate the on-board vehicle diagnostics systems, dramatically reducing vehicle performance.

Chapter 4-Quality (cont.)

Sensors in DEF tanks will notify the driver if volume is low or if the product concentration is not of good quality. Another sensor will indicate if the NOx level in the tailpipe exhaust is too high. These sensors will need to be maintained by fleet owners.

In the aftertreatment system, the heat from the exhaust hydrolyzes the urea into two components: anhydrous ammonia and CO2. This gas mixture of ammonia and NOx passes across the catalyst and reduces them to elemental nitrogen and water, harmless since air is composed of 78% elemental nitrogen. The additional CO2 emitted due to urea decomposition is offset by enhanced fuel economy. A gallon of diesel emits 10 times more CO2 than a gallon of DEF.

Chapter 5-Storage Challenges

A key specification in the ISO-22241 standard is the DEF product's urea concentration.

To ensure product stability, DEF producers, buyers, retailers and users should store the fluid at temperatures between 12°F-86°F (10°C-30°C). Doing so ensures a DEF shelf-life of at least one (1) year. Storage temperatures higher than 86°F will detrimentally affect urea concentration and below 12 ° F, DEF will begin to crystallize. Both of these circumstances could render the product out of specification and unfit for sale.

It is generally accepted that DEF will have a 1-year shelf-life if stored between 86°F (30°C) and 12° F (-11 ° C). If it is stored at temperatures above 86°F (30°C), the shelf-life will be reduced.

Chapter 6-Distribution

DEF will at least initially come into the fleet marketplace through truckstops along interstate routes and through truck terminals.

Although DEF production is centered East of the Rockies, there are plans to transload DEF by rail to the West Coast as needed. Eventually, product could be transported in higher concentrations and then diluted in regions that are farther away from production facilities if quality can be maintained.

Urea-based reductants are already being sold and distributed across North America, for NOx reductions in stationary SCR applications. A key to distribution across the country will be the movement of urea products to terminal locations in most metropolitan cities. Like in Europe, existing, large chemical distribution facilities will act as these terminal locations.

Facilities already exist which are ISO certified, have massive liquid storage capacity, blending, rail, and their own fleet of tanker trucks. Urea products for other markets are already being distributed through these facilities.

Fuel oil distributors will likely vend DEF in bulk tanker and mini-bulk quantities. The 275-gallon tote can be put into a “cupboard” at a fuel island and hooked to a dispensing pump for retail at service locations. Major pump equipment manufacturers have developed pump-island DEF dispensers.

The primary distribution point will be chemical distribution companies which will provide DEF in bulk tanker and mini-bulk quantities. This is the model in Europe where chemical distributors have compatible assets such as stainless tankers. Fuel oil distributors will supplement the distribution chain in select markets and geographical areas.

Chapter 7-Dispensing

Different pack sizes and configurations are being designed and range from small bottles, to totes and drums to bulk dispensers. Typical configurations include 275-gallon totes, 55-gallon drums, 2.5 gallon bottles, 2.0-gallon bottles and 1-gallon bottles. High-density polyethylene can be used in bottle packages but larger containers should be stainless steel or other ISO 22241-approved materials in order to avoid contamination.

Engine makers plan to dose DEF at a rate of 2%, or 2-gallons of DEF for every 100-gallons of diesel fuel. A heavy-duty truck with an average fuel economy of 6 MPG could travel 600 miles on that same 100-gallons of diesel fuel. That same trip would therefore only take around 2-gallons of DEF. That would give the truck a reasonable number of miles to get to a larger DEF dispensing facility to refill.

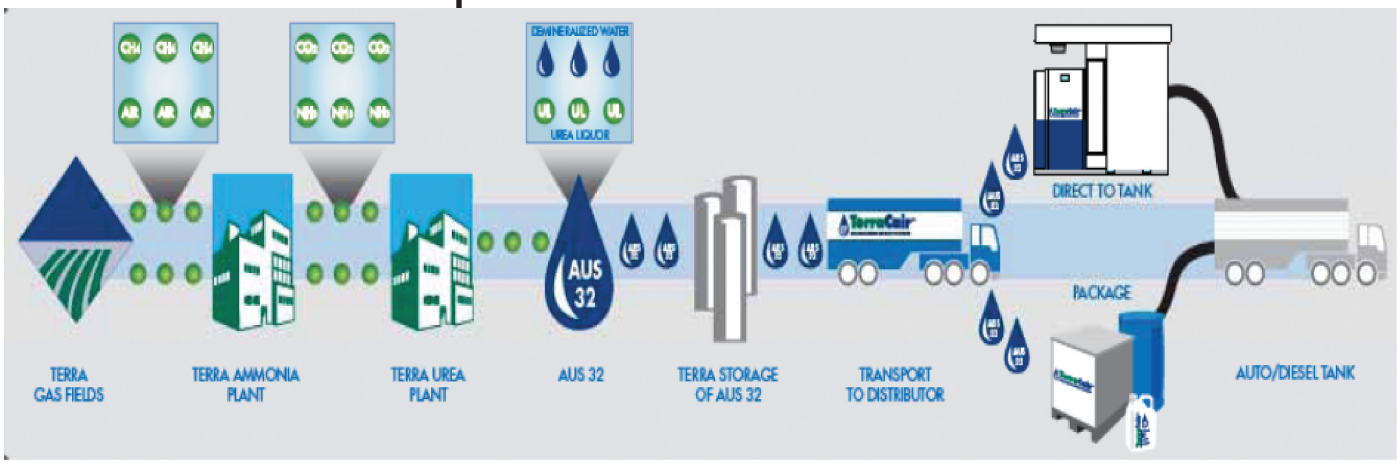
Fuel oil distributors will likely vend DEF in bulk tanker and mini-bulk quantities. The 275-gallon tote and mini-bulk tanks (up to a few thousand gallons) can be put into a “cupboard” at a fuel island and hooked to a dispensing pump for retail at service locations. Major pump equipment manufacturers have developed pump-island DEF dispensers.

These can be hooked up to either above-ground or below-ground DEF tanks. However, the product does need to be heated if it is stored above-ground because it will crystallize at 12°F (-11°C) or about the same temperature as diesel.

Chapter 7-Dispensing (cont.)

For smaller locations and service bays, smaller dispensing equipment may be appropriate. There will be stand-alone units of 1,000 to 2,000 gal for retail installation. That will be tied to the companies POS (Point of Sale) technology, making the transaction part of the overall sales experience.

This dispensing equipment may be in line with existing fuel island or stand-alone units. This equipment will provide fueling from diesel type dispensers, and special nozzles are being considered to prevent the possibility of introducing DEF into the diesel tank.



North American SCR Stakeholders Group Participating Organizations August 2008

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Agriliance
Agrium
AirBlueFluids, Inc.
Alliance
Alliance of Automobile Manufacturers
AluMag Automotive LLC
American Automobile Association
American Petroleum Institute
American Trucking Associations (ATA)
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Dyno Nobel
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Excelda
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EZ Fuel

(*Cont. on next page*)

Chapter 8-Retailing

Potential markets for DEF include heavy and medium-duty vehicles as well as light-duty vehicles. For heavy-duty and medium-duty vehicles, DEF demand will be filled like fuel is: through bulk dispensers. A typical vehicle in this class should consume more than 500 gal/year and about 90-95% of DEF sales will come from this class of vehicle. On-board DEF tanks typically have a volume of 20-30 gallons.

Light-duty vehicles will have demand filled like a lubricant: in gallon packs. A typical vehicle would consume about nine gal/year and the market-share of this class is likely to range from 5-10%. Service intervals may be synchronized with oil change cycles. Vehicle owners can add their own DEF much like they would top off their windshield wiper fluid.

Corporate Average Fuel Economy standard increases may drive more light-duty vehicle manufacturers to pursue a more aggressive SCR rollout in order to take advantage of the greater fuel economy offered by these clean exhaust systems.

Off-highway vehicles will need to meet EPA Tier 2 tailpipe emission standards by 2014. Additional demand from retrofitted diesel vehicles is expected to emerge as well.

Annual DEF volumes could reach more than 725 million gallons by 2015 at current fleet turnover rates, according to the Engine Manufacturers Association. It conducted a survey based on input from all major engine makers based on engine sales forecasts, vehicle miles traveled and dosing rates (2-4% of diesel fuel volumes).

Chapter 8-Retailing (cont.)

Essentially, 80% of diesel vehicle production in 2010 will feature SCR technology, requiring DEF.

DEF prices are likely to be above $3/gal at least initially until operational efficiencies in the supply chain and increased volume of DEF product moved begin to have an effect on price. Smaller containers may cost more if they are sold as convenience items. Eventually, access should become as easy as fuel or motor oil is today.

Engine makers have projected fuel economy increases of about 3% but depending on DEF price and dosing rates, that economic benefit might be mitigated in real-world application.

However, the environmental benefits of SCR systems using DEF are accepted as a state-of-the-art technology response to EPA's clean air regulations and ensure demand for quality DEF is here to stay.

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About Terra Environmental Technologies (TET)

Terra Industries Inc. (NYSE: TRA), with 2007 revenues of $2.4 billion, is a leading international producer of nitrogen products. Terra Industries Inc. formed TET in 2003 to provide products and services to customers using nitrogen products to reduce NOx emissions from various sources, including power plants and in other environmental processes such as water treatment plants. TET was incorporated in December 2007.

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About SPATCO

SPATCO began operations in Charlotte, North Carolina in 1935 as a distributor and installer of petroleum equipment. The company quickly expanded into other cities in North and South Carolina and eventually Tennessee, Georgia, Alabama, Florida and Virginia. Recognizing the value of its franchise and its dominant market share in petroleum handling equipment, the Company entered the industrial pump distribution business in the late 1960's concentrating in North and South Carolina and Eastern Tennessee.

With the new millennium, SPATCO continued its leadership position in liquid handling and completing a dominant offering of quality products, turnkey services, and exceptionally experienced people.

For over 70 years we have provided a complete assortment of equipment and services for the handling of petroleum products. We offer turnkey development for any petroleum project, including retail outlets and wholesale bulk plants. Our unmatched service will keep you pumping long after the sale.

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About Brenntag

Brenntag recorded global 2007 sales of EUR 6.7 billion (USD 9.1 billion). Today the company operates in excess of 300 locations with more than 11,000 people in 64 countries. In keeping with the company's strong position in world markets, Brenntag is committed to providing value to its customers and suppliers through superior supply chain logistics, single sourcing, technical assistance and other value added services.

Brenntag offers an unrivalled, extensive and state-of-the-art distribution network for industrial and specialty chemicals to its suppliers and customers alike throughout the United States and the world.

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