Bureau Veritas
Oil Analysis Programs

Controlling Power from the Source

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INTRODUCTION

It doesn't matter what your business is: Over-the-road trucking, city delivery, locomotive, marine, off-road machinery, or stationary power generation, the quality of your fuel reflects directly on your bottom line profits. Cost and consumption are the most obvious direct overhead factors, but operating with aged or contaminated fuel affects the short and long term service of your equipment as well. Filters, injectors, EGR components, deposit formations – all of these can be affected by fuel properties and contaminants. Are you getting the most out of your investments or are you adding to your already high fuel costs by having to correct for fuel related deficiencies?

The basic fuel requirements are satisfactory ignition and combustion, compatibility with fuel injection systems, and convenient handling at all levels (from the refinery to the engine fuel delivery) without suffering degradation or contamination. Their make-up represents various combinations of volatility, ignition quality, viscosity, sulfur, gravity, stability and other characteristics. Various additives are employed to improve certain properties and enhance the stability of the finished fuel.

The properties and contaminants within fuels affect more than just the combustion and power output of an engine. Fuel characteristics also affect filter plugging, injector deposits and wear, upper engine deposits, soot generation, acidity in combustion gases, and lube oil additive depletion (dispersants and alkaline reserve (BN). Most of the changes to fuels in the past several years have been related to progressively stricter controls over exhaust emissions. Current emission regulations have impacted the manufacturing processes, additive requirements, handling procedures, performance, and costs of today's fuels.

The properties of a product define its fitness to serve a stated purpose. The American Society of Testing and Materials (ASTM) has established various specifications used to characterize fuels and provide a framework for definition and reference that include: ASTM D975 Diesel Fuel Oils; D2880 Gas Turbine Fuel Oils; D2069 Marine Fuels; and D396 Fuel Oils. However, these are minimum requirements and they do not provide complete functional specifications for the indicated fuels. In general, they represent the requirements necessary to assure reasonable operation under typical conditions. When operational application, location, and ambient specific characteristics are being considered, additional properties are identified and must be specifically measured and evaluated by appropriate testing and analysis.

ASTM defines fuels as being in long term storage conditions after only six months. These fuels are all subject to aging degradation (oxidative products, condensation buildup, microbiological growth, etc.) and appropriate treatment and handling is necessary for safe and satisfactory performance. Emergency power supply systems have a high incidence of failure as a result of poor fuel quality due to degradation and contaminants. Since emergency and back-up power systems do not run continuously, it is necessary to implement a periodic fuel surveillance program to ensure reliable operations.

Our comprehensive fuel analysis programs enable end users to anticipate problems, implement a preventive fuel handling program, ensure reliable equipment operations, extend the performance life of filters, reduce engine deposits, and assist in achieving safe maximum lube oil service intervals. These controls will increase equipment reliability, longevity, and profitability.

It is the purpose of this document to assist in making you aware of the problems that can be associated

with fuel oils, what testing is available to monitor theses fuels, and offer the tools and means to implement preventive and/or corrective actions.

QUALIFICATIONS OF BUREAU VERITAS

- Independently owned and operated with over 45 years experience.
- Quality First: ISO 9001 registered, certified compliant to10CFR50 appendix B.
- Five laboratories in the USA and international service in Monterrey Mexico & Tokyo Japan.
- Chemists, STLE Certified Lubrication Specialists (CLS), and Oil Monitoring Analysts (OMA) at all locations.

LABORATORY SERVICES AND SUPPLIES

- 3-5 day turnaround on fuel analysis dependant upon test requirements.
- Rush analysis available at 1.5 times the cost of analysis (minimum $50 additional charge).
- Fax transmission and/or emailed reports upon request.
- Comprehensive interpretation with recommendations provided on each report.
- Sample container, processing form, and pre-addressed mailer available.
- D.O.T. approved shipping materials available.
- Bacon Bomb Sampler for storage tank sampling available.
- Vacuum Pump Sampler and rolled tubing available.
- Oil, transformer oil, refrigerant, coolant/ antifreeze, and grease analysis programs available.
- Field training and Root Cause Solutions Services available.

FUEL OIL

Are you sure about the quality of your fuel? Fuel consistency and cleanliness is increasingly variable.

Will your engines run on long-term stored fuel that is one, two, three years old or older? Most abnormal fuel conditions can be corrected without major expense, if each condition is diagnosed promptly. Fuel analysis gives you the diagnostic information you need to prevent real trouble with your engines, your fuel storage tanks, and your operating budget.

Three primary factors have a direct impact on your fuel performance: physical characteristics, stability in storage and use, and contamination. The diesel engine fuel system is sensitive to various design aspects, to contamination, or to poor fuel quality that may cause the engine to fail to supply power when needed. Excessive water, dirt, particulate debris, oxidation products, and microbiological growth can cause plugged filters and early fuel injector failure. Water and debris are especially destructive to the tight clearances and valve seat arrangements in modern fuel injectors. Erosion and corrosion of valve seats and lapped metal-to-metal interfaces cause poor combustion, smoke, and high or low combustion temperatures in the cylinder. A poorly adjusted or malfunctioning injector can wash the cylinder wall of its lubricating oil film causing premature wear and failure of pistons, rings, cylinder liners, or bearings.

It is important to realize that over an extended period of time fuel oils will degrade through oxidation, poor housekeeping practices and from normal condensation buildup in the tank. Water can combine with other compounds in the fuel to create corrosive by-products that can corrode fuel tank system components. Since the rate at which fuel oils degrade is unpredictable, it is important to take the necessary precautions to increase fuel system reliability. Good design and preferred fuel properties, sampling, testing, and maintenance all contribute to efficient fuel quality management that will ensure your engine has an opportunity to deliver optimum service.

PHYSICAL CHARACTERISTICS

Your engine performance depends partly on whether your fuel measures up to ASTM defined product requirements. ASTM D975 & D2880 list the minimum requirements necessary to assure reasonable operation under typical conditions. To meet special operating conditions, modifications of individual limiting requirements may be agreed upon by the purchaser, seller and equipment manufacture. Fuel oil normally recommended by engine manufactures and used most commonly in power generation engines is fuel oil No. 2-D or DF-2 and No. 2-GT or GT-2. Once your specifications and requirements are determined, the stored fuels should be monitored with the appropriate testing and analysis. With each new delivery of bulk fuel, a sample should be analyzed to assure it meets the minimum quality criteria, and is free of unwanted contamination.

STABILITY

Even if your fuel initially meets ASTM minimum requirements, you must still take steps to keep it stable. As your fuel ages, chemical oxidation creates particulate formation and associated deposits or sediment are generated. The rate of fuel degradation in extended storage is not predictable and is variable to many contributing factors including storage designs, locations, environmental issues, etc. Comprehensive testing will inform you as to whether your fuel requires purification, fortification of antioxidant additives, and additions of microbiological controls. Each time a new load of diesel fuel is added to an existing supply of good fuel, the risk contamination or the acceleration of the oxidation process is introduced.

CONTAMINATION

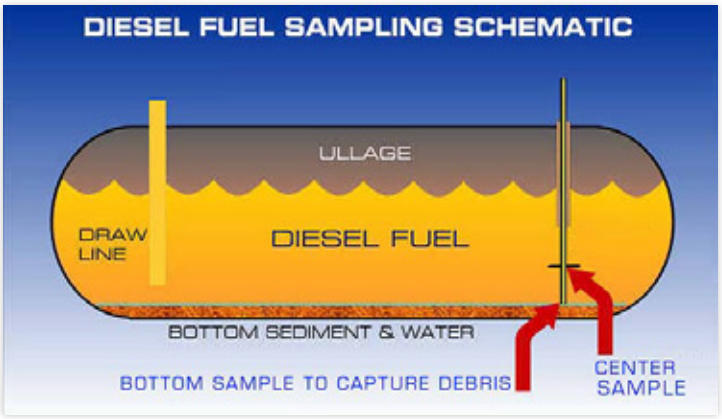
Once a fuel has been correctly specified and stabilized for storage and use, it must be kept free of contamination. Early detection of water contamination helps you reduce storage tank corrosion, avoid degraded fuel performance in winter and correct underlying problems with supplier storage facilities or handling procedures. Separate spectrochemical and physical tests detect metallic corrosion products, inherent trace metals that can act as a catalyst to oxidation, and solid contaminants such as sediment and insoluble gum. If solid contaminants and water accumulate in your storage tanks, you could be facing the formation of water-particulate sludge, an ideal growth medium for microorganisms (bacteria, yeast or fungi) which is a leading form of fuel contamination. Detection of these conditions in the early stages can lead to minor corrective action of improper fuel handling procedures, filtration, additive treatment, and problems with storage tank corrosion before they cripple your fuel storage and handling equipment.

PERIODIC SAMPLING AND ANALYSIS

Scheduled sampling and analysis packages are designed to support your overall fuel management program with thorough, scientific testing and sound advice. Bureau Veritas' fuel testing packages are carefully designed with selections from a broad range of ASTM tests which assess fuel suitability for use upon delivery and monitor fuel serviceability during long-term storage. Once your analyses are completed, experienced Data Evaluators interpret your results and provide concise, informative recommendations covering ASTM qualification, quality control, and required action to correct abnormal conditions or modify fuel properties for improved service.

Variable sampling points are recommended for specific testing packages to optimize the detection and control of contaminants and assessment of overall fuel characteristics. Water, dirt, oxides (rust), and other debris will settle to the bottom of a storage tank. It is important to detect and correct for these contaminants. However, the bottom sample may not be representative of the overall fuel characteristics.

Therefore, we recommend submission of both a 'Bottom" sample for contaminants and a mid-fuel level or "Center" sample be drawn to represent the general properties and characteristics of the tank's contents.



DEFINITIONS AND SIGNIFICANCE OF TESTING

Accelerated / Oxidation Stability - DuPont F21-61, ASTM D2274: Stability-related problems arise when the fuel is stored for a long period of time and may contain inorganic sediment, water, or dissolved metals. The resultant degradation or oxidation of certain reactive compounds (sulfur, oxygen and nitrogen) form soluble and insoluble gum and sediments. The gum and sediment formation can cause darkening of the fuel, filter plugging, lacquering of fuel system components, and a change in fuel properties. The test provides an indicator of the stability of the fuel. Diesel fuel stability can be improved by using antioxidants, which inhibit gum and sediment formation.

API Gravity – see Specific Gravity

Asphaltenes – ASTM 6560: The high molecular weight hydrocarbon components (asphalt) which are soluble in carbon disulfide but not in paraffinic naphtha.

Ash Content – ASTM D482: Noncombustible residue of a lubricating oil or fuel. This material is in the form of soluble metallic soaps (additives) and abrasive solids. Fuel injection components are precision manufactured to close fits and tolerances, which make them very sensitive to any abrasive material. Abrasive solids contribute to injector, fuel pump, piston, and ring wear. In addition, abrasive ash material and soluble metallic compounds may adversely affect the overall deposit formation in the engine.

Carbon Residue – ASTM D189 / D524: A measure of coked material remaining after a sample has been subjected to a high temperature in the absence of air. This is an approximation of a fuel's tendency to form carbon deposits. Carbon residue is primarily tested on residual fuels since distillate fuels normally do not have high carbon residue.

The carbon residue content of burner fuel can indicate the tendency of the fuel to form deposits in vaporizing pot, combustor, or sleeve type burners. On gas turbines, carbon deposits may form, creating heat insulated hot spots on the combustor. The hot spot formed may cause high stress, distortion, and cracking of the combustor shell. The carbon residue of diesel fuel can form deposits in the combustion chamber, or fuel injectors and is an indication of residual fuel oil contamination.

Cetane Index – ASTM D976 / D4737: Calculated estimate of the Cetane Number, a measure of ignition quality. A high cetane number indicates shorter ignition delay and improved combustion.

Ignition delay is the time from the start of injection to the beginning of combustion. A rapid pressure rise results from the accumulation of fuel during the ignition delay period. It is this rapid pressure rise that can cause an audible knock, increased stresses, and severe engine vibration. For most engines, high cetane number fuels generally cause a shorter ignition delay period and therefore lower rates of pressure rise. This tends to lessen combustion noise, improve control of combustion, and results in increased engine efficiency and power input.

Cloud Point – ASTM D2500: The temperature at which a cloud or haze of wax crystals form within a sample. The cloud point relates to the tendency of filter plugging at cold temperatures.

Depending on the origin, type and volatility range of the fuel, varying levels of paraffin may be found. The more paraffinic the fuel, the higher the precipitation temperature and the less suitable the fuel is for low temperature operation. The layout of the fuel system such as small exposed fuel lines and fine filters are more prone to be clogged by precipitated wax. The cloud point is a guide as to what temperature the fuel may plug filter systems and restrict flow.

Compatibility - ASTM D2781: A measure of the compatibility of a residual fuel with respect to a specific distillate fuel. Results are expressed in an assigned numerical value (compatibility rating).

Copper Corrosion – ASTM D130: The copper strip test measures the potential corrosive nature of fuel and the possible difficulties with copper and brass or bronze components of a fuel system.

Density – ASTM D1298: Accurate determination of the density (specific gravity), or API gravity is necessary for the conversion of measured volumes to volumes at a standard temperature. Density is a factor governing the quality of crude petroleum. This property is an uncertain indication of its quality unless correlated with other properties.

Distillation – ASTM D86: A process used to measure the volatility characteristics of a fuel. Volatility affects power output, fuel economy, exhaust emissions, and engine deposits.

The requirements vary with engine size, speed, load, design, starting, and atmospheric conditions. In general, the distillation range should be as low as possible without adversely affecting the flash point, viscosity or heat content of the fuel. Typically, the initial boiling point (IBP) for No. 2 fuel is 350-400oF. A low IBP may indicate contamination with a higher volatile fluid. If the 10% point is high, hard starting may occur, or may increase engine warm-up time. A low 50% point is desired to minimize smoke and odor. Low 90% and end points tend to ensure low carbon residuals and minimum crankcase dilution.

Flash Point – ASTM D93: The lowest temperature at which a fuel (vapor) will ignite above liquid when exposed to an open flame.

A low flash point may indicate contamination of a more volatile fluid such as gasoline. An approximate percentage of gasoline contamination may be determined by comparing the distillation range with typical diesel fuel. Flash point is important from a fuel handling aspect. Insurance companies, federal or state agencies set mandatory limits on flash point because of fire hazard potential.

Heat of Combustion – ASTM D240 / D4868: The heat of combustion is a measure of the energy available from a fuel.

It may be determined by bomb calorimetric techniques, or calculated from fuel density, sulfur, water and ash content. There are two values for the heat of combustion, or calorific value, commonly referred to as gross and net heat of combustion. A fuel of low-calorific value yields less heat on combustion and, therefore, less power than the same amount of a fuel with high calorific value. The significance of this property depends on whether the user purchases fuel on a weight or volume basis.

Insolubles – A sample is diluted with pentane, causing the product to lose solvency for certain resins and the precipitation of such extraneous materials as dirt, soot, and metals. This is reported as pentane insolubles. The pentane insolubles are then treated with toluene which dissolves the oxidation resins. The remaining solids are reported as toluene insolubles.

Microorganism Culture - ASTM D6469 compliant. A culture study for the determination of the presence of microbiological growth within a fuel.

Microbial growth has been implicated in a number of problems such as tank corrosion, filter / fuel line

plugging, and deactivation of coalescers and water separators. By-products of microbial growth can cause physical and chemical changes in the fuel. The principle biological offenders are aerobic bacteria, and fungi, both of which require oxygen, food (fuel) and water to survive. While bacterial cells and fungal spores remain alive in the fuel phase, they can only grow and reproduce in the water phase. The test requires 48-72 hours of incubation to determine the type and level of infestation. Once identified, the extent of clean-up and treatment of the fuel can be determined.

Oxidation Stability – ASTM D2274: See Accelerated Stability.

Particulate Contamination – ASTM D5452: A measure of the particulate contamination present in distillate fuel that may cause filter plugging, scoring of injector plungers, and other operational problems.

Pentane Insolubles – ASTM D893: See Insolubles

Pour Point – ASTM D97: A determination of the lowest temperature at which a fuel is observed to flow when cooled at a specific rate.

Pour point is a useful guide to the lowest temperature at which a fuel can be pumped. Sometimes additives are used to improve the low temperature flow of diesel fuels. These additives modify the wax crystals so that they do not form rigid structures. However, pour point cannot be used as a guide to indicate engine performance with any accuracy when additives are used. ASTM has standardized a method (D4539) to measure the low-temperature operability based on the plugging of cold filters.

Specific Gravity – The reaction of the mass of a given volume of fuel and the mass of an equal volume

of water at the same temperature. The standard reference temperature is 60^0F. The higher the specific gravity, the heavier the product.

A related measurement is density, an absolute unit defined as mass per unit volume. Gravity may also be formulated and defined as API Gravity.

$$\text{API Gravity (degrees)} = \frac{141.5}{\text{Specific Gravity (@ 60/60 degrees F)}} - \text{API Gravity (degrees)}$$

Therefore, the higher the API Gravity, the lighter the product (lower specific gravity)

Spectrochemical Analysis – ASTM D6728: The measure of specific metallic elements that may be present within the fuel. Reported values expressed in parts per million (ppm) by weight.

The elements of most concern relate to oxides (rust) and corrosion, dirt, brine, and additives from other petroleum products.

Sulfur – ASTM D4294 / D5453: A common natural constituent of petroleum products. High sulfur content may be undesirable as it can be corrosive and also create an environmental hazard when burned.

In general, the sulfur concentration in diesel and turbine fuels is limited by emission requirements rather than by technical or operational considerations. The effect of sulfur content on engine wear and deposits vary in importance and depends mainly on operating conditions. For instance, under low temperature conditions resulting from stopping and starting (or variable loads), condensation moisture is likely to accumulate within the engine. The sulfur combines with water to form acids that will corrode metal components and increase wear of moving parts. Sulfur can be present in a number of forms: mercaptan, sulfides, disulfide and other compounds. Active sulfur tends to attack and corrode injection system components. Sulfur compounds can contribute to combustion chamber and injection system deposits.

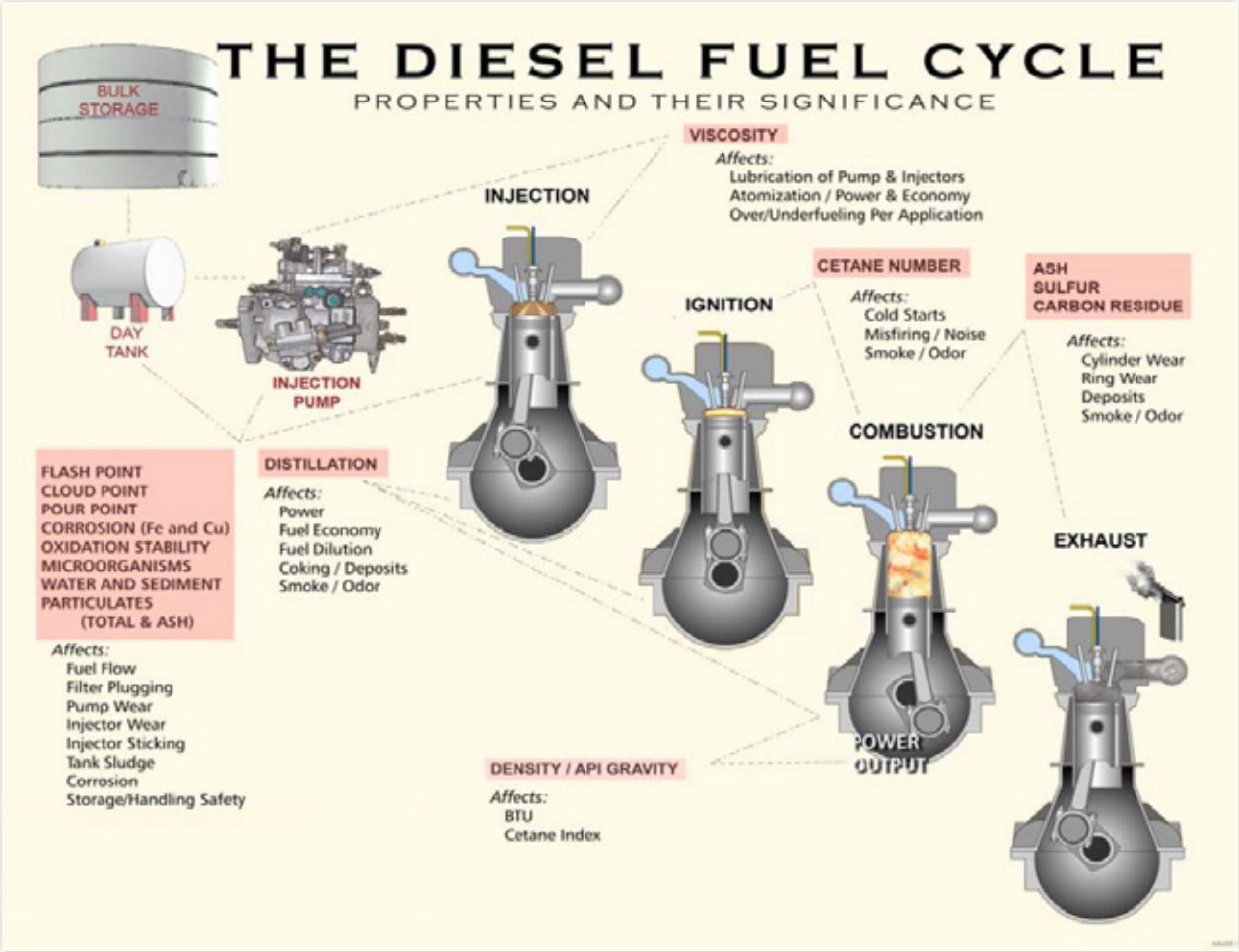
Toluene Insolubles – see Insolubles.

Viscosity – ASTM D445: Viscosity is a measure of a fluid's resistance to flow (in relation to time) at a constant (specified) temperature.

The importance of a fuel's viscosity is the effect it has on pumps and influence on injector systems spray pattern. High viscosity will cause poor atomization, and high spray jet penetration. The jet tends to be a solid stream. The fuel spray may impinge upon the cylinder walls, washing away the lube oil film and causing dilution of the crankcase oil. Low viscosity fuel does not penetrate far enough in the combustion chamber. Low viscosity leads to excessive leakage past the injection pump plunger. In either case the results are poor combustion, loss of power, inaccurate metering and increased wear in both the fuel system and engine.

Water & Sediment (BS&W) – ASTM D1796 / D 2709: The determination of water and sediment present by means of centrifugation. The results are reported in percent by volume.

Water is the second major source of contamination. Free water in the fuel system can lead to corrosion, fuel degradation, and create a fertile environment for microbiological growth. Water can enter a fuel system as condensation. Vents and seals that are poorly designed, or are faulty or damaged can allow water to enter. In addition, dirt, sand, rust and organisms can enter with water. Sediment usually consists of carbonaceous material, metals, or other inorganic matter. Contact with air during handling and long term storage, cause instability and resultant degradation of the fuel contribute to the formation of organic sediment.



DFQ - QUALITY ASSURANCE PACKAGE

Routine monitoring of deliveries and storage tanks: Diesel & Gas Turbine Fuels
Recommended for 'Center Level' samples where bottom samples receive DLC or DLTS testing

TEST	METHOD
CETANE INDEX (CALC.)	ASTM D4737
CLOUD POINT	ASTM D2500
DENSITY @ 15° C	ASTM D1298
DISTILLATION	ASTM D86
FLASH POINT (PMCC)	ASTM D93
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
SULFUR CONTENT	ASTM D4294

MINIMUM SAMPLE NEEDED - 16 OZ.

DFC – BOTTOM / CLEARANCE SAMPLE

Monitoring tanks for gross contamination: Diesel & Gas Turbine Fuels

TEST	METHOD
MICROORGANISM CULTURE	TEST KIT
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
TRACE METALS, ppm	ASTM D6728

MINIMUM SAMPLE NEEDED - 8 OZ.

DLTS - LONG TERM STORED PROPERTIES (ONLY)

Monitor degradation & gross contamination: Diesel & Gas Turbine Fuels

TEST	METHOD
ACCELERATED STABILITY	DUPONT F21-61
MICROORGANISM CULTURE	TEST KIT
PARTICULATE CONTAMINATION	ASTM D5452
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
TRACE METALS, ppm	ASTM D6728

MINIMUM SAMPLE NEEDED - 16 OZ.

DFS - DIESEL FUEL SPECIFICATION – ASTM D975

Product verification to ASTM, OEM, and purchasing specifications
Root cause analysis of fuel related problems / deficiencies

TEST	METHOD
ASH CONTENT	ASTM D482
CARBON RESIDUE, 10% RESIDUE	ASTM D524
CETANE INDEX (CALC.)	ASTM D4737
CLOUD POINT	ASTM D2500
COPPER CORROSION, STRIP	ASTM D130
DENSITY @ 15º C	ASTM D1298
DISTILLATION	ASTM D86
FLASH POINT (PMCC)	ASTM D93
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
SULFUR CONTENT	ASTM D4294
VISCOSITY @ 40˚ C	ASTM D445

MINIMUM SAMPLE NEEDED - 32 OZ.

TFS – GAS TURBINE SPECIFICATION – ASTM D2880

Product verification to ASTM, OEM and purchasing specifications
Root cause analysis of fuel-related problems / deficiencies

TEST	METHOD
ASH CONTENT	ASTM D482
CARBON RESIDUE, 10% RESIDUE	ASTM D524
DENSITY @ 15? C	ASTM D1298
DISTILLATION	ASTM D86
FLASH POINT (PMCC)	ASTM D93
POUR POINT	ASTM D97
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
SULFUR CONTENT	ASTM D4294
TRACE METALS, ppm (V,NA,K,CA,PB)	ASTM D6728
VISCOSITY @ 40? C	ASTM D445

MINIMUM SAMPLE NEEDED - 16 OZ.

GETS – GE GAS TURBINE SPECIFICATION – GEI-41047H

Product verification to OEM and purchasing specifications

TEST	METHOD
ASH CONTENT	ASTM D482
CARBON RESIDUE, 10% RESIDUE	ASTM D524
DENSITY @ 15° C	ASTM D1298
DISTILLATION	ASTM D86
FLASH POINT (PMCC)	ASTM D93
HEAT OF COMBUSTION	ASTM D240
NITROGEN	ASTM D3228
PARTICULATE CONTAMINANT	ASTM D5452
POUR POINT	ASTM D97
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
SULFUR CONTENT	ASTM D4294
TRACE METALS, ppm (V,NA,K,CA,PB)	ASTM D6728
VISCOSITY @ 40° C	ASTM D445

MINIMUM SAMPLE NEEDED - 32 OZ.

BIODIESEL FUEL BLEND STOCK

BBS – SPECIFICATION REQUIREMENTS – ASTM D6751

Product verification to ASTM, OEM, and purchasing specifications
Product handling and blending information

TEST	METHOD
ACID NUMBER	ASTM D664
ASH, SULFATED RESIDUE	ASTM D874
CARBON RESIDUE, RMS, % WT	ASTM D524
CETANE NUMBER	ASTM D613
CLOUD POINT	ASTM D2500
COPPER CORROSION, STRIP	ASTM D130
DISTILLATION, (REDUCED PRESS.)	ASTM D1160
FLASH POINT (PMCC)	ASTM D93
GLYCERIN, FREE & TOTAL	ASTM D6584
OXIDATION STABILITY (ACCEL.)	ASTM D2274
POUR POINT	ASTM D97
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
SULFUR CONTENT	ASTM D4294
SPECTROCHEMICAL, ppm	ASTM D6728
VISCOSITY @ 40° C	ASTM D445

MINIMUM SAMPLE NEEDED – 1 GAL.

INTERMEDIATE FUEL OIL

IFS - SPECIFICATION PACKAGE – ASTM D396

Product verification to ASTM, OEM, and purchasing specifications
Product handling and blending information

TEST	METHOD
ASH CONTENT	ASTM D482
ASPHALTENES	ASTM 6560
CARBON RESIDUE, 10% RESIDUE	ASTM D524
COPPER CORROSION, STRIP	ASTM D130
DENSITY @ 15? C	ASTM D1298
DISTILLATION	ASTM D86
FLASH POINT (PMCC)	ASTM D93
POUR POINT	ASTM D97
SEDIMENT & WATER (BS&W)	ASTM D1796 / D2709
SULFUR CONTENT	ASTM D4294
TRACE METALS, ppm	ASTM D6728
VISCOSITY @ 40? C	ASTM D445

MINIMUM SAMPLE NEEDED - 32 OZ.

HEAVY FUEL OIL

HFQ – QUALITY ASSURANCE PACKAGE – ASTM D396

Product verification to ASTM, OEM, and purchasing specifications
Product handling and blending information

TEST	METHOD
ASH CONTENT	ASTM D482
CARBON RESIDUE, 10% RESIDUE	ASTM D524
DENSITY @ 15? C	ASTM D1298
FLASH POINT (PMCC)	ASTM D93
POUR POINT	ASTM D97
SEDIMENT BY EXTRACTION	ASTM D473
SULFUR CONTENT	ASTM D4294
VANADIUM, ppm	ASTM D6728
VISCOSITY @ 100? C	ASTM D445
WATER, % VOL.	ASTM D95

MINIMUM SAMPLE NEEDED - 32 OZ.

MRF – MARINE RESIDUAL FUELS – ASTM D2069

Product verification to ASTM, OEM, and purchasing specifications
Product handling and blending information

TEST	METHOD
ASH CONTENT	ASTM D482
CARBON RESIDUE, CONRADSON	ASTM D189
DENSITY @ 15? C	ASTM D1298
FLASH POINT (PMCC)	ASTM D93
POUR POINT	ASTM D97
SEDIMENT BY EXTRACTION	ASTM D473
SULFUR CONTENT	ASTM D4294
VANADIUM, ppm	ASTM D6595
VISCOSITY @ 40? C	ASTM D445
WATER, % VOL.	ASTM D95

MINIMUM SAMPLE NEEDED - 32 OZ.

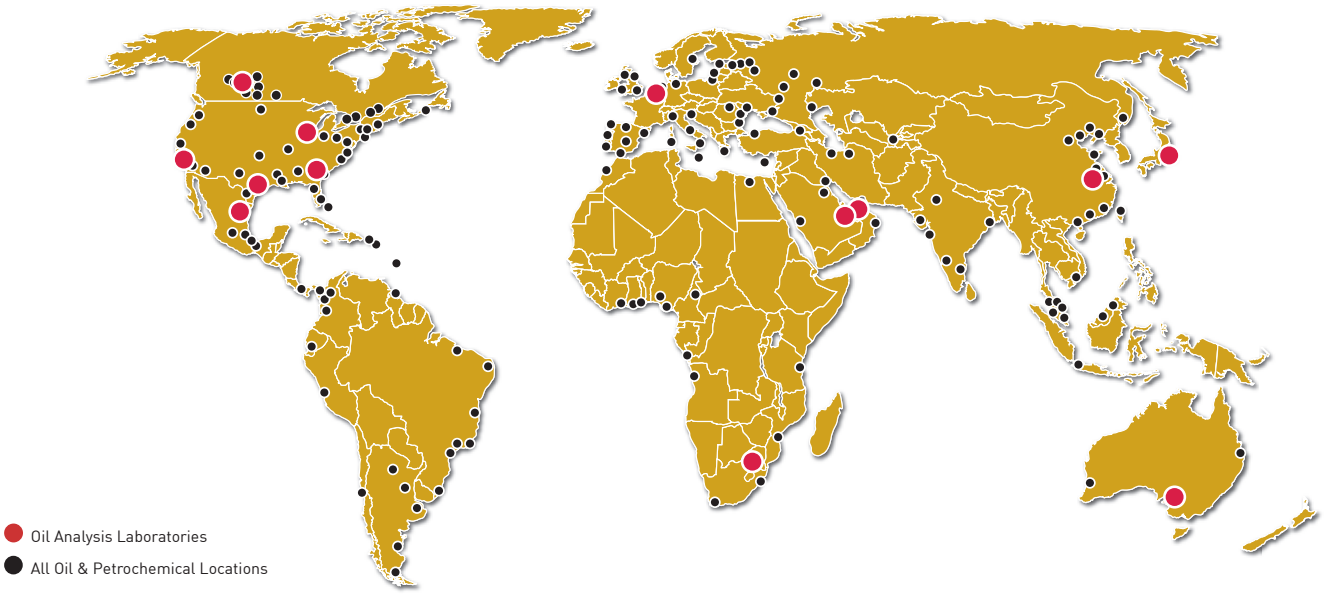
SUMMARY OF PACKAGES

ITEM	PACKAGE DESCRIPTION	SAMPLE VOLUME
DFQ	Distillate Fuel Quality Assurance	16 OZ
DFC	Distillate Tank Bottoms Contaminants	8 OZ
DLTS	Distillate Long Stored Properties (only)	16 OZ
DFS	Diesel Specification – ASTM D975	32 OZ
TFS	Gas Turbine Specification – ASTM D2280	16 OZ
GETS	Turbine Specification – GEI-41047H	32 OZ
BBS	Biodiesel Blend Specification	1 GAL
IFS	Intermediate Fuel Oil – ASTM D396	32 OZ
HFO	Heavy Fuel Oil – ASTM D396	32 OZ
MRF	Marine Residual Fuel – ASTM D2069	32 OZ

SAMPLING & SHIPPING SUPPLIES

ITEM	OPTIONAL SAMPLING MATERIALS	EACH
BBS	Bacon Bomb Sampler, 8 oz. (237 ml) 2 ¼ x 10”	$250.00
J16	16 ounce Sample Container	$2.50
J32	32 ounce Sample Container	$4.00
JHM16	D.O.T. Approved Hazmat Kit, 16 oz	$12.00
JHM32	D.O.T. Approved Hazmat Kit, 32 oz	$15.75
BA-4	38 mm Vacuum Pump	$37.75
TR5	100 Ft. Roll Tubing	$9.25

BACON BOMB SAMPLER



Our global network of professional Oil Analysis experts are dedicated to providing industry leading services to customers across the globe.

Contact us today so we can tailor a solution to meet your needs.

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