BP Marine
Focused on You

Engineers' Pocket Guide

contents

health & safety information

BP Marine is a responsible fuels and lubricants supplier and works hard to get HSE right.

Good HSE performance and the health, safety and security of everyone who works for us are critical to the success of our business.

Our goals are simply stated - no accidents, no harm to people, and no damage to the environment.

We continue to drive down the environmental and health impact of our operations by reducing waste, emissions and discharges, and using energy efficiently.

We produce quality products that can be used safely by our customers. BP Marine operates a Quality (ISO 9001) and Environmental (ISO 14001) Management System accredited by Lloyds Register Quality Assurance.

health safety & environmental information

Introduction

Marine fuels and lubricants, when properly used with safe handling procedures and high standards of personal and industrial hygiene, are unlikely to present risks to health, safety or the environment. However, if good standards are not maintained, adverse effects can arise. This Information Pack describes the hazards associated with marine fuels and lubricants, and provides guidance on how to minimise or avoid any potential risks.

Management of shipping companies, and those responsible for fuel and lubricant purchasing, should ensure that appropriate health, safety and environmental information reaches those who may come into contact with these products. Purchasers should note also that they have a contractual obligation, under BP Marine's Terms of Sale, to pass on health, safety, and environmental information which is received from BP Marine to their employees, to fuel and lubricant users, and to their customers.

This section of the Health Safety and Environmental Information contains general advice on the handling and use of marine fuels and lubricant's, this general advice is supplemented by more detailed information on specific products and grades, which can be found in our Material Safety Data Sheets.

General precautions when using marine lubricants

- Work methods should be devised which minimise contact with all oil products. Adequate washing and laundering facilities should be available.
- Supplementary controls such as eye protection, gloves, aprons and footwear should all be seen as essential elements in minimising the health risk associated with oil products. Skin care preparations such as skin cleansers and skin reconditioning creams, are all-important aids to personal skin care, their use should be encouraged.
- Engine room and machinery spaces should be well ventilated and those spaces should be kept free from oil residues by maintaining the highest standards of cleanliness.
- Accidental contact with the eyes may cause transient irritation but no lasting effects. Use eye protection when handling these products.
- To reduce the risk of accidental ingestion (swallowing), marine lubricants must never be stored in small, unlabelled or incorrectly labelled containers. Accidental ingestion may cause gastro-intestinal discomfort and in some instances irritation of the mouth and throat. No lasting effects would be expected. Accidental ingestion of the marine lubricant may cause vomiting followed by aspiration of liquid into the lungs, which can cause serious damage or death. For this reason, vomiting must not be induced as a first aid measure following ingestion.
- At normal temperatures the volatility of marine lubricants is too low to give rise to harmful levels of vapour. Under certain conditions however, fumes from hot lubricants may be released into the working environment. Similarly, certain test or maintenance operations may emit fine mists or sprays of oil. Excessive inhalation of oil fumes or mists may give rise to irritation of the eyes, nose, throat and lungs and, in extreme cases of gross over exposure, a condition resembling pneumonia. The concentrations of such mists in the working environment should be kept as low as possible. (Although specialised equipment is required to measure oil mist concentrations, the presence of a visible mist, when viewed against back ground light, indicates that unsafe levels may be present).
- Used engine oils are likely to contain potentially harmful contaminants, which arise from the products of combustion. For this reason skin contact with used engine lubricants should be avoided.

General precautions when using marine fuels

- Instruction and training should be given to all those involved in the use and handling of marine fuels to ensure they understand the potential hazards and are aware of the correct procedures to be followed to minimise risks.
- High standards of equipment maintenance and engine room cleanliness should be followed to minimise exposure; adequate ventilation of machi.ne spaces must be provided.
- Repeated and prolonged skin exposure to marine fuels may cause harm. Gas oils and other solvents should not be used for cleaning equipment unless the skin is protected, e.g. by impervious gloves. Gas oil or diesel oil should not be used for washing oil or grease from the skin.
- Special procedures and precautions must be adopted for anyone entering a fuel tank, e.g. for inspection, cleaning or maintenance, in order to avoid asphyxiation or other hazards arising from build-up of toxic or flammable gas from fuel or sludge. Such procedures & precautions should include the use of permits and check lists in which the necessary safeguards are defined, e.g. gas freeing of tanks, tank atmosphere testing, safety harness and lifeline, safety equipment and stand-by personnel. An appropriate safety code should be consulted for detailed advice. Two such codes are the “International safety guide for oil tankers and terminals” and the “Code of safe working practice for merchant seaman”.
- To reduce the risk of accidental ingestion, marine fuels must never be stored in small unlabelled or incorrectly labelled containers. Accidental ingestion of the lighter marine fuels may cause vomiting followed by aspiration of liquid into the lungs, which can cause serious damage or death. For this reason, vomiting must not be induced as a first aid measure following ingestion of fuels.
- Whenever protective equipment is required, clear instruction must be provided on its correct use, and appropriate facilities must be made available for cleaning, inspection, maintenance and storage of the equipment.
- The ash from fuel oil combustion can contain irritant, toxic and carcinogenic (cancer-causing) substances. Therefore, when solid deposits are being removed from the engine or boiler combustion and exhaust spaces, personnel involved should wear dust respirators, eye protection, gloves and appropriate protective clothing.
- If fuel has been injected through the skin by contact with high pressure or high velocity fuel sprays, the situation must be regarded as a serious medical emergency. Medical advice must be obtained immediately, as emergency surgery may be necessary. Ensure that the medical practitioner is aware of the “Medical Advice” section of the fuels MSDS.
- Precautions should be taken to eliminate or minimise exposure to oil mists, which might be emitted into the working environment during certain operations (for example, testing of fuel injection equipment). The concentrations of such mists in the working environment should be kept as low as possible. (Although specialised equipment is required to measure oil mist concentrations, the presence of a visible mist, when viewed against background light, indicates that unsafe levels may be present).

Skin care when using petroleum products

The most common route of exposure to marine fuels and lubricants for ships' crews is through skin contact. It is important that good hygiene practices are followed if the potential adverse health effects from repeated or prolonged skin contact are to be avoided. This section provides general advice on prevention of occupational skin diseases. The appropriate BP Marine Safety Data Sheet (SDS) should be consulted for specific advice on safe handling precautions and emergency procedures for a particular product.

Healthy skin

The skin is the main barrier protecting the body from harmful substances in the environment and comprises a thin outer layer (the epidermis) and a thicker inner layer (the dermis which contains sweat glands, hair follicles and blood vessels). The epidermis consists of a layer of dead cells (cells being the basic structural and functional building blocks of the body) bound together by natural oils to form an impervious barrier. The natural oils present are important in retaining water, and their loss (known as de-fatting) can lead to dehydration of the skin, which becomes stiff and cracks open exposing the underlying living cells to harmful substances or infection.

Effects of mineral oil products on the skin

Frequent or prolonged contact with mineral oil products can cause various skin conditions, which may occur singly or in combination:

Irritant Contact Dermatitis is inflammation of the skin resulting from contact with an irritant material. Such materials affect everyone's skin although the severity of response varies between individuals and between materials. Oils, particularly those of low viscosity, may be an irritant and defat the skin, leaving it dry and susceptible to dermatitis and infection. Irritant dermatitis is the most common skin condition caused by frequent or prolonged skin contact with mineral oil-based products.

Allergic Contact Dermatitis occurs only in individuals who have become allergic (sensitised to particular materials, as a result of pre-exposure to the chemical). The inflammatory effects on the skin in such cases are the same as in irritant contact dermatitis except that severe inflammation may be caused by even trivial contact with the material.

In both irritant and allergic contact dermatitis, the skin becomes red, dry and may be itchy. Small watery blisters may develop and burst, leaving the skin surface dry and flaky and in some cases, skin cracking and/or bleeding may occur. Dermatitis that develops over a long period can result in skin, which is thickened. (cont.)

Occupational contact dermatitis commonly occurs on the forearms, backs of hands and between the fingers, but may affect any areas of skin that have been exposed to the chemical. It can occur at any age although it is more common in middle age, sometimes after exposure to the same material for twenty years or more. Once contact dermatitis has developed, the skin does not always return to a normal healthy condition even if all contact with the offending material(s) is avoided. Prevention of contact dermatitis developing must therefore be the primary consideration.

Oil Folliculitis (blocking of hair follicles) and or Oil Acne (blocking of sebaceous and / or sweat glands) may develop as result of prolonged or repeated skin contact with mineral oil products (particularly where oil-soaked clothing has been allowed to remain in contact with the skin). The first sign is normally the appearance of "blackheads" but individuals that are more susceptible may suffer from boils or even carbuncles.

Keratosis (skin thickening) or warty growths may develop following frequent and prolonged skin contact with some lubricants, and fuels (particularly heavy fuel oils), especially if accompanied by poor standards of personal hygiene. Occassionally, a warty growth may become malignant (cancer). In addition, small growths or malignant ulcers may develop on otherwise normal skin. These most frequently occur on exposed areas (hands, forearms) but may also appear on other areas where the skin is habitually chafed by oil impregnated clothing. The skin of the scrotum (skin covering the testicles) is particularly susceptible and therefore oily rags or tools should never be put into trouser pockets. Work clothes should be changed regularly and changed promptly if they become contaminated.

Skin cancers do not appear for many years (usually more than twenty) after exposure first began, and are more readily cured by early medical treatment. Personnel with prolonged occupational exposure to mineral oil based products should be advised by management to examine themselves regularly (e.g. when bathing).
Handling instructions for materials suspected of being able to cause skin cancer should be followed carefully at all times. Anyone who develops a warty skin growth or skin sore or ulcer, which does not disappear or heal quickly, (even though they have not handled petroleum products for many years), should consult a physician.

Prevention of skin contamination
The best way to protect the skin from any harmful effects of oil products is to prevent skin contamination. Personal protection is less effective than properly engineered containment. If this is not possible, good housekeeping methods must be adopted that do not allow oil residues to accumulate. Working methods should minimise potential for skin contact and only disposable "wipes" should be used - workers should never put oily rags or tools into pockets.

It is essential to maintain high standards of personal hygiene.

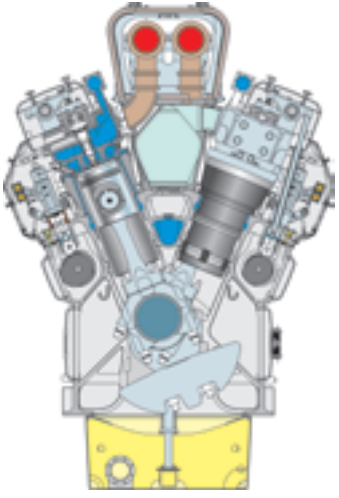
Skin care when using petroleum products (cont.)

Protective clothing: Cotton or polyester / cotton overalls normally provide adequate protection where only intermittent or occasional contact is likely. Where a higher degree of contact is possible, additional impermeable protective clothing (e.g. gloves, aprons, oil resistant footwear) should be worn as appropriate. Clothes should be changed regularly (immediately if impregnated, including boots) and laundered before re-use. Oil-saturated clothing should not be allowed to chafe against the skin.

Barrier creams: These may help to prevent grime becoming ingrained into the skin but offer little or no protection against harmful substances. Petroleum products should be washed off the skin using soap or proprietary skin cleansers and warm water.

Fuels (e.g. gas oil or kerosene) or solvents (e.g. white spirits) should never be used to clean skin as they themselves may cause dermatitis if used repeatedly. Workers should be encouraged to wash regularly, particularly before eating and before, as well as after, using the lavatory. Skin conditioners (moisturising creams) should be used regularly (at least at the end of each shift), as they help replace natural oils and prevent de-fatting.

Barrier creams and skin conditioning creams should never be put onto unwashed contaminated skin as they may make the effect of the underlying chemical exposure more severe. It is therefore important that skin is thoroughly washed before using these products.



Picture of Wartsila 46 engine
Courtesy of Wartsila NSD Finland OY

iso requirements

Requirements for marine distillate fuels
ISO 8217:2005 - Table 1

Characteristic	Unit	Limit	CATEGORY ISO-F- DMX	DMA	DMB	DMC(a)	Test Method Reference
Density at 15°C	kg/m³	max.	-	890.0	900.0	920.0	ISO 3675 or ISO 12185 (see also 7.1)
Viscosity at 40°C	mm²/s (b)	min.	1.40	1.50	-	-	ISO 3104
	mm²/s (b)	max.	5.50	6.00	11.0	14.0	ISO 3104
Flash point	°C	min.	-	60	60	60	ISO 2719
	°C	min.	43	-	-	-	(see also 7.2)
Pour point (upper) - winter	°C	max.	-	-6	0	0	ISO 3016
- summer	°C	max.	-	0	6	6	ISO 3016
Cloud point	°C	max.	-16 (c)	-	-	-	ISO 3015
Sulphur	% (m/m)	max.	1.00	1.50	2.00 (d)	2.00 (d)	ISO 8754 or ISO 14596 (see also 7.3)
Cetane index		min.	45	40	35	-	ISO 4264
Carbon residue on 10% (v/v) - distillation bottoms	% (m/m)	max.	0.30	0.30	-	-	ISO 10370
- carbon residue	% (m/m)	max.	-	-	0.30	2.50	ISO 10370
Ash	% (m/m)	max.	0.01	0.01	0.01	0.05	ISO 6245
Appearance			Clear and bright		(e)	-	See 7.4 and 7.5
Total sediment, existent	% (m/m)	max.	-	-	0.10 (e)	0.10	ISO 10307-1 (see also 7.5)
Water	% (v/v)	max.	-	-	0.3 (e)	0.3	ISO 3733
Vanadium	mg/kg	max.	-	-	-	100	ISO 14597, IP 501 or IP470 (see also 7.8)
Aluminium plus silicon	mg/kg	max	-	-	-	25	ISO 10478, IP 501 or IP470
Used lubricating oil (ULO)					The fuel shall be free of ULO (see table2)		
Zinc	mg/kg	max.	-	-	-	15	IP 501 or IP 470
Phosphorus	mg/kg	max.	-	-	-	15	IP 501 or IP 470
Calcium	mg/kg	max.	-	-	-	30	IP 501 or IP 470 (See also 7.7)

(a) Note that although predominantly consisting of distillate fuel, the residual oil proportion can be significant.

(b) 1 mm2/s = 1 cSt

(c) Purchasers should ensure that this pour point is suitable for the equipment on board, especially if the vessel operates in both the northern and southern hemispheres.

(d) This fuel is suitable for use without heating at ambient temperatures down to -16 °C.

(e) A sulphur limit of 1.5 % (m/m) will apply in SOx emission control areas designated by the International Maritime Organization, when its relevant protocol enters into force. There may be local variations, for example the EU requires that sulphur content of certain distillate grades be limited to 0.2 % (m/m) in certain applications. See 0.3 and reference [7].

(f) If the sample is clear and with no visible sediment or water, the total sediment existent and water tests shall not be required. See 7.4 and 7.5.

(g) A fuel shall be considered to be free of used lubricating oils (ULOs) if one or more of the elements zinc, phosphorous and calcium are below or at the specified limits. All three elements shall exceed the same limits before a fuel shall be deemed to contain ULOs.

Requirements for marine residual fuels

ISO 8217:1996 (equivalent to BS MA 100:1996)

(a) Annex C gives a brief viscosity/temperature table for information purposes only. 1 mm2/s = 1 cSt.

(b) Purchasers should ensure that this pour point is suitable for the equipment on board, especially if the vessel operates in both the northern and southern hemispheres.

(c) A sulphur limit of 1.5 % (m/m) will apply in SOx emission control areas designated by the International Maritime Organisation, when its relevant protocol enters into force. There may be local variations.

(d) A fuel shall be considered to be free of used lubricating oils (ULOs) if one or more of the elements zinc, phosphorous and calcium are below or at the specified lim its. All three elements shall exceed the same limits before a fuel shall be deemed to contain ULOs.

		CATEGORY ISO-F-									
Characteristic	**Limit**	**RMA 30**	**RMB 30**	**RMD 80**	**RME 180**	**RMF 180**	**RMG 380**	**RMH 380**	**RMK 380**	**RMH 700**	**RMK 700**	**Test Method Reference**
Density	max.	960.0	975.0	980.0	991.0		991.0		1010.0	991.0	1010.0	ISO 3675 or ISO 12185 (see also 7.1)
Kinematic viscosity at 50°c, mm²/s (a)	max.	30.0		80.0	180.0		380.0			700.0		ISO 3104
Flash point °C	min.	60		60	60		60			60		ISO 2719 (see also 7.2)
Pour point (upper), °C (b)												
- winter quality	max.	0	24	30	30		30			30		ISO 3016
- summer quality	max.	6	24	30	30		30			30		ISO 3016
Carbon residue, % (m/m)	max.	10		14	15	20	18	22		22		ISO 10370
Ash, % (m/m)	max	0.10		0.10	0.10	0.15	0.15			0.15		ISO 6245
Water, % (v/v)	max.	0.5		0.5	0.5		0.5			0.5		ISO 3733
Sulphur, % (m/m) (c)	max.	3.50		4.00	4.50		4.50			4.50		ISO 14596 or ISO 8754 (see also 7.3)
Vanadium, mg/kg	max.	150		350	200	500	300	600		600		ISO 14597, IP 501 or IP470 (see also 7.8)
Total sediment potnetial, % (m/m)	max.	0.10		0.10	0.10		0.10			0.10		ISO 10307-2 (see also7.6)
Aluminium plus silicon, mg/kg	max.	80		80	80		80			80		ISO 10478, IP 501 or IP470 (see also 7.9)
Used lubricating oil (ULO)		The fuel shall be of ULO. A fuel shall be considered to be free of ULO if one or more of the elements Zinc, Phosphorus ans Calcium are below or at the specified limits. **All** three elements shall exceed the same limits before a fuel shall be deemed to contain ULO.										
Zinc, mg/kg					15							IP 501 or IP 470 (see also 7.7)
Phosphorus, mg/kg					15							IP 501 or IP 500 (see also 7.7)
Calcium, mg/kg					30							IP 501 or IP 470 (see also 7.7)

iso requirements

Viscosity conversion

Estimated from those measured @ 50ºC
Annex C from ISO 8217:2005 (E)

KINEMATIC VISCOSITY mm²/s *				
	Approximate estimations @			
Measured at 50ºC	**40ºC**	**100ºC**	**125ºC**	**150ºC**
30	45	7	4	3
80	135	13	7	4
180	330	22	11	7
380	750	35	16	9
700	1500	50	22	11

***1 mm²/s = 1 cSt**

This International Standard specifies limiting values of kinetic viscosity at 50ºC for the fuel categories contained in the table above. In some cases, kinematic viscosity may be measured or quoted at other temperatures, the table above gives approximate relationships. This data should be used with caution because the variability of composition of residual fuels can cause variations in viscosity-temperature relations.

Ignition Quality

Ignition performance requirements of residual fuels in marine diesel engines are primarily determined by engine type and, more significantly, by engine operating conditions. Fuel factors influence ignition characteristics to a much lesser extent. For this reason, no general limits for ignition quality can be applied, since a value which can be problematical to one engine under adverse conditions can perform quite satisfactorily in many other instances. If required, further guidance on acceptable ignition quality values should be obtained from the engine manufacturer.

notes

notes

marine mineral oils

Cylinder & system oils
Low speed crosshead enines

Grade Name & Application	SAE Viscosity Classification	Kinematic Viscosity cSt 100°C	BN mgKOH/g	Description
CYLINDER OILS				
Energol CL 505	50	19.5	50	For prolonged operation on low to moderate sulphur fuel (distillate or heavy fuel).
Energol CL-DX 405	50	19.5	40	For prolonged operation on low sulphur fuel (distillate or heavy fuel).
Energol CLO 50M	50	19.5	70	A 70 BN cylinder oil recommended for all low speed crosshead applications when operating on heavy fuel oils having a wide range of sulphur content.
SYSTEM OILS				
Energol OE-HT -30	30	11.5	5	A high performance alkaline oil for the crankcase lubrication of all low speed crosshead engines and camless engines requiring high quality system oils for hydraulic functions.

The figures are typical of those obtained with the normal production tolerances and do not constitute a specification.

Crankcase oils
Trunk piston engines

Grade Name & Application	SAE Viscosity Classification	Kinematic Viscosity cSt 100°C	BN mgKOH/g	Description
DIESEL AND GAS OIL OPERATION				
Energol DL-MP 30	30	11.5	9	For lubrication of medium speed trunk piston engines operating with ISO 8217 type DMA/DMB fuels. Although OE-HT 30 is our primary recomendation for crosshead engine crankcase oil, DLMP 30 may be used in certain circumstances where only one storage tank exists and so a common oil is needed for both main and auxiliary engines.
Energol DL-MP 40	40	14.0	9	
Energol DS3-153	30	11.5	15	For lubrication of highly rated trunk piston engines operating with ISO 8217 type DMA/DMB/DMC fuels where there is a requirement for increased BN and for API CD diesel detergency.
Energol DS3-154	40	14.0	15	
RESIDUAL FUEL OIL OPERATION				
Energol IC-HFX 203	30	11.5	20	For use as crankcase and cylinder oil in highly rated trunk piston engines using residual fuels. These oils have a diesel detergency exceeding API CF performance.
Energol IC-HFX 204	40	14.0	20	
Energol IC-HFX 303	30	11.5	30	
Energol IC-HFX 304	40	14.0	30	
Energol IC-HFX 404	40	14.0	40	
Energol IC-HFX 504	40	14.0	50	

The figures are typical of those obtained with normal production tolerances and do not constitute a specification

High speed diesel engine oils

Grade Name & Application	SAE Viscosity Classification	Kinematic Viscosity cSt 100°C	BN mgKOH/g	Description
Energol HPDX 40	40	14.0	12	Premium quality, monograde engine oil suitable for high speed diesel engines burning distillate fuel. Especially suitable in fast ferry and coastal vessels. MTU approved type 2 oil.
Vanellus C4 Global	15W40	14.0		Multigrade high-speed diesel engine oil. API CF-4
Vanellus C5 Global	15W40	14.0		Multigrade high-speed diesel engine oil. API CG-4
Vanellus C6 Global	15W40	14.0		Premium high-speed multigrade diesel engine oil. API CH-4, ACEA E3/E5
Vanellus DD 40	40	14.0		Monograde diesel engine oil containing less than 0.8% sulphated ash, specially developed for all Detroit 2-stroke diesel engines.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification

marine mineral oils

Ancillary oils

Grade Name & Application	Kinematic Viscosity cSt 40°C	VI	Description
HYDRAULIC OILS - HIGH VISCOSITY INDEX			
Bartran HV 15	15	152	High performance Zinc-free, anti-wear hydraulic oils suitable for highly loaded hydraulic systems. The additives used ensure a high level of performance with respect to anti-wear, anti-oxidation, filter ability, hydrolytic stability and multi-metal compatibility.
Bartran HV 22	22	155	
Bartran HV 32	32	153	
Bartran HV 46	47	152	
Bartran HV 68	70	142	
Bartran HV 100	100	133	
Bartran HV 150	150	128	
Bartran HVX 46	46	141	A range of high performance, highly shear stable mineral-based hydraulic oils containing non-zinc-based anti-wear additives, combining high lubrication performance with outstanding filterability.
Bartran HVX 68	68	141	
Bartran HVX 100	100	141	
HYDRAULIC OILS - VERY HIGH VISCOSITY INDEX			
Energol SHF-LT 15	15	>300	Specially formulated for use where very low temperatures can be expected. Primarily intended for use in cargo valve hydraulics and similar systems where there are long lengths of small bore pipes.
HYDRAULIC OILS - SPECIAL			
Energol HLP-D 68	68	100	Special hydraulic oil for some fin stabiliser applications.

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Ancillary oils

Grade Name & Application	Kinematic Viscosity cSt 40°C	Description
REFRIGERATOR COMPRESSOR OILS		
Energol LPT 68	68	Napthenic oil for refrigeration systems operating on R12 and some R22 applications.
Energol LPT-F 32 Energol LPT-F-46	29 54	Napthenic oils with low floc point particularly suitable for systems operating on R22, at low evaporating temperatures.
STRAIGHT MINERAL OILS		
CS 220	220	Straight mineral oil for running-in of certain slow-speed marine diesel engines.
TURBINE OILS		
Energol THB 68 Energol THB 100	65 96	High quality marine steam turbine oils intended primarily for lubrication of steam turbines and reduction gears. THB 68 can be used in some turbo-chargers.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification.

marine synthetic oils

Grade Name & Application	Kinematic Viscosity cSt 40°C	Description
AIR COMPRESSOR OILS		
Enersyn RC-S 32	29	For the lubrication of rotary air compressors.
Enersyn RC-S 46	44	
Enersyn RC-S 68	68	
Enersyn RX 100	95	For use in reciprocating air compressors.
GAS COMPRESSOR OILS		
Enersyn GCS 180	185	For use in compressors where there is contact between the gas and lubricant.
GAS TURBINE OILS		
BP Turbo Oil 2197		5 cSt high thermal stability turbine engine oil. Meets MIL-PRF-23699F HTS.
BP Turbo Oil 2380		5 cSt synthetic turbine oil. Type II. Meets MIL-PRF-23699F STD
GEAR OILS		
Enersyn HTX 150	165	For the lubrication of certain marine thruster gears.
Enersyn HTX 220	227	For the lubrication of centrifuge gearboxes.
Enersyn HTX 320	320	High viscosity Index PAO synthetic gear oils
Enersyn HTX 460	460	for special applications.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification.

Grade Name & Application	Kinematic Viscosity cSt 40°C	Description
REFRIGERATOR COMPESSOR OILS		
Enersyn LPS 46	45	These Alkyl Benzene based lubricants are for use in reciprocating refrigeration compressors and some rotary compressors.
Enersyn LPS 68	67	
Enersyn LPS 100	96	
Enersyn LPS-PO 68	69	These are Poly Alpha Olefin based, for the lubrication of Stal mini-screw compressors when specified by Stal Refrigeration AS.
Enersyn LPS-PO 220	209	
Enersyn MP-S 32	32	Polyol Ester based for the lubrication of refrigeration compressors where Hydrofluorocarbon (HFC) refrigerant e.g. R134a, R407C, R404A, R410A and R507 are in use.
Enersyn MP-S 46	46	
Enersyn MP-S 68	68	
Enersyn MP-S 100	100	
Enersyn MP-S 170	170	
Enersyn MP-S 220	210	
TURBOCHARGER OILS		
Enersyn TC-S 68	68	Special low-friction turbocharger oil. Approved by ABB.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification.

speciality products

Grade Name & Application		Description
CORROSION PREVENTATIVES - SPARE GEAR		
Stemkor 171		Solvent deposited temporary corrosion preventative for medium to long term outdoor storage.
HEAT TRANSFER FLUIDS		
Transcal N		For closed liquid phase heating systems operating at bulk temperatures up to 320°C.
Transclean 801		A high performance detergent liquid, soluble in all mineral/synthetic hydrocarbons for internal cleaning of systems using heat transfer fuels.
STEAM RECIPROCATING ENGINE OILS		
Energol ME-CC 220	230	Emulsifiable oil for gravity-fed stern tube systems. Such oil is recommended by the bearing/seal manufacturer. Can help minimise leakage in worn/ damaged sealing rings.
Energol AC-C 460	480	For the lubrication of steam cylinders, also suitable for some worm gearboxes.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification.

Grade Name & Application	Kinematic Viscosity cSt 40°C	Description
TRANSMISSION OILS		
Autran MBX	39	A 'universal' automatic transmission fluid meeting GM and Ford specifications.
Terrac Super Transmission	69	Transmission fluid for oil-immersed brakes in some winch drives.
WIRE ROPES		
Energrease MP-MG2		Multi-purpose calcium sulphonate complex grease for general greasing requirements including wire ropes and open gears.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification.

marine greases

Grade Name & Application	NLGI Classification	Base	Drop Point °C	Description
Energrease HTG 2	2	Clay	non melting	For high temperature bearing applications up to 200°C, for continuously operating rolling bearings advice should be sought on re-greasing periods.
Energrease L21-M	2	Lithium	190	A grease containing Molybdenum disulphide.
Energrease MM-EP0 Energrease MM-EP1 Energrease MM-EP2	0 1 2	Lithium Lithium Lithium	163 173 175	A lithium based non-leaded EP grease, intended for general shipboard use. It has excellent salt-water corrosion resistance and is suitable for working temperatures up to 120°C. 0 and 1 grades are particularly suited to centralised lubrication systems with small bore pipe work.
Energrease MP-MG 2	2	Calcium Sulphonate Complex	>300	A multi-purpose marine grease for motor bearings, wire ropes and open gears. Replaces MM-EP 2, OG and Energol WRP.

The figures are typical of those obtained with normal production tolerances and do not constitute a specification

Picture of Alpha Laval Separation Unit
Courtesy of Alpha Laval Sparation AB, Tumba/Sweden

SAE/ISO ranges

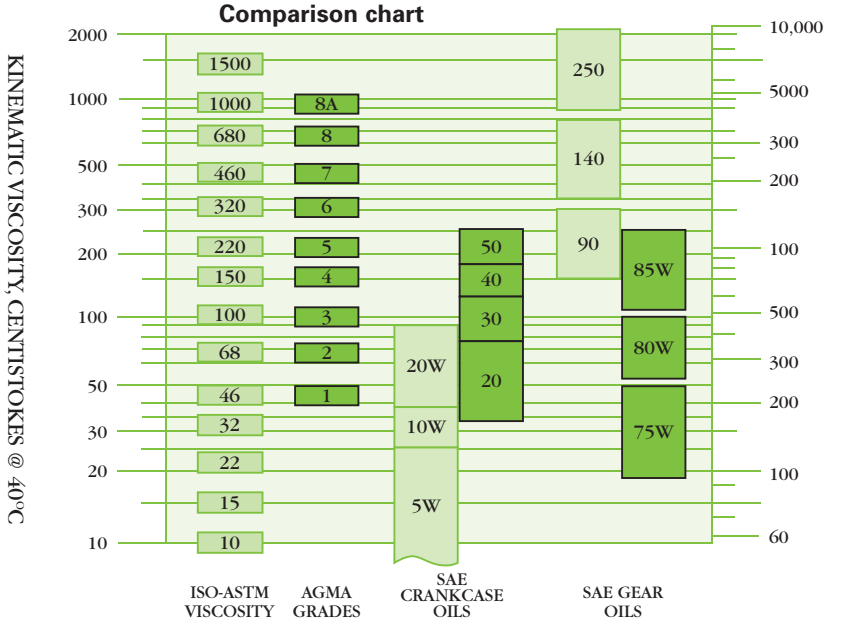
SAE VISCOSITY RANGES

	Dynamic Viscosity (cP)	Viscosity @ 100°C (cSt)	
SAE Grade	Maximum	Minimum	Maximum
OW	3250 @ -30°C	3.8	
5W	3500 @ -25°C	3.8	
10W	3500 @ -20°C	4.1	
15W	3500 @ -15°C	5.6	
20W	4500 @ -10°C	5.6	
25W	6000 @ -5°C	9.3	
20		5.6	9.3
30		9.3	12.5
40		12.5	16.3
50		16.3	21.9
60		21.9	26.1

ISO VISCOSITY RANGES

	Viscosity @ 40°C (cSt)	
ISO Grade	Minimum	Maximum
15	13.5	16.5
22	19.8	24.2
32	28.8	35.2
46	41.4	50.6
68	61.2	74.8
100	90	110
150	135	165
220	198	242
320	288	352
460	414	506
680	612	748

For example
A 15W40 multigrade oil will have a low temperature cranking viscosity of 3500 centipoise (cP) @ -15°C and a high temperature viscosity between 12.5 and 16.3 centistokes (cSt) @ 100°C, similarly a 10W30 multigrade oil will have a low temperature cranking viscosity of 3500 centipoise (cP) @ -20°C and a high temperature viscosity between 9.3 and 12.5 centistokes (cSt) @ 100°C.

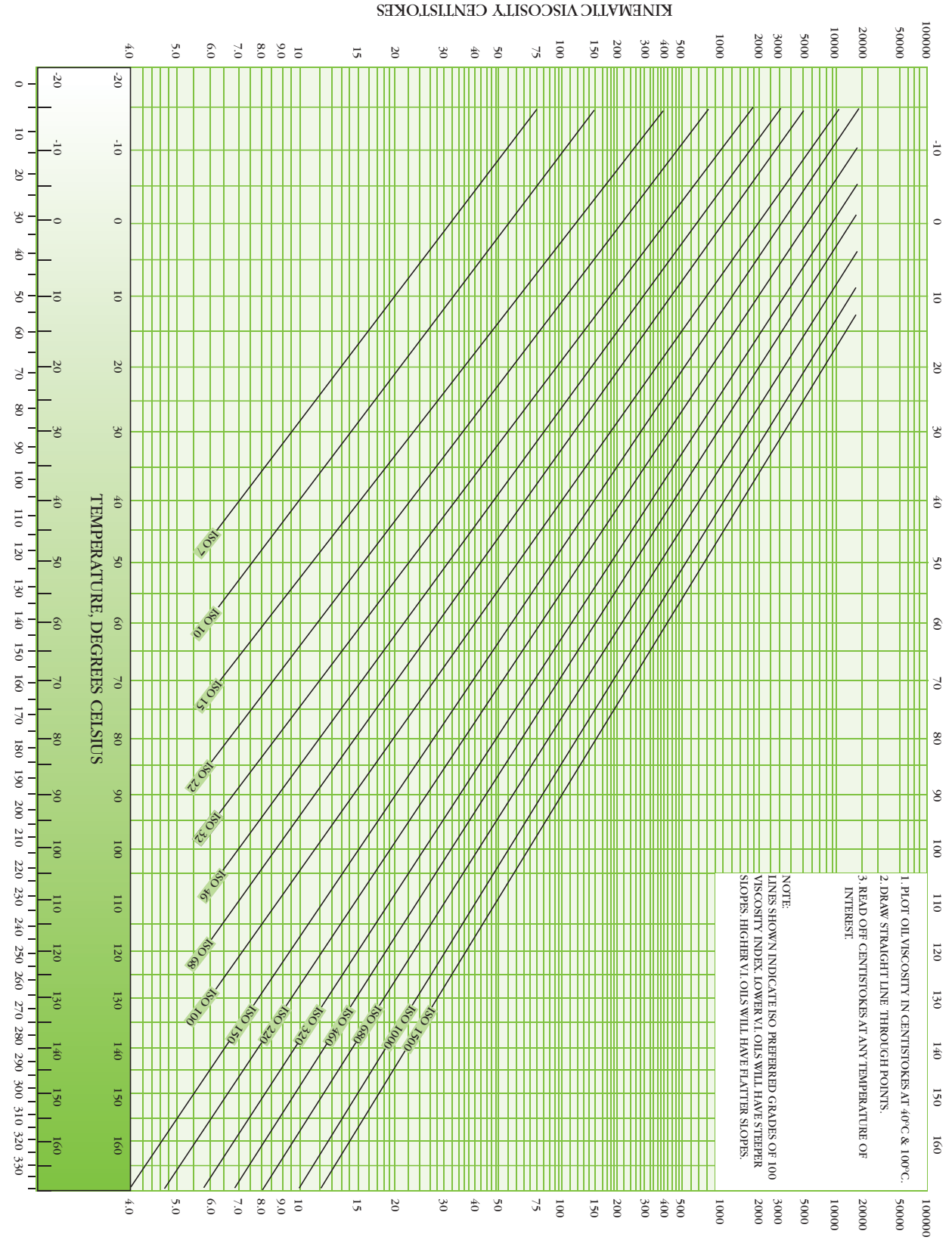


NOTES:
- SAE gear and crankcase viscosities are at 100°C
- Assume 95VI oils

Gear lubricant
viscosity ranges

	Viscosity @ 100°C (cSt)		Max temperature for
SAE Grade	Minimum	Maximum	viscosity of 150 000 cP(°C)
70W	4.1	-	-55
75W	4.1	-	-40
80W	7.0	-	-26
85W	11.0	-	-12
90	13.5	24.0	-
80W-90	13.5	24.0	-26
85W-140	24.0	41.0	-12
140	24.0	41.0	-
250	41.0	-	-

Temperature variation graph



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refrigerants

Production of chlorofluocarbons (CFCs) has been phased out. Environmentally acceptable replacement compounds are therefore needed for use in existing medium and low temperature refrigeration applications. Refrigerant R134a was developed to meet these needs. Refrigerant R134a is a commercially available hydrofluorocarbon (HFC) refrigerant for use as a long-term replacement for R12 in new equipment and for retrofitting medium temperature CFD-12 systems.

R409A is a low ozone depleting blend of R22, R124, and R142b. Refrigerant R409A is formulated to closely resemble the properties of Refrigerant R12. R409A is an alternative refrigerant blend for retrofitting R12 medium and low temperature refrigeration systems. R409A provides a slightly higher capacity than R12 and R134a in lower temperature applications. R22 or HCFC-22 is a single component HCFC with low ozone depletion potential.

As production of CFCs refrigerants is reduced and ultimately eliminated, environmentally acceptable replacement compounds are needed for use in chillers. These alternative refrigerants should have operating characteristics similar to those of CFCs, both to reduce the cost of converting existing chillers to alternatives and to limit the design changes involved in manufacturing new chillers that can use the alternative refrigerants.

R408A is a low ozone depletion potential near azeotropic blend of HCFC R22 and HFC R125 and R143a. R408A was developed to provide a fast and convenient and reliable retrofit solution for medium and low temperature refrigeration systems which are currently R502. R408A has been blended to closely match the physical and refrigeration properties of R502. R408A was not developed to use in new equipment but rather in R502 systems.

Refrigerant R404A is a zero ozone depletion near azeotropic blend of HFC refrigerants R125, R143a, and 134a. R404A is the ultimate and long term HFC zero ozone depletion replacement for refrigerant R502. The properties closely match the properties of R502. New system manufacturers have approved R404A for the refrigerant in their new equipment.

R407A has been identified as the energy efficient replacement for R502 in non-hermetic systems (hermetics use 407B). 407A has the lowest global warming potential of any HFC replacement for R502. This is a zero ODP refrigerant.

refrigerants

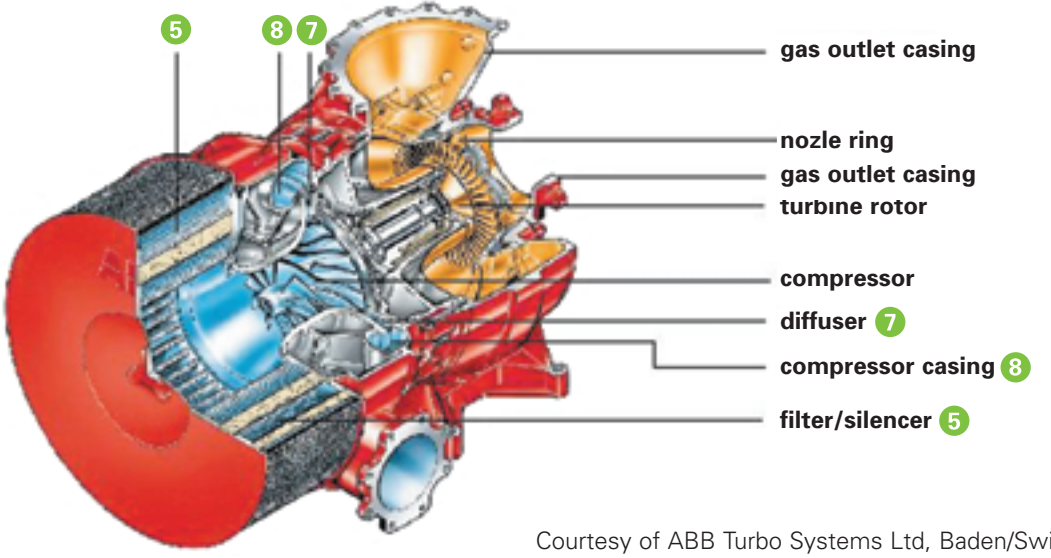
The table below lists refrigerants that cover 95% of all marine applications

	Temperature Range	Ozone Depletion Potential (ODP)	Global Warming Potential (GWP)	Refrigerant Type	Recommended Lubricant
R22	High, Medium, Low	0.05	1700	HCFC Single component	Mineral based
R134a	High, Medium	0	1300	HFC Single component	Polyol Ester
R407C	High, Medium	0	1610	HFC Zeotropic Blend	Polyol Ester
R404A	Medium, Low	0	3750	HFC Near Azeotropic Blend	Polyol Ester
R507	Medium, Low	0	3800	HFC Azeotropic Blend	Polyol Ester
R410A	High, Medium, Low	0	1890	HFC Near Azeotropic Blend	Polyol Ester
R401A	High, Medium, Low	0.03	1080	HCFC Zeotropic Blend	Mineral based
R409A	High, Medium, Low	0.05	1440	HCFC Zeotropic Blend	Mineral based
R407D	High, Medium, Low	0	1430	HFC Zeotropic Blend	Polyol Ester
R717	High, Medium, Low	0	0	NIK Halogen Free	Mineral based

The information in the above table was supplied courtesy of **UNITOR REFRIGERATION ASA**
Suffix **"a"** indicates a single substance.
Suffix **"A, B, C or D"** indicates a blend, with varying degree Toxic potential. E.g. **A** = Toxicity >400ppm. **B** = Toxicity <400ppm etc.

Lubricant / refrigerant compatibility

	Mineral Oil (MO)	Alkyl Benzene (AB)	MO & AB	Poly Alpha Olefin (PAO)	Polyol Ester (POE)	Poly Alkylene Glycol (PAG)
HCFC	Compatible	Compatible	Compatible	Limited application	Limited application	Not suitable
SERVICE BLENDS	Limited application	Compatible	Compatible	Not suitable	Compatible	Not suitable
HFC + Blends	Not suitable	Limited application	Not suitable	Not suitable	Compatible	Limited application
HYDROCARBONS	Compatible	Compatible	Compatible	Compatible	Compatible	Limited application
AMMONIA	Compatible	Limited application	Limited application	Compatible	Not suitable	Limited application



Courtesy of ABB Turbo Systems Ltd, Baden/Switzerland

Consistency: NLGI numbers

The consistency (softness or hardness) of a grease is indicated by suffix number, as in Energrease MP-MG 2. This is the NLGI number, in the classification system laid down by the National Lubricating Grease Institute (USA). Consistency is defined as the depth, in tenths of a millimetre, that a standard cone penetrates into a sample of grease that has been subjected to mechanical working. The test is conducted in prescribed conditions of weight, time and temperature.

In the NLGI range there are nine 'Penetration Grades' from very soft Grade 000 to the almost solid Grade 6.

NLGI Number	Worked Penetration @ 25°C (0.1mm)
000	445 - 475
00	400 - 430
0	355 - 385
1	310 - 340
2	265 - 295
3	220 - 250
4	175 - 205
5	130 - 160
6	85 - 115

Grease compatibility chart

Grade Type	Aluminium Complex	Barium	Calcium	Calcium 12-Hydroxy	Calcium Complex	Calcium Sulfonate	Clay	Lithium	Lithium 12-Hydroxy	Lithium Complex	Polyurea
Aluminium Complex	N/A	I	I	C	I	I	I	I	I	C	I
Barium	I	N/A	I	C	I	B	I	I	I	I	I
Calcium	I	I	N/A	C	I		C	C	B	C	I
Calcium 12-Hydroxy	C	C	C	N/A	B		C	C	C	C	I
Calcium Complex	I	I	I	B	N/A	C	I	I	I	C	C
Calcium Sulfonate	I	B			C	N/A	I	C		C	B
Clay	I	I	C	C	I	I	N/A	I	I	I	I
Lithium	I	I	C	C	I	C	I	N/A	C	C	I
Lithium 12-Hydroxy	I	I	B	C	I		I	C	N/A	C	I
Lithium Complex	C	I	C	C	C	C	I	C	C	N/A	I
Polyurea	I	I	I	I	C	B	I	I	I	I	N/A

KEY I INCOMPATIBLE C COMPATIBLE B BORDERLINE COMPATIBILITY

sampling

At BP, we believe in promoting and practising the highest health and safety practices and therefore, this information provides basic guidance on effective sampling of lubricants in order to accurately monitor oil condition, system cleanliness and machinery wear. In addition to general sampling guidance, some machinery types are considered individually to highlight particular sampling challenges which can be encountered, and some practical solutions.

Of equal importance is correct labelling and dispatch to ensure that samples reach the laboratory quickly and can be immediately processed. The execution of the whole sampling, labelling and dispatch process is described to ensure that you receive your analysis result reports correctly assigned and in the shortest possible time.

This will help ensure that the hazards associated with sampling are minimised, and it is strongly recommended that attention is paid to the next section describing safe sampling precautions.

Safe sampling

Always take the following precautions:

- Check the oil temperature in the system before sampling and avoid hot oil splashing on body or clothing. In general, oil temperatures below 50°C are relatively safe if boiler suit and suitable gloves are worn. Between 50°C and 70°C extra protection should be worn. Above 70°C, only use a closed sampling system, (note that thermal oil systems operate at up to 250°C). Direct sampling into Enercare sample bottles must not be undertaken under any circumstances with oils above 70°C. The sample bottle will begin to soften at about 70°C.
- Check oil pressure, and avoid high pressure oil spraying onto the body, clothing, into eyes or onto hot surfaces. Control of oil flow during sampling will depend upon the type of sampling valve that is fitted. Oil pressures of up to 5 bar may be handled with normal boiler suit, suitable gloves and eye protection. Between 5 bar and 20 bar extra care must be taken. A simple on/off cock is not suitable for sampling, and above 20 bar, consideration should be given to a closed sampling system with a suitable pressure reduction valve.
- Always review sampling position with respect to moving, rotating or automatic start machines. Do not sample if there is a risk of contact with moving or rotating machinery and isolate auto-start machines. If necessary ensure a colleague is standing by in case assistance is needed.

Hazards associated with sampling include high oil pressures, hot oil, risk of fire and a sampling point in the vicinity of rotating, moving or auto start machinery. In addition to the these notes, particular hazards are also noted within the sections covering specific machinery applications.

Correct sampling

In order to ensure meaningful advice is provided from oil analysis it is vital that the sample is representative of the oil in service. Remember that the size of the sample being tested (normally 120ml) represents less than 10 parts per million (or 0.001%) of the total oil charge in a large diesel engine system.

It is also important to consider the point at which the sample is to be taken. In the past when sampling was only for the purposes of assessing oil condition, the ideal sample point was near the oil entry line into the machine. The theory behind this was that the sample would reflect the condition of the oil as delivered to the machine. Today, the picture is a little more complex and some thought needs to be given to what type of information is being sought. If the concern is machine wear and condition monitoring, then samples should be taken at a convenient point directly after the oil has passed through the machine and is carrying particles of wear debris from the moving components. For assessment of oil condition and system cleanliness sampling before the inlet to the machine is a better choice. In order to monitor trends, consistent sampling from only one sampling point is more important than the actual sample location. Ideally sampling should always be undertaken whilst the machine is operating under steady and stable conditions. This is necessary to ensure that the sample is homogeneous and that the sample will represent the total oil charge. This applies to both pump circulated systems and static systems such as oil reservoir and sumps.

Ideal sampling conditions include:

- Pumped systems; ensure that the oil is in circulation during sampling, and machine is operating under steady and stable conditions.
- Ensure that sampling line has been thoroughly flushed prior to taking the sample.
- Always use the same sampling point to ensure consistent trend history.
- Avoid selecting sampling points located in dead legs, at the bottom side of a pipeline or points where water, dirt and debris tends to accumulate as this may lead to an unrepresentative sample.
- Avoid opening and closing the sampling cock while sampling, as foreign particles unrepresentative of the system might be released into the oil.
- If during sampling there are indications of gross contamination, (e.g. cloudy oil due to water contamination), consideration should be given to draining off a quantity of oil to ensure that the sample is representative of the system oil and not just due to local settling of contaminants.

Stern tube sampling

Many Classification Societies will now accept oil analysis as the key parameter of tailshaft condition monitoring. Successful monitoring with no indications of defects will, in most cases, avoid/reduce the need for the traditional periodic drydocking and tailshaft withdrawal.

It is important to note that the intention of traditional surveys focused on corrosion, wear and other defects which can occur in a tailshaft, and also on the condition of the bearings. In general, seals are considered consumable items and are replaced either on a planned periodic basis or when failure begins to occur, and no special monitoring is generally necessary. It is therefore important that, not only is the correct sampling undertaken, but also that for the purposes of classification requirements only the bearing system is sampled, as many stern tubes today have separate lubricating oil systems for seal arrangements.

In order to ensure that sampling complies with Classification Society requirements, the following should be observed:

- Samples must be taken from the system which lubricates the stern tube bearings, and not from systems used for seal lubrication and cooling, seal leakage detection or seal pressure equalisation.
- In several of the newer stern tube arrangements lubricating oil is circulated from the main stern tube reservoir through an external cooler. In these systems the ideal sampling point is from the outlet line from the reservoir to the cooler.
- Always sample at sea under normal and stable running conditions. If in doubt please consult your local BP Marine representative who will be happy to provide advice.
- If it is necessary to evaluate the condition of seal oil this can be achieved by drawing an oil sample at the small gravity tanks located close to the tail shaft assembly. This sampling should be treated separately from stern tube monitoring, and generally will not be examined when the classification surveyor is considering survey deferral.
- In addition to the oil monitoring schedule, regular draining of oil at the lowest point is recommended, as part of the routine daily stern tube monitoring.

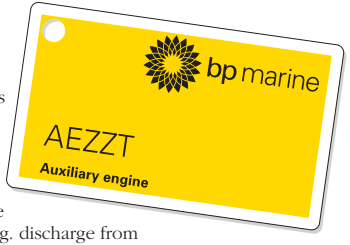
The main hazards associated with sampling stern tubes are from the close proximity of rotating propeller shafts and flanges to the sampling point. In some cases the sampling point may require access to the tank top area where slipping or falling hazards exist.

Diesel engine sampling

In the majority of cases, diesel engine system oils are monitored to assess oil condition, and whether the oil is suitable for continued use. The oil will be analysed for its key properties and for contaminants such as water, insolubles and fuel leakage.

Generally the most accessible and suitable sampling point is near the oil inlet manifold to the engine. However, if sampling is required for assessing machine condition a sample point must be selected which is close to the oil return line and always before any filters. The following points describe the minimum requirements necessary to ensure sampling which is representative of the "average" condition of the oil in circulation in a diesel engine:

- Samples should always be taken with the engine running under reasonably steady and stable load conditions. Sampling in rough weather, or just after top-up with a significant quantity of fresh oil should be avoided. Frequent and small fresh oil top-ups will avoid disturbing the oil equilibrium and distorting oil analysis results.
- The ideal sampling points are described above, however, consistent sampling from the same sampling point is the more important. Mark the sample point with an Enercare sample point tag.



If possible fit a dedicated sampling valve including a means to secure the valve when not in use.

- Whilst it is easiest to take oil samples from near the oil purifier, a sampling point before the purifier is recommended (e.g. discharge from purifier feed pump).

On smaller engines, locating a representative sampling point can be difficult. It may be possible to sample using a sampling pump through the dipstick pipe. This is not an ideal sampling point as the dipstick pipe will often extend to just above the sump bottom and therefore contain some stagnant oil. Pumping up to 0.5 litre to waste should ensure that the sampled oil is representative of the oil flowing in the system. Alternative sample points often require modifications to the pipework or piercing the engine casing. If such a sampling point is fitted, then such modifications must be correctly executed to ensure that no leakage or connection failure occur in later service.

In some cases the filter is the most convenient sampling point. Never use the filter drain as this is likely to contain unrepresentative sludge. In the case of duplex filters, first determine which filter is in use and then use the filter vent as the sampling point. Depending upon the size of the filter case, between 0.5 and 2 litres of oil should be drained off before sampling.

In general, sampling is straightforward with relatively low oil pressures and temperatures. In compact medium and high speed engines, higher lubricant oil temperatures may be encountered, (in excess of 90°C), and suitable precautions should be taken to avoid contact with the body.

- Always exercise vigilance to avoid oil spraying, splashing or dripping onto hot exhaust pipes or accumulating in pipe lagging.
- If sampling at pressure gauge lines, first determine if the line is connected to a pressure monitoring system that might shut down the engine. Similarly do not sample from pressure switch line before first ensuring that appropriate steps have been taken to establish the consequences of the pressure switch operating whilst the machine is running. Note: sampling through switch and gauge lines will extend the duration of the sampling procedure.

Thermal system sampling

Thermal oil systems operate at extremely high temperatures. The nature of the risks from sampling these systems necessitates the permanent installation of special sampling devices and special sampling procedures. For further information on sampling these systems contact your local BP Marine representative who can provide a special customer bulletin on monitoring Thermal Oil systems.

In order to ensure meaningful advice is provided from oil analysis it is vital that the sample is representative of the oil in service. Remember that the size of the sample being tested (normally 120ml) represents less than 10 parts per million (or 0.001%) of the total oil charge in a large diesel engine system.

Hydraulic system sampling

In order of descending importance, the parameters monitored for hydraulic oils should be system cleanliness, oil condition, and then system wear. System cleanliness provides an indication of the overall rate of ingress of contaminants and the effectiveness of the in-line filter system to remove contaminants. With this in mind, the location of the sampling point is not as important as the consistent use of the same sampling point for all sampling. Generally the most convenient location is in the system return line where relatively low pressures allow safe sampling without the need to fit special sampling connections.

Some major OEM's are now fitting sampling points to their hydraulic systems. In such cases always use the manufacturers designated sampling point. In cases where it is necessary to sample from non-circulating systems (hydrostatic systems), representative sampling is almost impossible. In such cases sampling from the expansion tank is sufficient.

To ensure sampling is representative for the purpose of assessing system cleanliness, it is vitally important that ingress of contaminants is minimised during the sampling process. Measures to ensure representative sampling include:

- Do not sample when the sample point is exposed to dusty, moist or windy conditions.
- Ensure system is in operation and oil flows and temperatures are steady and stable.
- Ensure that the sample point valve is wiped and thoroughly clean.
- Where sampling can only be taken from a filling point of an oil reservoir, the use of a sampling pump and clean hose is recommended.
- Flush through at least one litre of oil before sampling commences.
- Only open sample bottle when sampling is about to commence.
- Fill and shake sample bottle and drain out. Do this twice before filling with final sample.
- Seal sample bottle immediately after filling.

The very high pressures which can be encountered in hydraulic systems present a significant hazard for sampling. Great care should be taken to establish the working pressure on the sampling line prior to opening the sample valve. In cases where the line pressure is greater than 20 bar, sampling is not recommended unless suitably closed sampling connection and pressure reducing device are fitted. When sampling on the low pressure return line, precautions should be taken to avoid risks caused by fluctuations in pressure and oil flow rates.

Gearbox sampling

Typically most ships will be fitted with several gearboxes for applications as diverse as centrifuges, pumps and engine turning gear to critical items such as main engine speed reductors. In general only large and critical gear-sets are monitored.

Gearboxes are normally totally enclosed systems and quite reliable, with low risk of ingress of contaminants. Lubricant sampling for these applications is often for the purposes of monitoring system cleanliness and machinery wear, as well as lubricant condition. As samples may be used for machine condition monitoring purposes, samples should always be drawn after the oil has passed through the gears and bearings. The following advice applies to pumped and splash lubricated systems.

- For gearboxes fitted with lubricating oil circulation pumps, the sample should be taken at the pump discharge, before filters.
- For splash lubricated gearboxes, the sample may be drawn from the bottom of the sump by means of a sampling pump or from a convenient drain plug as low down in the sump as possible. Sampling should only be attempted when the gearbox is stopped, to avoid the risk of trapping the sampling pump pipe in the gears or loss of oil charge when using the drain plug. It is recommended that a permanent sampling point is installed as an alternative to drain plug sampling. Always sample immediately after stopping the gearbox to ensure that contaminants and wear particles do not have time to settle out.

The main hazard associated with sampling gearboxes is the relatively high temperature of the oil in circulation, (often higher than 90°C) and the possibility of introducing contaminants into the system.

Special circumstances

Most routine sampling is covered by the preceding sections. There may be occasions where sampling of unusual systems or for special circumstances is necessary. The first consideration should be to identify the purpose of the sampling. Is it for a technical investigation, or trouble shooting, or for a non-routine analysis?

In the case of a technical investigation, it may be important to establish a sample point close to the area under investigation. In such cases sample trending may not be important. In trouble shooting cases and cases of machinery failure, often the oil will no longer be in circulation and may rapidly become contaminated, (e.g. water leakage into the sump tank). In these cases, it is important to sample as soon as possible and to take multiple samples in case further laboratory testing is required. Often the only place available to take a sample is in the system or sump tank. Samples from about mid oil depth are probably ideal. If a sampling pump and clean sampling tube is not available then sampling by dipping a clean container into the oil is often the only alternative.

In the case of non-routine sampling or sampling unusual systems consider which aspect of the sample analysis is of primary importance. The three generic areas are oil condition, system cleanliness, and machinery wear. Machinery wear is probably most critical in terms of the optimum sampling point. Machinery wear is very much a dynamic process with indicators of wear (wear particles) being created and then filtered or settled out of the system.

Sampling must always be undertaken at a point as close to the oil outlet from the machinery bearings, gears and other rubbing and relative moving surfaces. Samples must not be taken after in-line filters.

Sampling pumps that fit onto sample containers can be made available to pump oil out of oil reservoirs, however such procedures are not recommended for routine oil analysis, as once the oil is in circulation the properties do not match those of the sample taken.

Detecta and Predict Specialist services require that samples are drawn at specific locations, usually before filters.

Determine the oil pressure and oil temperature at the sampling point and arrange to direct oil flow into a collecting vessel before opening the sampling point. Avoid body contact with used lubricant and should contact occur, wash off the oil as soon as possible.

To ensure safe sampling, wear eye protection, full body covering, (long sleeved boiler suit) and oil resistant gloves. Avoid body contact with used lubricant and should contact occur, wash off the oil as soon as possible.

Sample bottle labelling & dispatch

The key to speeding your sample through the analysis system is correct labelling. Unfortunately, far too often we receive poorly labelled samples, i.e. no IMO number, no vessel name, etc, which means that investigations must be undertaken to match the sample to the appropriate vessel. To assist in correct labelling and to speed sample reporting, BP Marine provide three things:

1. A Machinery List together with pre-printed, bar coded sample bottle labels with tear off reference slip, which clearly notes all UOA (Used Oil Analysis) sampling points. This is agreed by you and your BP Marine Representative. A copy is held at your office and an additional copy is placed on board.
2. Sample Point Tags which can be attached adjacent to the standard sampling point. These tags provide:
   - Identification of the sample point, ensuring samples are always taken from the same sampling point (very important for accurate lubricant condition trending).
   - Identification of the sample point code and location code (the unique sample point ID). The location code should be written on the sample point tag.
3. Sample Bottles with Labels which will ensure the BP Enercare laboratory have all the correct information needed to process your samples. Transferring correct information from the machinary list to the sample label will enable quicker sample reporting.

Your BP Marine Representative will be able to provide you with Sample Point Tags that match your agreed Machinery List.

Do

- Check sampling instructions on the Enercare sample pack.
- Always sample a system from the same sample point.
- Mark sample point with a BP Marine Enercare sampling point tag.
- Ensure system is under steady and stable operating conditions before sampling.
- Ensure the sample point is clean and at least 2-5 litres of oil is flushed through before sampling.
- For hydraulic systems flush sample bottles twice with sample point oil before final filling.
- Seal sample bottle immediately after sampling.
- Label sample bottle prior to sampling or immediately upon sampling.
- Dispatch samples by courier/air mail at next port using the BP Marine Enercare envelopes. Ensure agent despatches sample bottles marked as Free Domicile.

Don't

- Sample downstream of a filter or oil strainer unless there is a special reason to check filter effectiveness.
- Leave sample bottles open prior to sampling.
- Hand samples to BP Marine delivery agents. Samples should be sent in the Enercare pre-addressed envelopes to the BP Enercare laboratory.
- Sample within 24 hours of topping up a system with a significant quantity of fresh oil.

abbreviations

Used Oil Test Abbreviations

Abbreviation	Test Type	Units
BN	Base Number	mgKOH/g
IR	Infra Red	% area
NV	Neutralisation Value	mgKOH/g
SAN	Strong Acid Number	mgKOH/g
TAN	Total Acid Number	mgKOH/g

NB: 1ppm = 1mg/kg = 0.0001%

Elemental Abbreviations

Abbreviation	Element Name	Commonly Used Units
Ag	Silver	ppm
Al	Aluminium	ppm
B	Boron	ppm
Ba	Barium	ppm
Ca	Calcium	ppm
Cr	Chrome	ppm
Cu	Copper	ppm
Fe	Iron	ppm
Mg	Magnesium	ppm
Mn	Manganese	ppm
Mo	Molybdenum	ppm
Na	Sodium	ppm
Ni	Nickel	ppm
P	Phosphorus	ppm
K	Potassium	ppm
Pb	Lead	ppm
S	Sulphur	ppm
Sb	Antimony	ppm
Si	Silicon	ppm
Sn	Tin	ppm
Ti	Titanium	ppm
V	Vanadium	ppm
Zn	Zinc	ppm

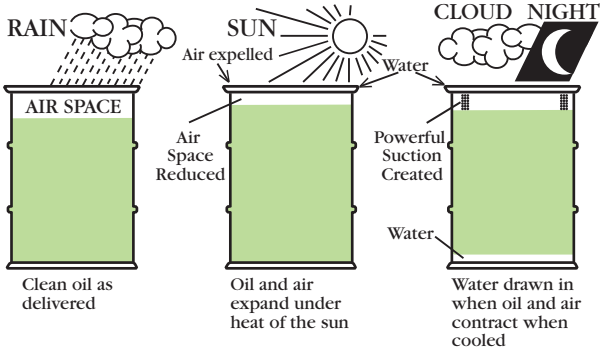
drum storage

Indoor storage of lubricants is strongly recommended because of the smaller temperature fluctuations and the protection from sea-water, rain and direct sunlight. High local temperatures, such as from steam pipes affect some products adversely. Examples of products that should always be stored indoors include refrigerator oils, white oils and greases.

Drums stored horizontally should be raised clear of the ground, on baulks of timber or on stacking frames. They can be stored three-high in this way but must be carefully wedged to prevent rolling. All too often, however, the topmost drums stacked in this way are used and soon replaced by new ones, so the lower ones remain untouched for long periods of time. Good stock rotation must be maintained to avoid this malpractice.

Ideally, horizontal drums should lie with their bungs at a level below the surface of the contents (between three and nine o'clock) to keep the bung seals moist and prevent entry of air.

All containers stored outside should be covered - but allowed free access to circulating air - and they should be checked at fixed intervals for signs of water and leakage. Drums that stand in the open suffer variations of temperature, and variations of internal pressure. If the bung seal is not tight, this can lead to "breathing", the entry of air, and the accumulation of moisture within the drum.



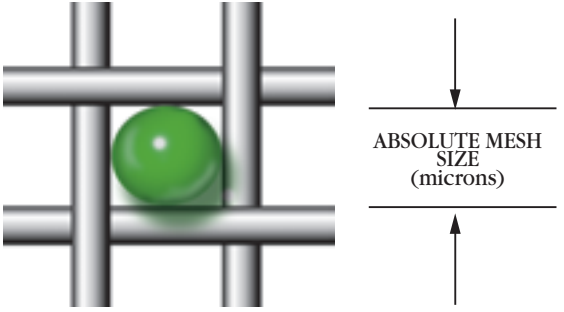
Where packaged lubricants are stored outdoors, the opening and dispensing operations should always take place under cover and the open packages should subsequently be kept under cover.

filters

Several definitions of filter fineness are in use:-

- Absolute fineness (sphere passing mesh). (See example right)
- Nominal fineness, which is a practical definition, indicating about 85-90% of the particles bigger than the nominal fineness are retained by the filters.

The nominal fineness figure is approximately 30-40% smaller than the corresponding absolute fineness figure. The removal characteristic of the surface filter is such that it removes particles bigger than the specified mesh with a high efficiency, but smaller particles with a lower efficiency.



Filter size conversion chart

Mesh (Imperial)	Absolute Mesh Size (Inches)	Absolute Mesh Size (Microns)
20	0.037	920
30	0.023	570
40	0.016	410
60	0.010	260
80	0.007	178
100	0.006	142
120	0.005	122
150	0.004	109
180	0.0035	91
300	0.002	45

filters

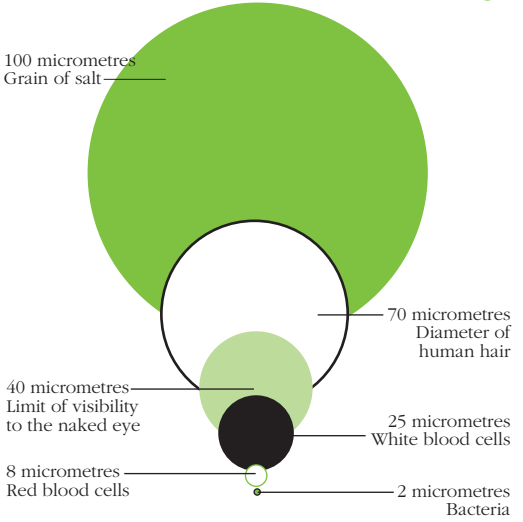
'Micro-filters' remove the smaller particles whilst larger particles are collected by 'strainers'.

For either type, the 'filter efficiency' is measured by:

$$\text{Efficiency} = \left(1 - \frac{\text{number of emergent particles}}{\text{number of impingent particles}}\right) \times 100\%$$

Type	Quality	Size (μm)
Strainer	Coarse	Above 500
	Fine	100 - 150
Standard filter	Coarse	50 - 100
	Medium	40 - 50
	Fine	20 - 40
Micro-filter	Ultra fine	10 - 20
	Micron	2 - 10
	Sub-micron	Below 1

Strainers are usually made of metal, possibly incorporating magnetic elements to assist the collection of ferrous particles suspended in the fluid.



Diagramatic indication above to show relative size in the range of typical filter meshes.

cleanliness classes

Particle count

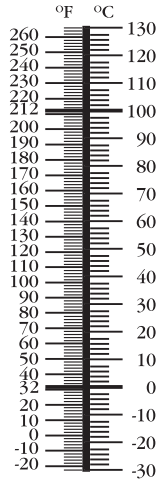
BS 5540/4 ISO/DIS 4406 Code	Def. Std 05/42 Table A	Def. Std 05/42 Table B	NAS 1638 Class	SAE 749 Class
11/8	-	-	2	-
12/9	-	-	3	0
13/10	-	-	4	1
14/9	-	400F	-	-
14/11	-	-	5	2
15/9	400	-	-	-
15/10	-	800F	-	-
15/12	-	-	6	3
16/10	800	-	-	-
16/11	-	1300F	-	-
16/13	-	-	7	4
17/11	1300	2000F	-	-

BS 5540/4 ISO/DIS 4406 Code	Def. Std 05/42 Table A	Def. Std 05/42 Table B	NAS 1638 Class	SAE 749 Class
17/14	-	-	8	5
18/12	2000	-	-	-
18/13	-	4400F	-	-
18/15	-	-	9	6
19/13	4400	6300F	-	-
19/16	-	-	10	-
20/13	6300	-	-	-
20/17	-	-	11	-
21/14	15,000	-	-	-
21/18	-	-	12	-
22/15	21,000	-	0	-
23/17	100,000	-	-	-

The above tables indicate an approximate equivalent of contamination classes.

General conversions

Temperature Conversion



SI > English		English > SI		SI Prefixes		
Millimetre (mm)	= inch x 25.4	Inch	= mm x 0.03937	1×10^{9}	G	giga
Litre (L)	= $inch^3$ x 0.016	$Inch^3$	= litre x 61	1×10^{6}	M	mega
Litre (L)	= gallon x 4.55	Gallon	= litre x 0.22	1×10^{3}	k	kilo
Gram (g)	= ounce x 28.3	Ounce	= gram x 0.035	1×10^{2}	h	hecto
Kilogram (kg)	= pound x 0.454	Pound	= kg x 2.2	10	da	deca
Kilonewton (kN)	= pound x 0.00445	Pound	= kN x 225	0.1	d	deci
Newton metre (Nm)	= lb-ft x 1.36	Lb-ft	= Nm x 0.74	1×10^{-2}	c	centi
Kilopascal (kPa)	= psi x 6.89	psi	= kPa x 0.145	1×10^{-3}	m	milli
Kilowatt (kW)	= hp x 0.746	hp	= kW x 1.34	1×10^{-6}	µ	micro
Kilowatt (kW)	= Btu/min x 0.01758	Btu	= kJ x 0.948	1×10^{-9}	n	nano
Kilojoule (kJ)	= Btu x 1.055	Btu/min	= kW x 56.869			
°Celsius (C)	(°F–32)/1.8	°Fahrenheit	= (°C x 1.8) + 32			

Equivalent viscosities

This table may be used for approximate conversion from one viscosity scale to another, **at the same temperature.** Note that Engler is typically @ 50°C.

Redwood No1 seconds	Kinematic Viscosity centistokes(cSt)	Saybolt Universal seconds	Engler degrees
33	3	36	1.23
36	4	39	1.31
38	5	42	1.40
41	6	46	1.48
44	7	49	1.57
46	8	52	1.66
49	9	56	1.75
52	10	59	1.84
55	11	63	1.93
88	12	66	2.02
61	13	70	2.12
65	14	74	2.22
68	15	78	2.33
71	16	81	2.44
75	17	85	2.55
78	18	90	2.65

Redwood No1 seconds	Kinematic Viscosity centistokes(cSt)	Saybolt Universal seconds	Engler degrees
82	19	94	2.76
86	20	98	2.88
90	21	102	2.99
93	22	107	3.11
97	23	111	3.22
101	24	115	3.34
105	25	120	3.5
125	30	142	4.12
145	35	165	4.75
165	40	188	5.4
185	45	212	6.0
205	50	234	6.7
225	55	258	7.3
246	60	282	8.0
265	65	305	8.7
288	70	330	9.4

Density

In each of the following 4 tables to convert into **desired units** multiply **given units** by factor in the intersected box.
E.g. to convert 80 kilograms per cubic metre to pounds per cubic foot, multiply by 0.06243
i.e. 80 x 0.06243 = 4.99 lb/ft³.
NB. For this and the following conversion tables the **emboldened numbers** indicate exact factors, normal numbers indicate an approximate factor.

GIVEN UNITS \ DESIRED UNITS	Kilograms per cubic metre (kg/m³)	Pounds per cubic foot (lb/ft³)	Grams per cubic centimetre (g/cm³)	Tonnes per cubic metre (t/m³)
Kilograms per cubic metre (kg/m³)	**1**	0.06243	**0.001**	**0.001**
Pounds per cubic foot (lb/ft³)	16.02	**1**	0.01602	0.01602
Grams per cubic centimetre (g/cm³)	**1000**	62.43	**1**	**1**
Tonnes per cubic metre (t/m³)	**1000**	62.43	**1**	**1**

Capacity

GIVEN UNITS \ DESIRED UNITS	Millilitre (ml)	UK Fluid Ounce (UK fl oz)	US Fluid Ounce (US fl oz)	Litre (l)	US Gallon (US gal)	UK Gallon (UK gal)	Cubic Foot (ft^3)	Barrel (bbl)	Cubic Metre (m^3)
Millilitre (ml)	**1**	0.03520	0.03381	**0.001**	2.642×10^{-4}	2.200×10^{-4}	3.531×10^{-5}	6.290×10^{-6}	**1×10^{-6}**
UK Fluid Ounce (UK fl oz)	28.41	**1**	0.9608	0.02841	0.007506	0.006250	0.001003	1.787×10^{-4}	2.841×10^{-5}
US Fluid Ounce (US fl oz)	29.57	1.041	**1**	0.02957	0.007812	0.006505	0.001044	1.860×10^{-4}	2.957×10^{-5}
Litre (l)	**1000**	35.20	**33.81**	**1**	0.2642	0.2200	0.03531	0.006290	**0.001**
US Gallon (US gal)	3785	133.2	128.0	3.785	**1**	0.8327	0.1337	0.02381	0.003785
UK Gallon (UK gal)	4546	160.0	153.7	4.546	1.201	**1**	0.1605	0.02859	0.004546
Cubic Foot (ft^3)	28317	996.6	957.5	28.32	7.481	6.229	**1**	0.1781	0.02832
Barrel (bbl)	158 987	5596	5376	159.0	**42**	34.97	5.615	**1**	0.1590
Cubic Metre (m^3)	**1×10^6**	35195	33814	**1000**	264.2	220.0	35.31	6.290	**1**

Pressure

GIVEN UNITS \ DESIRED UNITS	Pounds per square inch (psi)	Pounds per square foot	Inches head of water	Feet head of water	Metres head of water	Kilograms per square centimetre (kg/cm^2)	Kilograms per square metre (kg/m^2)	Standard Atmosphere	Pascal
Pounds per square inch (psi)	**1**	144	27.6804	2.3067	0.70309	0.070307	703.07	0.068046	6894.74
Pounds per square foot	0.006944	**1**	0.1922	0.01602	0.00488	4.88×10^{-3}	4.88243	4.73×10^{-4}	47.88
Inches head of water	0.036127	5.202	**1**	0.08333	0.0254	0.00254	25.4	2.458×10^{-3}	249.09
Feet head of water	0.43352	62.428	12	**1**	0.3048	0.03048	304.8	0.0295	2989.07
Metres head of water	1.4223	204.817	39.37	3.281	**1**	**0.1**	1000	0.09678	9806.65
Kilograms per square centimetre (kg/cm^2)	14.2233	2048.17	393.7	32.81	10.00028	**1**	10000	0.96784	98066.5
Kilograms per square metre (kg/m^2)	0.001422	0.204816	0.03937	0.003281	0.001	0.0001	**1**	0.97×10^{-4}	9.80665
Standard Atmosphere	14.696	69968.1	406.78	33.9	10.33	1.0332	10332.27	**1**	101325
Pascal	0.000145	0.020886	0.004015	0.000335	0.000102	0.00001	0.101972	0.00001	**1**

Energy

GIVEN UNITS \ DESIRED UNITS	British thermal unit (Btu)	Kilocalorie (Kcal)	Megajoule (MJ)	Horsepower hour (hp h)	Kilowatt hour (kWh)	Therm (therm)
British thermal unit (Btu)	**1**	0.2520	0.001055	3.930×10^{-4}	2.931×10^{-4}	**1×10^{-5}**
Kilocalorie (Kcal)	3.968	**1**	**0.004184**	0.001560	**0.001163**	3.968×10^{-5}
Megajoule (MJ)	948.45	239	**1**	0.3725	0.2778	0.009478
Horsepower hour (hp h)	2546	641.2	2.685	**1**	0.7457	0.02544
Kilowatt hour (kWh)	3414	860.4	**3.6**	1.341	**1**	0.03412
Therm (therm)	**100061.6**	25215	105.5	39.30	29.31	**1**

common terms

Abrasive Particulates
For fuels, generally refers to catalyst fines which may be present, but can also refer to other abrasive particles such as rust etc.

Acid Number
A measure of the amount of KOH needed to neutralise all or part of the acidity of a petroleum product. Sometimes referred to as Neutralisation Value. For hydraulic and turbine oils the term “neutralisation value” has traditionally been used to describe total acidity. While in strict analytical terms “neutralisation value” refers to a specific test method, for practical purposes in oil condition monitoring total acid numbers and neutralisation values can be regarded as being comparable.

Afloat
Cargoes on board vessel en route to destination.

ARA
Antwerp/Rotterdam/Amsterdam

Arbitration
Out of court settlement of points of legal dispute by one or more professional person appointed by the two parties.

Ash
Metallic compounds formed when a fuel or lube is burned. More precisely, a measure of the incombustible part of the fuel which remains after the total combustion of a sample of the fuel in air, under prescribed conditions. Primarily, ash comprises metallic oxides and sulphates free from carbonaceous matter.

Asphaltenes
A generic name for complex structures of high molecular weight and very high carbon/hydrogen ratio, with associated sulphur, oxygen, nitrogen and metals, found in residual fuel oil. Used in an analytical sense, asphaltenes are a specific group of asphaltic structures defined as the wax free material insoluble in heptane but soluble in hot toluene.

Azeotropic
Is a blend that behaves essentially like a pure fluid. The composition, however varies with temperature and pressure.

Ballast
A term to describe a vessel sailing without cargo, but taking water into her tanks to give stability.

Base Number [formerly known as Total Base Number (TBN)]
The amount of acid (perchloric or hydrochloric) needed to neutralise all or part of a lubricant's basicity, expressed as KOH equivalents. It measures the ability of a lubricant to neutralise acids. High BN lubricants are necessary when high sulphur fuels are burnt.

BENDS
Short for "both ends". Used when any loading and discharging term for a vessel is the same for both loading and discharging: e.g. 4,000 mt per WWD SHINC BENDS.

Bill of Lading (B/L)
A receipt for goods shipped on board a vessel - signed by master or his agent; subsequent possession of this document gives the ownership of the cargo described to the holder.

Blow-by
Passage of unburned fuel and combustion gases past the piston rings of internal combustion engines, resulting in fuel dilution and contamination of the crankcase oil.

BN
Base Number (see above).

Boundary Lubrication
Form of lubrication between two rubbing surfaces without development of a full-fluid lubricating film. Boundary lubrication can be made more effective by including additives in the lubricating oil that provide a stronger oil film, thus preventing excessive friction and possible scoring. There are varying degrees of boundary lubrication, depending on the severity of service. For mild conditions, oiliness agents may be used; by plating out on metal surfaces in a thin but durable film, oiliness agents prevent scoring under some conditions that are too severe for a straight mineral oil. Compounded oils, which are formulated with polar fatty oils, are sometimes used for this purpose. Anti-wear additives are commonly used in more severe boundary lubrication applications. The more severe cases of boundary lubrication are defined as extreme pressure conditions; they are met with lubricants containing EP additives that prevent sliding surfaces from fusing together at high local temperatures and pressures.

Bubble Point
Lowest temperature in a glide.

Bunker
Noun - Fuel for use in ships.
Verb - To deliver or receive fuel or lubricant for a ship.

common terms

Bunker 'C'
An American term which refers to the highest viscosity and density product available in any particular port; is usually used in connection with steam ship bunkers.
NB Bunker 'C' has no actual or legal definition of its properties and is seldom referred to for purchasing fuels.

Calorific Value - (Specific Energy)
The amount of heat liberated by the combustion of unit quantity of a substance under specified conditions. The gross calorific value (or higher specific energy) is the sum of the heat produced by the total combustion of the substance and the heat released by the condensation of the water vapour formed by such combustion. The net calorific value (or lower specific energy) is the gross value minus the heat released by the condensation of the water vapour formed by the combustion. Energy content can be determined in a combustion 'bomb' but is more normally calculated using various empirical formulae.

Capesize
A vessel of about 120,000 dwt.

Carbon Residue
A measure of a fuel's tendency to form a carbonaceous deposit after intense heating in an oxygen deficient atmosphere. Carbon residue was recognised as a property which defined the total amount of material present that burnt relatively slowly and could therefore give rise to carbonaceous deposits in boilers and diesel engines.

Catalyst
A substance which alters the rate at which a chemical reaction occurs, without itself undergoing any permanent chemical change.

Catalyst Fines
Small particles of the silicon/aluminium catalyst used in refining processes.

Catalytic Cracking
The process whereby heavy hydrocarbon molecules are broken down (cracked) into lighter molecules by passing them over a suitable catalyst (generally heated and under high pressure).

CCAI
Calculated Carbon Aromaticity Index - a number, calculated from an empirical formula, indicating the ignition quality of a residual fuel. Only the fuel's density and viscosity are required. The formula was derived by Shell Research. The higher the CCAI value, the worse the ignition quality.

CIF
Cost, Insurance & Freight (in full is price charged). The term refers to a sale in which it is the seller's duty to deliver the cargo on board vessel, to procure contracts of affreightment and insurance for benefit of Buyer and to direct vessel to named discharge port. Risk passes as cargo passes the vessel's rail at discharge port and property passes as documents pass. Buyer must provide a berth at discharge port and may be liable for demurrage if vessel is delayed.

CII
Calculated Ignition Index - a number, calculated from an empirical formula indicating the ignition quality of a residual fuel. Only the fuel's density and viscosity are required. The original formula was derived by BP Research. The higher the CII value, the better the ignition quality. CII is analogous to Cetane Number or Cetane Index for distillate diesel fuels.

C&F
Cost and freight. A C&F price includes the cost of the cargo and the freight.

Cloud Point
The temperature at which the formation of visible wax crystals occurs in a clear distillate fuel. It is an indicator of the suitability of the fuel for use at low temperatures, in unheated fuel systems incorporating fine mesh or paper filters which could become blocked by wax crystals.

Corrosive Wear
Wear caused by chemical reaction between acids formed in combustion with metal surfaces.

Cracked Distillates
Distillates derived from fractionation following secondary processing (thermal cracking or fluid cracking) of heavy distillates or residues. Terms such as light and heavy visbroken gas oil, light and heavy catalytically cracked gas oils, and cycle oils, are used to describe different distillate fractions from these processes.

Cracked Fuel Oil
Usually refers to thermal cracking but more recently a specific type of thermal cracking termed 'visbreaking'. Cracked fuel oil can also embrace residue hydrocracking which comprises thermal cracking plus hydrogenation.

Cracking
The process of converting a heavy hydrocarbon (e.g. residual fuel oil) to a lighter fraction (e.g. gas oil and motor gasoline components).

Demulsibility
A measure of a fluid's ability to separate from water.

Density
Mass per unit volume.

common terms

Detergent
A substance added to fuel or lubricant to keep engine parts clean. In motor oil formulations, the most commonly used detergents are metallic soaps with a reserve of basicity to neutralise acids formed during combustion.

Dew Point
Highest temperature in a glide.

Diesters
A class of chemicals used as a base stock for synthetic lubricants. Pour points range from -50 to -65°C. Advantages include good thermal stability, tendency to dissolve varnish or sludge rather than leave deposits. In fact, diesters can remove deposits formed by other lubricants.

DWT
Deadweight tons. The weight which a vessel is capable of carrying by way of cargo, plus bunkers, stores and fresh water, when loading to maximum permitted marks. This is measured in tons of 2240 lbs.

Demurrage
An agreed daily amount of money payable to the owner by charterer as a penalty if vessel takes more than the lay time for loading or discharging.

Despatch
The opposite of demurrage, an amount payable by owner to charterer for loading or discharging a vessel more quickly than the laytime. Traditionally half the demurrage rate.

Draught
The depth to which a floating vessel is submerged. When a figure is quoted in a vessel's description this refers to her being fully loaded including stores and water.

Elasto-hydrodynamic Lubrication
In rolling element bearings, the elastic deformation of the bearing (flattening) as it rolls, under load, in the bearing race. This momentary flattening improves the hydrodynamic lubrication properties by converting point or line contact to surface-to-surface contact.

ETA
Estimated time of arrival.

ETD
Estimated time of departure.

ETR
Estimated time of readiness.

ETS
Estimated time of sailing.

Ferrography
An analytical method of assessing machine health by quantifying and examining ferrous wear particles suspended in the lubricant or hydraulic fluid. Analytical ferrography is the magnetic precipitation and subsequent analysis of wear debris from a fluid sample. This approach involves passing a volume of fluid over a chemically treated microscope slide which is supported over a magnetic field. Permanent magnets are arranged in such a way as to create a varying field strength over the length of the substrate. This varying strength causes wear debris to precipitate in a distribution with respect to size and mass over the Ferrogram. Once rinsed and fixed to the substrate, this debris deposit serves as an excellent media for optical analysis of the composite wear particulates.

Fire point
The temperature to which a combustible liquid must be heated so that the released vapour will burn continuously when ignited under specified conditions.

Flash point
The temperature to which a combustible liquid must be heated to give off sufficient vapour to form momentarily a flammable mixture with air when a small flame is applied under specified conditions.

FAS
Free alongside.

FOB
Free on board. An FOB price does not include insurance and freight.

FOC
Free of charge.

Force Majeure
Circumstances beyond reasonable control.

Fuel Oil
A product blended from residue and distillate components derived from a variety of refining processes. Chemically, fuel oils are highly complex colloidal structures of heavy asphaltic compounds dispersed in an oil phase.

FZG
A method for determining the load carrying ability of lubricants. Calibrated spur gears are operated at fixed speed and controlled initial oil temperatures for 15 minute stages. The load on the gear teeth is increased after each stage. Performance is judged by the number of stages run up to a defined weight loss of the test gears or visual assessment of damage to tooth flanks. Maximum number of stages is 12. Reported value is normally the load stage at which the gear test is deemed to have failed.

common terms

Gas Oil
A wholly distillate product comprising 'middle' distillates within the boiling range of approximately 180 to 370°C, and which is clear and bright.

Gearless
The vessel has little or no means aboard for loading and discharging cargo.

Gravity
In petroleum products only, the mass/volume relationship expressed as:-

$$\text{Specific Gravity} = \frac{\text{Mass/unit volume product @ 60°F}}{\text{Mass/unit volume water @ 60°F}}$$

$$\text{API Gravity} = \frac{141.5}{\text{Specific Gravity @ 60°F/ 60°F}} - 131.5$$

Handysize
A vessel of about 35,000 dwt.

Hydrodynamic Lubrication
A system of lubrication in which the shape and relative motion of the sliding surfaces causes the formation of a fluid film having sufficient pressure to separate the surfaces.

Hydrofining
A fixed-bed catalytic process to desulphurise and hydrogenate a wide range of feed stocks from gases to waxes. Normally used in a refinery to desulphurise middle distillates.

Ignition Quality
The property that defines a fuel's ability to initiate combustion when injected into hot compressed air. For distillate fuels this property is defined by Cetane Number (obtained by direct measurement in a diesel engine) or by Diesel or Cetane Index derived empirically from other properties linked to the fuels chemical composition. No standard test exists for heavy fuel oils, but both BP and Shell have developed engine tests and empirical formulae for assessing ignition quality, refer CCAI and CII.

Insolubles
Contaminants found in used oils due to soot, wear particles, asphaltenes, residual fuel contamination or oxidation products. Often measured as heptane, pentane or toluene insolubles to differentiate the different sources. Heptane insolubles are very similar to pentane. For used lubricating oils the heptane insolubles measures the total amount of contaminant. Toluene insolubles measures the soot and wear particle portion. The difference between heptane and toluene insolubles is sometimes designated as products of oxidation (resins) or asphaltenes which are all fuels and combustion related.

ISO8217
The international standard - 'Petroleum products - Fuels (class F) - Specification for marine fuels. Defines a range of fuel grades which meet the requirements for marine fuels supplied on a world wide basis for consumption onboard ships. The standard sets out the required properties of the fuels at the time and place of custody transfer. The current version of the standard was published in 1996.

Knot
Measure of speed, one knot being one nautical mile of 6,080 feet traversed in one hour.

Laid up
A vessel being moored through lack of employment usually without full crew and with engine sealed.

Laydays
A specific period in days during which the ship must arrive and be ready for loading.

Laytime
The time available for loading or discharging a vessel's cargo without incurring demurrage.

LOA
Length overall.

LWT
Lightweight tons. This is the weight of steel in a ship and is usually given when a ship is sold for scrap when the price is given in dollars per lightweight ton.

Marine Diesel Oil - (MDO)
A low viscosity fuel, which can vary from gas oil to a blend of residue and gas oil and where the colour can vary from 'clear and bright' to black depending on the grade.

Multigrade Oil
Engine or gear oil that meets the requirements of more than one SAE viscosity grade classification, and that can be used over a wider temperature range than a single grade oil.

Near Azeotropic
Blends comprising multiple components of different volatility that, when used in the refrigeration cycle, change volumetric composition at different temperatures. Temperature Glide less than 6°C.

common terms

Nitration
The process whereby nitrogen oxides (which are formed in combustion process) react with petroleum fluids at high temperatures, often resulting in viscosity increase and deposit formation.

NOR
Notice of readiness. This is tendered by vessel to the receiver's agent (usually in office hours) to indicate that it is ready to load or discharge. The time of tender is the start of turn time.

Neutralisation Number
See Acid Number.

OBO
Ore/bulk/oil carrier.

Oxidation
Occurs when oxygen react with petroleum fluids. The process is accelerated by heat, light, metal catalysts and the presence of water, acids or solid contaminants. It leads to increased viscosity and deposit formation.

Panamax
A vessel of about 65,000 dwt.

Paraffinic
A type of hydrocarbon containing a high proportion of straight chain saturated hydrocarbons. Often susceptible to cold flow problems.

Polyalphaolefins (PAO)
A class of chemicals used as a base stock for synthetic lubricants. PAOs are the most widely used basestock for synthetic lubricant, and contain no sulphur, phosphorus or metals. They are wax free and hence have low pour point characteristics.

Polyolesters
A class of chemicals used as a base stock for synthetic lubricants. These are like diesters and contain no sulphur, phosphorus or wax. They have very low pour points and viscosity index ranges from 120 to 160.

Polyalkylene glycols (PAG)
A class of chemicals used as a base stock for synthetic lubricants. PAGs have good high temperature stability and high viscosity indexes and can be used over a wide range of temperatures. They exhibit low deposit formation and tend to solublise their decomposition products.

Pour Point
Is defined as 3°C above the complete solidification temperature, the temperature at which sufficient wax is out of solution in a fuel to cause it to solidify. Pour point is an important characteristic for the handling and transfer of fuel. Mainly related to crude oil source but can be influenced by the refining process, components of fuel and/or the use of additives.

Relative Density
The ratio of the mass of a given volume of liquid at a stated temperature to the mass of an equal volume of pure water at another stated temperature. Both temperatures should be reported when stating relative density. Relative density decreases with increase of temperature and vice versa. It can only be compared one with another at the same temperatures. The standard temperature for quoting the relative density for most petroleum products is 15°C.

Running Days
Days of 24 consecutive hours including holidays, Saturdays, Sundays, unless excepted, i.e. a vessel is told she will be loaded in 4 running days, whether or not she is worked upon; alternative is say 4 WWD SHEX - 4 weather (permitting) working days, Sundays and holidays excepted.

Rust Preventative
Compound for coating metal surfaces with a film that protects against rust. Commonly used to preserve equipment in storage.

SATSHEX
Saturdays, Sundays, holidays excluded.

Sediment
The measure of all material in a fuel which may separate from it. Sediment may be from inorganic material (rust, debris etc.), water or unstable hydrocarbons. The presence of sediment may give rise to fuel handling difficulties. Normally determined by using test technique employing filtration or centrifuging. The value measured is very dependent on the specific test method used.

Sediment - Existent, Potential & Accelerated
Total sediment existent (TSE), is a measure of the amount of sediment (according to the specified test method) in a sample of fuel as received. It is an indicator as to whether a fuel can be handled and pre-treated successfully onboard a ship.
Total sediment potential (TSP), is a measure of the amount of sediment (according to the specified test method) after the fuel sample has been heated and stored for 24 hours at 100°C, to replicate thermal ageing which may occur in shipboard fuel systems. It is an indicator as to whether a fuel can be handled and pre-treated successfully onboard a ship.
Total sediment accelerated (TSA) is similar to TSP, but replaces the thermal ageing step with a chemical-ageing step, in order to shorten the test period.

common terms

SF
Stowage factor. Used to determine whether a vessel's holds will be filled before the vessel reaches her maximum draught. A vessel's maximum cargo is determined by dividing the vessel's cubic capacity by the cargo's SF. It may be expressed as m^3/mt.

SHEX
Sundays and holidays excluded. This term usually follows a loading or discharging per day figure.

SHINC
Sundays and holidays included.

Spot
Term for a ship available to charter in the immediate vicinity of a charterer's requirement for tonnage and similarly for a cargo immediately available. Also for fuel or lube sales on one-off basis, not subject to a term contract.

Stevedore
The contractor who employs labourers to load/discharge vessels. These labourers are often wrongly called stevedores.

Suezmax
A vessel of about 120,000 to 200,000 dwt.

Temperature Glide
Occurs when the refrigerants in a blend at a given pressure change state at different temperatures. That is, when a refrigerant consisting of different components boils at different temperatures, the temperature glide is an indication of the difference between the boiling points.

TBN
Total Base Number, an obsolete term now replaced by 'Base Number',see p.47

Thermal Cracking
A process in which the chemical structure of petroleum fraction is modified by the application of very high temperatures under pressure.

Timecharter
Charter arranged for a fixed period. Payment is either per day or per dead-weight ton per month, but it excludes voyage costs. The charterer has the use of the vessel with the shipowner supplying the crew and provisions.

Trimmed
The trimming of a dry bulk cargo is when it is levelled off after loading.

Trip Timecharter
Charter arranged for a single voyage, often with destination loosely described, e.g. Spanish Mediterranean, but delivery point specified, e.g. Gibraltar Payment calculated per timecharter.

TT
Turn time. Quoted in hours, being the time between the tendering of notice of readiness (NOR) and laytime commencing.

ULCC
Ultra large crude carrier. Generally means crude oil tanker of 350,000 dwt or above.

UOA
Used oil analysis.

VLCC
Very large crude carrier. Crude oil tankers of about 175,000 dwt up to 350,000 dwt.

Viscosity
The measure of a fluid's resistance to motion or flow. Viscosity increases as temperature decreases. When discussing viscosity the reference temperature must always be quoted.
There are two measures for viscosity:

- Kinematic viscosity - a measure of the resistance to gravity flow of a liquid, the pressure head being proportional to its density. It is expressed in centistokes - cSt, or more correctly in the identical units of mm^2/s

Viscosity (cont.)

- Dynamic viscosity - the ratio between the applied shear stress and the rate of shear, is the measure of the resistance to flow of a liquid.
  It is expressed as the centipoise - cP
  The viscosity of marine fuels is generally quoted in cSt, e.g.:-
  IF180 = 180cSt max. @ 50°C (approximately 21.8cSt @ 100°C)
  RMF25 = 25cSt max. @ 100°C (approximately 225 cSt @ 50°C)

Viscosity Index (VI)
Relationship of viscosity to temperature of a fluid. High viscosity index fluids tend to display less change in viscosity with temperature than low viscosity index fluids.

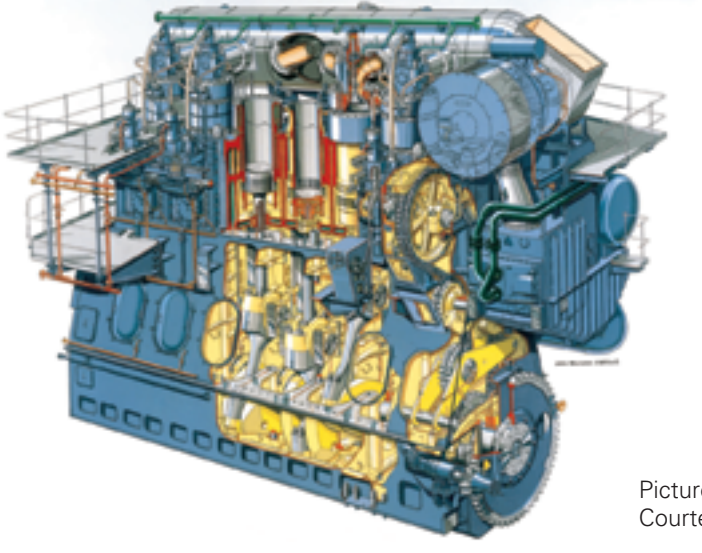
Volatile
When a mixture of hydrocarbons is heated to a certain temperature a portion of the mixture will boil or evaporate off. The constituents that boil-off are termed volatile, those that remain non-volitile.

Voyage Charter
Charter arranged for a single voyage with agreed loading and discharging ports. Payment is per metric ton of cargo loaded and includes all voyage costs.

common terms

WWD
Weather working days. This is usually qualified by SHEX or SHINC and means the exclusion of time lost through bad weather.

Zeotropic
Blends comprising multiple components of different volatility that, when used in the refrigeration cycle, change volumetric composition and saturation temperatures as they evaporate or condense at constant pressure. Temperature Glide greater than 6°C.



Picture of 6L60MC Engine
Courtesy of Man B+W Diesel A/S, Copenhagen/Denmark

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BP Marine Ltd
Building D
Chertsey Road
Sunbury on Thames
Middlesex TW16 7LN
United Kingdom

Tel: +44 (0) 1932 774560
Fax: +44 (0) 1932 739438

www.bpmarine.com

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