Hydrocarbon management

HM 50

Guidelines for the cleaning of tanks and lines for marine tank vessels carrying petroleum and refined products

2nd edition

HYDROCARBON MANAGEMENT

HM 50 GUIDELINES FOR THE CLEANING OF TANKS AND LINES FOR MARINE TANK VESSELS CARRYING PETROLEUM AND REFINED PRODUCTS

2nd edition

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FOREWORD

The Energy Institute (EI) Hydrocarbon Management Committee is responsible for the production and maintenance of standards and guidelines covering various aspects of static and dynamic measurement of petroleum. The Hydrocarbon Management Subcommittee 4B (HMC-4B) deals primarily with the measurement and loss of crude oil and oil products, focusing in particular on transport in the marine environment.

HMC-4B is made up of experts from the oil industry, cargo inspectors, ship owners and representatives from marine terminals. It is a truly international panel with representatives from most Western European countries, the Middle East, Far East and North and South America. Equipment manufacturers and experts with specific knowledge of measurement techniques are regularly invited to present papers to the committee.

The EI maintains liaison with parallel working groups of the American Petroleum Institute's Committee on Petroleum Measurement, and other organisations concerned with quantitative measurement in other countries and in other industries. The API are permanent invitees to meetings of the HMC-4B committee.

The EI Hydrocarbon Management guidelines (formerly petroleum measurement manual and petroleum measurement papers) are widely used by the petroleum industry and have received recognition in many countries by consumers and the authorities. In order to promote their wide adoption internationally, it is the policy to submit selected standards via the British Standards Institution to the International Standards Organization's technical committee TC-28 Petroleum Products and Lubricants, as potential International Standards.

A full list of Hydrocarbon Management guidelines is available on request from the EI.

The EI Hydrocarbon Management guidelines are recommended for general adoption but should be read and interpreted in conjunction with safety, environmental, weights and measures, customs and excise and other regulations in force in the particular country in which they are to be applied. Such regulatory requirements have precedence over corresponding clauses in the EI document except where the requirements of the latter are more rigorous, when its use is recommended. Users should also consider contractual constraints imposed by charterers, cargo owners, ship owners and any other interested party.

Although it is believed that adoption of the recommendations of this guideline will assist the user, the EI cannot accept any responsibility, of whatsoever kind, for damage or alleged damage arising or otherwise occurring on vessels or in or about premises where this document has been applied, as final responsibility for adequate preparation of the vessel to receive a cargo lies with the parties controlling this task.

Users of these guidelines are invited to send comments, suggestions, or details of relevant experience:
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Aviation Fuel Management issues have been reviewed by the Joint Inspection Group (JIG) Product Quality Committee.

The guidelines were compiled by Melverley Consultants Limited.

1 INTRODUCTION AND SCOPE

This publication has been compiled with the aim of sharing the experiences of oil companies and other bodies represented on the HMC-4B with other branches of the oil industry, by providing guidance with regard to cleaning and washing of tanks on board petroleum tank vessels, particularly when carrying refined products and changing from one product to another.

This document addresses issues relating to most classes of refined product but does not cover chemicals or gases.

Guidelines for crude oil washing are contained in HM40 *Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being transported by sea*, latest edition, published by the Energy Institute.

Instructions regarding washing are normally issued by the charterers or vessel owners either in the form of a specific instruction or a general tank cleaning guideline provided on board. This publication is intended to provide additional guidance to those involved with issuing such instructions and to other parties who may be involved in confirming that suitable procedures have been followed.

This publication has been prepared primarily with the aim of maintaining product quality through the use of minimum effective economic procedures. Safety and environmental issues are paramount in the operations described and for detailed guidance on these issues the latest revisions of ISGOTT, MARPOL and SOLAS regulations should be referred to and will take precedence over any recommendations made here.

2 TANK CLEANING GUIDELINES

2.1 GENERAL INFORMATION

2.1.1 Introduction and cleanliness standards

Tank cleaning is carried out to:

– Prepare tanks for the carriage of the next cargo.
– Prevent the build-up of oily residues.
– Facilitate gas-freeing and tank entry for repairs/tank mopping.
– Comply with charter party requirements.
– Comply with MARPOL regulations.
– In extreme circumstances, prepare tanks for the carriage of clean ballast.

It can be accomplished by means of portable or fixed tank washing machines, or sometimes a combination of both using hot, cold, fresh or sea water and/or chemical detergents singly or in combination.

In order to reduce unnecessary bunker consumption, impact on the environment and associated costs, vessels should only tank clean when necessary. Also, introducing water into the cargo system is not always the best action as it can increase contamination if tanks and lines are not properly cleared.

Cargo tanks should be cleaned to the standard necessary to meet the requirements for the next cargo or, where applicable, for clean ballast or for tank-entry and repairs. The tank cleaning Table 4 is to be used as a guide to the degree of cleaning necessary between cargoes.

Depending on the intended use of the product concerned, the standard of cleanliness required by some charterers/receivers may be different from that found within these guidelines. It is therefore extremely important to ensure that cleaning instructions are provided in writing.

In crude oil carriers and black oil product carriers, periodic washing should be carried out to control sediment build-up. On crude oil ships this sediment control is achieved by crude oil washing some or all cargo tanks during cargo discharges as specified by MARPOL or more frequently depending on the cargo characteristics.

2.1.2 Inert gas

The inert gas system, where fitted, should be operated appropriately during tank washing, gas-freeing and tank preparation operations. Additional safety precautions should be taken for vessels which do not have inert gas systems, although the tank washing recommendations provided in this document still apply. Safety recommendations contained in ISGOTT should be followed and in particular section 11.3.5.2 for non-inert washing.

Prior to commencement of tank washing, and at maximum intervals of one hour, the oxygen level within each tank being washed should be verified as less than 8 % by volume at one metre below deck and at 50 % tank depth.

Should the oxygen content exceed 8 % by volume at any time, tank washing should cease and the tank should be purged before washing may continue.

In the event that vessels are gas-free for inspection, loading should not commence until all tanks have been re-inerted to below 8 % oxygen. Loading should never commence into tanks which do not contain inert gas.

Note 1: Inert gas systems and scrubbers which are not operated correctly or are poorly maintained can result in cargo contamination with soot, SO_2 or SO_3 . For aviation jet fuel cargo this can lead to filtration issues and reduce the effectiveness of static dissipators.

Note 2: Guidance on the design, operation and maintenance of inert gas systems can be found in American Bureau of Shipping documents Pub 131 *Guide for inert gas system for ballast tanks* and Pub 24 *Guidance manual for material selection and inspection of inert gas systems.* At the time of publication these could be downloaded from www.eagle.org.

2.1.3 Static electricity

Precautions to prevent static discharge during washing operations should be followed at all times. These are detailed in ISGOTT.

Particularly hazardous conditions may exist when washing under non-inert conditions or when using hot water wash which can increase the temperature of cargo residues closer to their flash point.

2.2 BOTTOM AND LINE FLUSHING

2.2.1 General

It may be acceptable to flush the tank bottoms with the next grade to be loaded as an alternative to washing. This flushing medium is normally then discharged ashore or segregated on board. Discharges to shore can only take place after discussion with all parties involved. There will be costs associated with this procedure (in particular the flushing medium) and all parties will also need to agree these costs and how they are to be met.

Flushing pumps and lines using water can only be considered when suitable reception facilities are available ashore or where washings can be pumped to a suitable slops tank. On completion, all lines and pumps should be well drained, but the practice of draining to the pump room bilge should be avoided

2.2.2 Fuel oil cargoes

When changing from heavy to light grades, or from low to high sulfur, it may be possible, under certain circumstances, to reduce the tank preparation procedures. Tanks which are to receive the lighter grade should be very well drained, with a minimum ROB quantity.

Provided that any contamination would not significantly alter the quality of the cargo to be loaded, then load on top may be possible. However, this matter should always be clarified with all interested parties and the cargo owners, the necessary calculations undertaken to check the effect on the quality of the subsequent cargo, and preparation procedures received in writing from the installation representative and/or cargo inspectors. Where uncertainty exists, the tank washing guidelines should be followed.

When loading vacuum gas oil/waxy distillate or other feedstock products, it will be necessary to 'fresh water rinse' any tank which has previously contained salt water ballast or has been cleaned using salt water (see Table 3).

2.3 ELIMINATION OF WATER FOR CRITICAL CARGOES

When it is necessary to mop tanks dry for critical cargoes such as aviation kerosene or lubricating oil, care should be taken to achieve a compatible standard of preparation throughout that portion of the cargo system allocated to the critical product. The following procedures should be followed:

The cargo lines which are to load and discharge the critical product should be opened and drained dry. This includes manifolds, drop line, pump discharge lines and tank suction lines.

Cargo pumps and their associated air vessels, strainers and bypasses should be opened and drained dry. This is to include any vacuum breakers.

Individual tank suction valves should be opened and remain open during the mopping process. Valve inspection covers should be opened as necessary.

Where fitted, fixed eductor systems should be blown through with air, valves opened and lines left to drain into the tank prior to mopping.

Fixed tank washing lines should be drained, and any water in the leg between the main line and the machine allowed to drain into the tank via the machine prior to mopping.

After draining, the fixed tank cleaning machines should be positively isolated from the supply line by blanking or other secure means.

Any list placed on the vessel to assist in draining and mopping should be removed before the tank is finally inspected. This will allow any water which may have collected on upper stringers/stiffeners, etc, to drain down.

Particular attention should be paid to the inert gas deck seal overboard line. It should be ascertained that this line is free from blockage and that there are no valves partially or fully closed. Any substantial increase in the deck seal water level will cause 'carry over' and introduce water back into the tank during re-inerting.

As a general rule when loading, the product should be directed initially into a single tank using as many lines as possible. This will ensure that any water trapped in the system will be flushed through to this single tank. The water is then much easier to deal with at the discharge port if necessary. However, this procedure should be verified with the charterers.

2.4 DISPOSAL OF RESIDUES

2.4.1 Cargo residues

Tank-washings and oily-ballast residues remaining on crude oil and black oil carriers should be retained on board. Crude oil carriers should load cargo on top of these residues, unless otherwise instructed by the company or a charterer. Black oil carriers should discharge the residues to shore reception facilities, when they are available, otherwise they should retain them on board, segregated from the cargo until such times as it is possible to either load on top or discharge to a shore facility.

Residues on white oil carriers can be dealt with in compliance with the MARPOL 73/78 Regulations to reduce the quantity of residues on board. When shore reception facilities are available at the loading port, residues should be discharged to the facilities. If they are not available, residues should be retained on board, segregated from the cargo.

2.4.2 Tank washing residues

Scale and solid residues on the horizontal surfaces within a tank can contain volatile liquids and generate gas when disturbed. On crude oil carriers the build-up of sludge deposits can be controlled by effective crude oil washing. On other ships, routine water washing can be used. When sludge has to be physically removed from tanks, it shall not be disposed of overboard at sea but should be bagged and landed to shore reception facilities. In coated tanks scale should be minimal, unless significant coating breakdown occurs.

2.4.3 Engine room residues

These are generally the by-product of engine room separators/purifiers and are normally stored in holding tanks within the engine room. Periodically it is necessary to empty these tanks, particularly on those vessels not equipped with the facility to burn such products.

If shore reception facilities are not available, on black/crude oil vessels it is acceptable to discharge this residue to the cargo slop tanks where it may be subsequently discharged to shore or have cargo 'loaded on top', where voyage orders allow. On white oil vessels, this residue should not be discharged to tanks which may subsequently be loaded with clean oils, as the residues may affect the quality of the loaded cargo. It would however be acceptable to discharge the residue to the slop holding tank where fitted, provided this tank can be washed during subsequent discharge of these slops to shore facilities.

Note: Not all shore reception facilities will accept engine room residues due to their chemical content and these may have to be stored in segregated slop tanks until arrival at a suitable port.

Whenever residues are transferred from the engine room to the cargo system, such transfers should be recorded in accordance with MARPOL regulations, in both machinery and cargo oil record books.

2.5 TANK WASHING

2.5.1 After black oil cargoes

These cargoes range from gas oils to heavy fuel oils and the degree of cleaning will vary considerably with the grade to be loaded and the grades previously carried. Products within this group are persistent oils and residues and should be handled in accordance with 2.4. In the absence of specific cleaning instructions or advice of next cargoes, with the exception of the slop tank, cargo tanks should be cleaned on normal ballast passages to a standard suitable for any of the products within the ship's usual trading pattern.

Inert gas systems should be operated to reduce oxygen and hydrocarbon gas levels in accordance with 2.1.2 of these guidelines. Any slops generated should be disposed of in accordance with 2.4.

If the ship is re-loading at the discharge port, it may be possible to pump washings/residues from tank cleaning operations to a shore facility. Otherwise the residues will be retained on board. Regardless of the medium used for washing (cargo or water) care should be taken to ensure that segregation is not compromised.

Heavy fuel oils may leave residues on tank bottoms and structures at low temperatures and these can cause serious contamination of the lighter fuels and gas oils. Washing should be continued until the required degree of cleanliness is achieved. The bottom portion of the tank, together with any internal structure, may require particular attention, especially after carrying heavy or waxy fuel oils.

Hot water should always be used when the nature of the cargo warrants it or when a special degree of cleaning is required. The temperature of any residues should be 15 °C above the pour point in order to achieve effective removal by tank washing.

Scale formation is not usually heavy in ships which are employed solely on black oil trading, but where present it may be mixed with waxy deposits from fuel oils, which make it difficult to clean to the standard for gas oils and light fuel oils etc. If a build-up occurs special arrangements may need to be made to remove or reduce these deposits.

The amount of washing required when changing from a black oil cargo to a white oil cargo cannot be defined precisely as it varies considerably and depends primarily on the length of time the vessel was in the black oil trade, the condition of the tank coating and the arrangement of the cleaning machines within the tanks. In the best of situations it might take a little as four hours per tank; however, under less than ideal circumstances it can take many, many times longer. It is particularly important to ensure that blind areas under structures are adequately washed.

After the initial washing, the tank should be gas-freed and inspected to check on the effectiveness of the washing.

One of the major causes of tanks not being washed properly is poor monitoring of machines. They are prone to sticking so that the nozzles fail to rotate in the vertical plane and the body fails to rotate in the horizontal plane. This results in the majority of the structure being washed only by splashing. Where washing with hot water has not been undertaken for some time, scale is likely to detach from the inside of the tank-washing main and collect in the neck of the tank-washing machine, preventing rotation. This can occur frequently at the start of a hot wash and ship's staff should have spare machines available for use.

2.5.2 After white oil cargoes

White oil cargoes range from very light volatile oils like naphtha, to gas oils and lubricating oils.

Good stern trim and efficient use of washing equipment are important. Minimum tank washing patterns should be used.

The inert gas system, where fitted, should also be operated to reduce oxygen and hydrocarbon gas levels in accordance with 2.1.2 of these guidelines. Any slops generated should be disposed of in accordance with section 2.4.

For coated tanks cold water washing is generally adequate for cleaning after most cargoes, except after the carriage of the heavier lubricating oils where hot water or detergent wash may be required. Also, the incompatibility of certain grades with one another may require the removal of all previous cargo (see Table 4).

The use of hot water expedites tank cleaning and gas-freeing after the discharge of white oil cargoes. It removes oil films more quickly and, by raising the temperature of the tank atmosphere, promotes the release of gas trapped in scale and accelerates ventilation. Hot washing should be used when cleaning for dry-docking or repairs or when a special degree of cleanliness is required.

Although it is often important to remove all traces of the last cargo it is equally important to avoid excess tank washing as this may eventually lead to expensive renewal of tank coatings. Providing that the coatings are in a good condition, adhesion of most types of clean oil is minimal and this reduces the amount of washing required.

With volatile cargoes, little residue is left on tank sides and structure other than liquid and gases trapped in scale and other loose materials. With gas oils and lubricating oils an oily film will remain. With all cargoes, there is also a small amount of liquid left below the effective stripping level. Bottom washing and stripping should be continued until all oil residues are removed.

Most white oil ships have coated or stainless steel cargo tanks and scale deposits will be minimal. Any accumulations of scale should be removed frequently, and excessive coating break-down leading to build-up of scale should be reported.

2.5.3 After crude oil cargoes

The statutory requirements for washing after crude oils are contained within MARPOL for both segregated and dedicated ballast tankers. Additional sources of information are the vessel's cargo operations manual and EI HM 40.

As with other cargo types noted above, inert gas should be operated to reduce oxygen and hydrocarbon gas levels in accordance with 2.1.2 of these guidelines and any slops generated should be disposed of in accordance with 2.4.

The following points should be assessed when considering the need for water washing of crude oil tanks:

– the build-up of sludge in the tanks;
– wax content of the crude;
– the possibility of delaying the washing until the vessel is in warmer water;
– the use of portable machines, and
– the next crude to be carried and its suitability for washing.

2.5.4 After vegetable oil cargoes

Vegetable oils can be defined as drying, non-drying and semi-drying.

Non-drying oils are liquid at ambient temperatures and are easy to clean from surfaces using detergents and degreasers. Iodine values tend to be below 110 (examples are coconut oil, palm oil, palm kernel oil, olive oil).

Drying oils create solid residues which can form a hard skin at ambient temperatures. They are more difficult to remove from surfaces. Iodine values tend to be between 140 and 190 (examples are linseed oil, tung oil).

Semi-drying oils have iodine values between 110 and 140.

The drying properties (iodine value) are not related to the melting point so a light oil may well exhibit drying properties.

Before loading any white oil cargo after the carriage of vegetable oils, clarification of cleaning procedures should be obtained from the charterer/receiver.

There are many types of vegetable oil, some of which have chemical additives. Generally, efforts should be made to remove all traces of such cargoes before loading petroleum products, as vegetable oil traces may affect not only the next cargo but those following later.

Lighter vegetable oils will typically be cold water washed then washed with warm water and a degreaser or saponifier. Heavier types may require hot water washing, again with degreaser or saponifier, followed with a solvent wash. If the previous cargo was a drying oil then a hot wash with saponifier followed by additional water washes until the ph is neutral will be required. Cold water washing of each tank immediately after completion of discharge may avoid formation of a film on internal tank surfaces and should be carried out before warm or hot water washes which may cause oil films to dry ('varnish') unless cold water is used first.

See also 2.5.5, 2.12.2 and 2.12.7 regarding loading aviation jet fuel and aviation gasoline cargoes after biologically derived products.

2.5.5 After fatty acid methyl esther (FAME) or blended biodiesel cargoes

Recent analysis has shown that FAMEs adhere to surfaces more readily than other oils. However, as they remain liquid at ambient temperatures they can be cleaned using a water wash and saponifier as described in 2.5.4 for lighter vegetable oils.

Note: Detergents, saponifiers and cleaning products containing surfactants should not be used to prepare tanks for aviation jet fuel or aviation gasoline cargoes as residues can harm aviation fuel filters (see 2.12.7).

Contamination of aviation kerosene with FAME is a serious concern and current specifications permit only 5 ppm FAME in aviation kerosene (possibly to be increased to 100 ppm). Intermediate cargoes and a strict washing regime is therefore recommended when following these cargoes with aviation kerosene (see 2.12.7).

There have been no reported problems from these cargoes with odour or with softening or absorption into coatings.

2.5.6 After gasoline/ethanol blended cargoes

For tank cleaning purposes these cargoes may be treated in the same way as the equivalent non-biologically derived cargoes for non-aviation fuel purposes. Where aviation products are involved, see Table 2.

2.5.7 Use of chemicals

Due to environmental considerations, tank cleaning chemicals should no longer be used except where there is a requirement for stringent cleaning in which case specific instructions should be issued for chemically-assisted cleaning at the time of the cargo nomination. Where chemicals are used slops should be segregated to allow for easier disposal.

2.5.8 Using crude oil (crude oil washing (COW))

Guidelines for crude oil washing are contained within the following publications:

– *International safety guide for oil tankers and terminals*, 5th edition, published by Witherby.
– *Regulations for the prevention of pollution by oil*, Annex 1 and Annex II of MARPOL 73/78 including amendments, published by IMO.
– *Crude oil washing systems*, revised 1983, published by IMO.
– HM40 *Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being transported by sea*, 2004, published by the Energy Institute.
– Client/charterer procedures.

The entire COW system should be tested to 1,5 times the working pressure at a suitable time prior to arrival.

2.5.9 Cleaning of sampling equipment and stilling wells

The tight specifications for sensitive grades require extreme care during sampling, particularly closed or restricted sampling, to avoid contamination from previous cargoes or build-up of residues. Examples of this are FAME contamination of aviation fuels, and vegetable oils in gasolines. To reduce the possibility of drawing unrepresentative samples, the cleaning of sampling equipment, vapour locks, stand pipes and stilling wells is recommended as part of the tank cleaning regime.

2.6 TANK INSPECTIONS

2.6.1 General

Responsibility for the cleanliness and overall suitability of tanks, lines and pumps to carry the nominated grades lies with the Master. Inspections are frequently carried out by the loading supervisors from the shore facility or by independent inspectors acting on behalf of the cargo owner. However, while such inspections may provide an opinion regarding those tanks which have been inspected they do not relieve the Master of his/her responsibilities.

Tank entry for inspections is potentially dangerous and should only be done under close scrutiny in accordance with a strict permit to enter/work system in gas-free tanks. Careful attention should be given to the need for lighting, access, safety equipment, personal protective equipment and the general tank environment e.g. residues on plates (slip hazard) etc.

2.6.2 Inerted tanks

Any requirement for cargo tank(s) to be de-inerted and gas-freed to allow internal inspection should be contained within the agreed charter party or voyage orders for the voyage about to be undertaken as de-inerting/re-inerting is costly and time-consuming.

Reference should be made to ISGOTT recommendations with regard to inerting.

2.7 HEATING COILS

2.7.1 Testing

Heating coils should be pressure tested, and if necessary, blown through and repaired, on each occasion prior to:

– Loading a cargo which requires heating.
– Carrying out tank repairs or tank entry (so that any coil leak will not introduce hydrocarbon gases or product into the tank).
– Gas-freeing for voyage repairs or dry-docking.

Similar action should be taken when changing from a low flashpoint to a high flashpoint cargo or from black oil products to white oil products.

2.7.2 Heating coils made from copper-containing alloys

Heating coils made from copper-containing alloys can reduce the thermal stability of aviation kerosene due to copper dissolving into the cargo from the alloy.

Concentrations of copper in aviation kerosene fuel above 10 parts per billion (ppb) start to affect thermal stability and 50 ppb invariably results in failure to meet specified requirements.

For this reason, aviation kerosene should not be carried in ships fitted with heating coils made from copper-containing alloys.

2.8 TANK COATINGS

2.8.1 Temperature restrictions

In ships with coated tanks, the temperature and pressure of washing water should not normally exceed 66 °C and 10,5 kg/cm² respectively. However, these may be increased subject to the following criteria:

Agreement from the coating manufacturer that excessive heat and/or pressure will not damage the coating.

Agreement from the tank cleaning equipment manufacturer that excessive heat or pressure will not cause damage to the machines.

The temperature of the washing water should always be at least 15 °C above the pour point of the previous cargo.

In coated tanks of white oil carriers washing with cold water is generally adequate, except where more stringent cleaning is required after the carriage of vegetable oils, lubricating oils and diesel fuel. Hot water (and/or detergents) may be used occasionally to degrease tank structures, expedite gas-freeing for entry or where a gas-free condition is required for a major change of grade. When hot water is used this should be in accordance with the criteria noted above.

2.8.2 Coating compatibility

Although not directly related to tank washing, it should be noted that tank coatings are not compatible with all products. Problems usually relate to chemicals rather than petroleum products but manufacturers' resistance lists (usually kept on board) should be consulted if there are any doubts regarding coating compatibility.

Organic epoxy coatings can absorb some chemical cargoes, particularly chlorinated solvents. The contamination potential to subsequent cargoes (particularly aviation kerosene) may be considerable as significant quantities can be absorbed and retained depending on the chemical, exposure time, temperature, specific coating type, thickness, condition, etc. Contamination can persist after several subsequent cargoes and washings.

For aviation fuels, many oil companies have their own list of acceptable coatings. Coatings containing zinc may not be suitable for the carriage of aviation fuels as zinc can dissolve into the cargo and can reduce the thermal stability. The charterer should be consulted regarding coating acceptability for aviation fuel cargoes.

2.8.3 Stainless steel

Although stainless steel is compatible with most grades it is subject to attack by chlorinated compounds. This is made worse by the presence of water. Also, some stainless steel grades are subject to attack by sea water so if a sea water wash is used in a stainless steel tank this should be followed immediately by a fresh water rinse.

Note: Some shore supplied 'fresh' water can contain sufficient chlorine to attack/ discolour stainless steel.

2.8.4 Coating condition

Damaged, flaking or blistering paint can increase hold up of residues from previous cargoes and tanks with damaged coating should be avoided, particularly for critical cargoes such as naphthas, light distillate feedstock and aviation kerosene.

2.9 CARGO LINES

2.9.1 General

Procedures for line washing should be contained in the vessel's cargo operations manual. Careful visual inspection of the actual pump room and above-deck piping configuration should be undertaken to identify any problem areas or 'dead ends' which will require special attention.

2.9.2 Cargo compatibility

When loading more than one grade of cargo it should be determined whether the grades are compatible in both the liquid and vapour state.

Compatibility between cargoes is entirely dependent on their essential characteristics and the quality specification of each grade. Permissible admixture of one cargo by another is governed by the tolerance of quality characteristics such as flashpoint, colour, sulfur content, viscosity, etc.

Table 1 provides guidance for acceptability of pipeline admixture and the more detailed information in Tables 2 and 3 can also be used to assist in determining the pump/line changeover procedures required between cargoes during loading and discharging operations and to optimise the use of lines and pumps to expedite cargo handling.

2.9.2.1 Liquid compatibility

If the grades are not compatible each grade should be loaded through a separate system with segregation provided by two valves or a blind.

Where different but compatible cargoes, such as two grades of crude, are loaded, single valve segregation may be acceptable providing that the critical valves have been tested and proved tight.

If two or more cargoes are compatible, loading should be carried out in sequence commencing with the most critical cargo. Any admixing which may occur should not adversely affect the quality of the second cargo to be loaded. Lines should be drained and/or stripped dry between grades.

2.9.2.2 Vapour compatibility

Vapours from a volatile cargo such as gasoline, can be taken up in diesel or gas oil cargoes which share the same vent systems, or are under the same positive pressure of inert gas.

If vapour mixing can occur, each cargo should be loaded on a separate cargo and vent system with vent system cross-over valves locked and tagged in the closed position.

If it is not possible to load using separate vent systems then, when the ship design allows without impacting on SOLAS Chapter 2 - II Reg 2.5.3, individual tanks should be isolated from the system.

Interconnecting inert gas block valves should be closed and tagged and if vapour contamination from slops is possible, slops should be isolated from the main inert gas line. The oxygen content of isolated slop tanks should be monitored to ensure that it remains less than 8 % by volume.

Note: Before any tank is isolated from the main venting system due consideration should be given to meeting the SOLAS requirements and a formal risk assessment should be conducted. The pressure in any tank segregated from the main venting system should be carefully monitored to ensure that individual tank venting arrangements are adequate to prevent formation of vacuum or a build-up of pressure.

Table 1 Pipeline admixtures

	Changing from:									
Changing to:	**Avgas**	**Motor gasoline**	**Motor gasoline components, naphtha, oxygenates (MTBE, ethanol etc.)**	**Aviation jet fuel and components**	**Premium kerosene**	**Gas oil, distillates, diesel**	**FAME and blended biodiesel**	**Naphthenic distillate**	**Marine diesel (note 5)**	**Fuel oil**
Avgas	*	1#	X	X	X	X	X	X	X	X
Motor gasoline	1	*	*	Xs	Xs	1	1	X	X	X
Motor gasoline components, naphtha, oxygenates (MTBE, ethanol etc.)	1	*	*	Xs	Xs	*	*	X	X	X
Aviation jet fuel and components	X	X	X	*	*	X	X	X	X	X
Premium kerosene	X	X	X	*	*	X	X	X	X	X
Gas oil, distillates, diesel, blended biodiesel	X	X	X	Xs	Xs	*	*	X	X	X
Naphthenic distillate	X	X	X	X	X	X	X	*	X	X
Marine diesel (note 5)	X	X	X	1	1	*	X	1	*	1
Fuel oil	X	X	X	1	1	*	X	*	*	*

X Pipeline admixture not acceptable
1 Pipelines and pumps to be drained of previous product (see note 3 below)
* Pipeline admixture acceptable (see note 4 below)
# Pipeline admixture with motor gasoline containing MTBE or ethanol not acceptable
s Pipeline admixture not acceptable when loading low sulfur products

Notes:
1. Pipeline admixture should be kept to a minimum at all times as each admixture will result in some change in the quality of the cargo.
2. Acceptable admixtures are indicated for planning purposes only.
3. Where pipelines have been drained it is assumed that the admixture will not exceed 0,2 %.
4. Where pipeline admixture is allowable total admixture should not exceed 1 %.
5. Including all blended diesel fuels and treated as black oil cargoes.

2.9.3 Testing of cargo lines and valves

On each occasion a tank is gas-freed and opened for entry, every effort should be made to pressure test the associated internal pipelines and valves. A brief inspection of coatings and fittings should be undertaken at the same time. On no account should cargo be used to test pipelines and valves. Only clean water should be used for this purpose.

2.10 PRODUCT QUALITY

2.10.1 Product characteristics

The quality of petroleum and petroleum products is defined by certain characteristics meeting specified requirements. These characteristics are measured by standard laboratory tests. The specification of the product will depend on its end use and, if it is a finished product, where it is to be marketed.

2.10.2 Critical properties

Some critical properties for white and black oils respectively are given in Tables 2 and 3.

2.11 TANK CLEANING

2.11.1 Cleaning table

Table 4 provides guidelines for cleaning. These guidelines are based on the following comments, taking into account the critical aspects of each cargo as summarised in Tables 2 and 3.

The table assumes that tanks are coated and in good condition. Where this is not the case additional cleaning may be required depending on the cargo involved, typically the addition of gas-freeing, descaling and mopping where wash only is specified.

Stripping and draining following discharge or washing is assumed to be thorough such that any liquid ROB is confined to the pump well (if present). All associated lines (suction, deck lines, and drop lines, etc.) are to be cleared and drained of all product or water.

Where washing is specified this includes deck lines, loading drop lines and cross over lines.

The following of these guidelines does not necessarily mean that the tank(s) will be acceptable for the next intended cargo. The Master is ultimately responsible for the cleanliness of the tank(s) and should ensure that the end result meets the owner's/charterer's/shipper's expectation.

2.12 COMMENTS ON INDIVIDUAL CARGOES (CARGO TYPES)

2.12.1 Naphthas and light distillate feedstocks (and/or - clean condensate, feedstocks, straight run benzene, pentane, natural gasoline, straight run gasoline)

Naphtha and light distillate feedstocks should not be contaminated by lead and should not be carried directly after cargoes that contained lead e.g. aviation gasoline. Tank coating should

be in good condition as blistered or flaking tank coating can be a source of contamination from the previous cargo.

Oxygenates can affect naphtha processing and washing is therefore required when loading naphtha into tanks which have previously contained unleaded gasoline cargoes. Sea water washing should be followed by a fresh water rinse to remove chlorides.

Heavier feedstocks can tolerate minor admixing of aviation kerosene, kerosene, solvents or lighter feedstocks.

2.12.2 Aviation gasoline (and/or - avgas, aviation spirit)

These products normally have a high lead content and are always dyed.

Uncoated tanks should be hot water washed and have any loose bottom scale removed before loading.

Water cannot be tolerated and extreme care should be taken to ensure that tanks and lines are dry before loading or discharging. Hand mopping is recommended.

Detergents and saponifiers should not be used to prepare tanks for aviation gasoline cargoes as residues can harm fuel filters/coalescers.

Contamination of aviation gasoline with oxygenates (ethanol, MTBE, etc.) could lead to specification issues. Thorough washing is required to ensure prevention of cross contamination and the proposed tank cleaning/flushing plan should be discussed and agreed with the Charterer.

To avoid contamination from FAME it is recommended to have three intermediate cargoes with no FAME between FAME (B100) or any cargo with a FAME content greater than 15 % (B15) and an aviation gasoline cargo.

When following cargoes with a FAME content of 5 % or less (B5 or below) a hot water wash, including flushing of pumps and lines, followed by draining is recommended as a minimum.

When following cargoes with a FAME content of 15 % (B15) or less, but above B5, a hot water wash, including flushing of pumps and lines, followed by draining is again recommended as a minimum. However, tanks must be in good condition and washing needs to be particularly stringent. A single intermediate cargo with no FAME content is suggested as an alternative, followed by a hot water wash, including flushing of pumps and lines, and by draining.

The very low tolerance for FAME contamination requires extreme care during sampling. To reduce the possibility of drawing unrepresentative samples, consideration should be given to cleaning of stand pipes and stilling wells as part of the tank cleaning regime when tanks have previously held cargoes containing FAME.

Note: The recommendations relating to FAME also apply to FAEE.

2.12.3 Leaded motor gasoline (and/or - premium/regular motor spirit, motor gasoline, mogas)

These products are often dyed and may contain surfactant additives.

Only minimal amounts of higher boiling point cargoes such as gas oil can be tolerated in motor gasoline. Depending on the product specification, up to 0,1 % volume may be tolerated. Where the product is close to specification limits a nil tolerance level will apply.

Tanks will require washing when following cargoes of dyed gas oil or kerosene.

Uncoated tanks should be hot water washed and have loose bottom scale removed before loading.

2.12.4 Unleaded motor gasoline (and/or - unleaded motor spirit, regular unleaded, premium unleaded, super unleaded, toluene, methyl tertiary butyl ether (MTBE), reformate, alkylate, cracked spirit, motor spirit/gasoline blending components)

Thorough tank washing is required when following leaded products, dyed gas oil or kerosene.

Uncoated tanks should be hot water washed and have any loose bottom scale removed before loading.

2.12.5 Ultra low sulfur gasolines

In addition to the comments in 2.12.4 these cargoes have a typical maximum sulfur content of 10 ppm (or possibly 50 ppm depending on location). If they are to be loaded into tanks or through lines that have previously contained cargoes that had a greater sulfur content care should be taken to ensure that admixing is kept to a minimum.

These products are salt water critical as the high specifications will not allow sodium or potassium. Fresh water washing and mopping may be specified.

2.12.6 Solvents (and/or - special boiling point solvents, rubber solvent, unleaded cleaning spirit, white spirit)

These are volatile unleaded products.

Due to wide variations in specifications within grades specific guidance should be sought on the allowable levels of admixing with other solvents.

No admixing with other types of product can be tolerated and these products should not be carried after leaded cargoes.

Uncoated tanks should be hot water washed and have any loose bottom scale removed before loading.

2.12.7 Aviation jet fuel (and/or - aviation kerosene, dual purpose kerosene, Jet, Jet-A1, Avtur, ATK, JP5, JP8, synthetic jet fuel)

Products are unleaded and fairly volatile.

Products may contain relatively high levels of sulphur which could affect the quality of a subsequent low sulphur cargo.

Very tight specifications preclude admixing by other cargoes except undyed general purpose kerosenes with no biological components.

Water cannot be tolerated and extreme care should be taken to ensure that tanks and lines are dry before loading or discharging. Hand mopping is recommended.

Due to strict limitations on biological contamination (FAME content maximum 5 ppm, possibly increasing to 100 ppm) it is recommended to have three intermediate cargoes with no FAME between FAME (B100) or any cargo with a FAME content greater than 15 % (B15) and a subsequent aviation jet fuel cargo.

When following cargoes with a FAME content of 5 % or less (B5 or below) a hot water wash, including flushing of pumps and lines followed by draining is recommended as a minimum.

When following cargoes with a FAME content of 15 % (B15) or less, but above B5, a hot water wash, including flushing of pumps and lines, followed by draining is again recommended as a minimum. However, tanks must be in good condition and washing needs to be particularly stringent. A single intermediate cargo with no FAME content is suggested as an alternative, followed by a hot water wash, including flushing of pumps and lines, and by draining.

The very low tolerance for FAME contamination requires extreme care during sampling. To reduce the possibility of drawing unrepresentative samples, consideration should be given to cleaning of stand pipes and stilling wells as part of the tank cleaning regime when tanks have previously held cargoes containing FAME.

Where the FAME content of a previous cargo is not known it should be assumed to be 15 %.

Other cargoes can have a deleterious effect on aviation kerosene product quality and intermediate cargoes are recommended in these circumstances (see Tables 2 and 4).

Detergents and saponifiers should not be used to prepare tanks for aviation kerosene cargoes as residues can harm aviation fuel filters.

In all cases salt contamination needs to be minimised after washing with sea water. A fresh water rinse is recommended but thorough mopping may suffice

Note: The recommendations relating to FAME also apply to FAEE.

2.12.8 Premium and regular kerosenes (and/or - kerosene feedstock, burning oil, stove oil)

Products may contain relatively high levels of sulphur which could affect the quality of a subsequent low sulphur cargo.

Admixing of dyed kerosene with undyed kerosenes can result in the undyed cargo not meeting colour specifications. Tanks which have carried dyed products will require washing and mopping dry prior to loading undyed products.

Where dye is not a concern, these products will not require tanks to be mopped after water washing unless following lube oil or light fuel oil.

Small amounts of gas oil may be tolerated (up to 0,1 % volume) subject to comments under 2.12.9.

2.12.9 Gas oil and automotive diesel fuel (and/or - automotive gas oil, automotive diesel oil, DERV, extra light fuel oil, distillate marine diesel)

Some admixing with lighter distillate cargoes such as kerosene is acceptable, depending on minimum flashpoint requirements for the individual cargo. However, flashpoint requirements will preclude admixing with any naphtha, motor gasoline or other cargoes with low flashpoints.

Water contamination is a problem leading to 'haze' in' the product. This can produce a water layer and subsequent corrosion in downstream storage. Sodium in any dissolved salt can lead to damage to blades if the fuel is used for gas turbines. Care should therefore be taken to ensure that water is removed from tanks, pumps and lines before loading.

Uncoated tanks should be hot water washed and have any loose bottom scale removed before loading.

The admixing of dyed gas oil with undyed gas oil can result in the undyed material not meeting the colour specification and tanks which have carried dyed products will require washing prior to loading undyed products.

Saponifiers and degreasers can have a negative effect on gas oil or automotive diesel fuel quality and if these are used hot water washing is recommended to remove any traces.

Increasingly, diesel fuels for road transport are blends of FAME and conventional diesel fuel-blended biodiesel. These blends may simply be referred to as diesel fuel, but the grade name may indicate the percentage of FAME. Thus a B5 diesel fuel contains 5 % FAME and B15 diesel fuel, 15 % FAME. Cleaning procedures vary with the percentage of FAME in the blend so it is important that shippers determine the FAME content of diesel fuel cargoes. Where the FAME content of a diesel fuel cargo is not known it should be assumed to be 15 %.

Note 1: These comments also apply to FAEE.

Note 2: Some national specifications do not permit FAME in diesel which is not designated as bio-diesel, even at contamination levels. In such cases precautions similar to those used for aviation jet fuel should be followed.

Note 3: Some gas oils may contain up to 2 000 ppm sulfur.

2.12.10 Ultra low sulfur automotive diesel fuel (and/or - ULSD, ULS turbine gas oil, LS marine gas oil, ULS Diesel)

In addition to the comments in 2.12.9 these cargoes typically have a typical maximum sulfur content of 10 ppm (possibly 50 ppm depending on location). If they are to be loaded into tanks or through lines that have previously contained cargoes that had a greater sulfur specification, care should be taken to ensure that admixing is kept to a minimum.

These products are salt water critical as the high specifications will not allow sodium or potassium. Fresh water washing and mopping may be specified.

2.12.11 Crude oil and condensate

The specifications of these cargoes vary considerably. General guidance together with a list of physical properties of many grades together with washing and carriage recommendations is given in HM40 *Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being transported by sea*.

2.12.12 Lubricating oils (and/or base oils)

The quality of lubricating oils is greatly affected by admixing with water and tank preparation will normally include mopping. Valves and strainers will also require opening and draining. To maintain quality and avoid introduction of water, lubricating oils should be loaded, carried and discharged under air and not inert gas.

2.12.13 Vacuum gas oil (and/or - cracker feed, waxy distillate)

These cargoes are sodium critical and tanks which have been salt water washed will require fresh water washing to remove any salt traces. Vacuum gas oil may be loaded on top of some light crude oils and condensates without washing. However, as with fuel oils, the need to heat the product leads to a high flashpoint specification and precludes admixing with any volatile residues.

2.12.14 Medium and heavy fuel oils

The admixing of these cargoes with waxy residues can result in the material not meeting the maximum pour point specification limit. Tanks which have carried high pour point cargoes should be carefully drained and stripped prior to loading.

The need to heat the product leads to a high flashpoint specification and precludes admixing with any volatile residues. Washing will generally be required when loading these products after crude oil cargoes.

2.12.15 Low sulfur fuel oil (and/or - low sulfur atmospheric residue (LSAR), low sulfur waxy residue (LSWR))

In addition to comments in 2.12.14, these products are frequently traded with sulfur content very close to the specified upper limit. Admixing with cargoes with higher sulfur content should therefore be kept to a minimum. Hot washing will normally be required when loading after crude oils or other fuel oils.

Cargoes for refinery cracking will also be sodium critical and tanks which have been salt water washed will require washing with fresh water to remove any salt traces.

2.12.16 Light fuel oil

The admixing of these cargoes with waxy residues can result in the material not meeting the maximum viscosity and/or pour point specification limit. Tanks which have carried high pour point or high viscosity fuel oil or crude oil should be hot washed at the highest permitted temperature to remove wax traces.

Washing may be avoided if a previous cargo of heavier grade fuel oil has low wax content and ROB is minimal (less than 0,1 % of volume).

2.12.17 Gas to liquids (GTL) products

A number of these are entering the market: typically naphtha, condensate and diesel. Properties are as per similar non-GTL cargoes but all are ultra low sulfur and should be handled accordingly.

2.12.18 FAME and blended biodiesel

FAMEs vary considerably in properties depending on the original source of the oil/fat. However, all are prone to absorb water both from the atmosphere and from tank washing activities. Tanks which have been subject to water washing should therefore be mopped dry before loading any cargo of FAME or FAME/petroleum diesel blend.

2.12.19 Light cycle oil (LCO)

LCO can be a dark or clear, straw coloured product.

With regard to products following LCO: dark LCO should be treated as a black oil cargo and clear LCO can be treated as gasoil.

Cleaning before loading LCO will depend on the end use of the product and, of course, the previous cargo. Advice should be requested from the cargo owner/charterer.

Table 2 Critical properties-white oils

Grade	Density	Flash point	Lead	Water	Colour	Octane	Comments
Aviation gasoline	690-730			Water critical		Preserve Higher Octane Quality	Sulfur critical. Oxygenate critical (ethanol and MTBE etc). Contamination from biologically derived products or components (FAME or FAEE) not acceptable
Motor spirit (unleaded)	700-780		Lead free stow				Sulfur critical. Not dyed in the USA
Motor spirit (leaded)	700-780					Preserve Higher Octane Quality	Sulfur critical. Not dyed in the USA
Ethanol blended motor spirit	700-780			Water critical			
Motor spirit components, MTBE	650-850			Water critical			
Naphtha	650-780		Do not load after leaded cargo	Water critical	May be colour critical		May be sensitive to oxygenate contamination from unleaded gasoline
Kerosene	780-810	Medium			Colour critical		
Aviation jet fuel and components	775-840	Medium	Lead free stow	Water critical	Colour critical		Contamination from biologically derived products or components (FAME or FAEE) not acceptable
Gas oil	810-940	High					
Diesel fuel	820-845	High	Do not load after leaded cargo	Water critical			Sulfur critical
FAME	860-900	High		Water critical			
Vacuum gas oil	810-900	High		Salt water critical			Waxy, requires heating

Grade	Density	Flash point	Lead	Water	Colour	Octane	Comments
Solvents	630-740		Do not load after leaded cargo		Colour critical		'Odour' contamination may occur after gasoil
White spirit	760-900	Medium/ High	Do not load after leaded cargo		Colour critical		
Lubricating oil	860-960	High		Water critical	Clear/ Green		

Notes:	
Flash point	In order to meet flash point specification for all medium/high flash cargoes it is critical that tank and line admixing with low flash cargoes is rigorously avoided.
Lead	Certain cargoes require that precautions are taken to avoid admixing with previous leaded cargoes. However, tanks that have contained leaded cargoes may be used providing that tanks are thoroughly cleaned. Tanks which have previously contained leaded cargoes should not be used for solvents (SBPs) or white spirit as these products can be used in food manufacture (lead free below 50 ppb; Japan-two previous lead free cargoes). To minimise tank cleaning it is recommended that a minimum number of tanks on each vessel should be used for leaded cargoes, the remainder being kept lead free.
Water	Drain pipelines/pumps and mop up water in tanks prior to loading water critical grades. As far as possible maintain separate lines and pumps for these grades and avoid using these to pump water for shore purposes.
Colour	Colour critical grades should be stowed in tanks which have previously held colourless grades. Machine washing with hot water is required for colour critical grades after black oils. However, additional cleaning including removal of deposits and flushing tanks and pipes with a suitable wash oil may be necessary. Internal inspection is recommended. Wash oil costs should be agreed between the parties.
Octane number	Unavoidable pipeline mixing between aviation gasoline or motor gasoline cargoes should be from a higher to a lower octane number cargo.
Hydrogen sulphide and mercaptans	When present in sufficient quantities these make a cargo 'sour' and are frequently found in naphthas and natural gasolines as well as crudes and fuel oils.
Odour	Solvents (SBPs) are odour critical, which is a consideration after gas oil cargoes. Odour contamination via common vapour lines should be considered.
Vapour pressure	Many white oil grades have a high vapour pressure and details should be obtained at the load port with a view to appropriate handling at discharge.

Table 3 Critical properties-black oils

Grade	Density	Flash point	Water	Sediment	Colour	Viscosity	Wax	Comments
Vacuum gas oil	850-900	High	Salt Water Critical					
Marine diesel	830-890	High			Often Critical			
Waxy distillate/slack wax	820-920	High	Critical	Critical				Metal and asphaltenes critical (see note)
Light fuel oil	900-980	High				Wash tanks after high viscosity grades	Some grades wax critical – water wash	
Medium fuel oil	950-1 000	High						
Heavy fuel oil	950-1 000	High						
Waxy residue pour point>/= 38°C	870-970	High						
Carbon black feedstocks	1 050	High	Salt water critical	Critical				
Bitumen	980-1 100	High	Critical	Critical				Penetration, flash point
Bitumen cutback	920-1 100	High	Critical	Critical				
Crude oil (light, medium, heavy) spiked/ recon crude oil	790-970							
Extra heavy crude oil	980-1 010							
Wax free naphthenic crudes	930-990						Wax critical	
Naphthenic distillates	860-960	High	Very critical	Critical			Wax critical	

Table 3 Notes

Flash point	In order to meet flash point specification for all medium/high flash cargoes it is critical that tank and line admixing with low flash cargoes is rigorously avoided.
Water	The majority of black oils do not require extensive precautions such as mopping tanks dry. However, water contamination (and particularly salt water contamination) should be avoided where possible, so tanks used for ballast and associated pipelines should be well drained before loading. Bitumen and naphthenic distillates are exceptions and every care should be taken to ensure dryness of tanks, lines and pumps. Vacuum gas oil cargoes will need salt water free stowage and tanks and lines should be fresh water rinsed.
Viscosity	Cargoes with high viscosity (>650cS at 50ºC) may have a detrimental effect on lighter products
Metals and asphaltenes	All cargoes in the waxy distillate/slack wax range are sensitive to these contaminants which are present in sea water, scale and residues from other grades. Thorough cleaning and draining is necessary prior to loading.

Table 4 Cleaning recommendations

	Grade discharged							
Loading	**Aviation gasoline**	**Aviation turbine gasoline**	**Aviation jet fuel and components**	**Motor gasoline containing oxygenates (ethanol or MTBE etc.)**	**Motor gasoline (unleaded)**	**Ultra low sulphur motor gasoline (unleaded)**	**Motor gasoline (leaded)**	**Naphtha (lead free)**
Aviation gasoline #	1	1	2	2	1	1	1	2M
Aviation turbine gasoline #	2M	1	1	2M	2M	2M	2M	2M
Aviation jet fuel and components #	2PM	2PM	1	2PM	2PM	2PM	2PM	2PM
Motor gasoline containing oxygenates (ethanol or MTBE etc.)	2PM	1	1	1	1	1	2PM	1
Motor gasoline (unleaded) †	2	1	1	1	1	1	2	1
Ultra low sulphur motor gasoline (unleaded) †	2PM	2PM	2PM	2PM	2PM	1	2PM	2PM
Motor gasoline (leaded) †	1	1	1	1	1	1	1	1
Naphtha (lead free) †#	X	1	1	2	2	2	X	1
Natural gasoline (ngls) †	X	1	1	1	1	1	X	1
Kerosene (undyed)	2P	2P	1	2P	2P	2P	2P	2P
Kerosene (dyed)	2P	2P	1	2P	2P	2P	2P	2P
Gas oil (undyed)	2P	2P	1	2P	2P	2P	2P	2P
Gas oil (dyed)	2P	2P	1	2P	2P	2P	2P	2P
Ultra low sulphur gas oil/diesel	2PM	2PM	2PM	2PM	2PM	2PM	2PM	2PM
Solvents and white spirit † #	2PM	2PM	1	2PM	2PM	2PM	2PM	2PM
Lubricating oil	2PM	2PM	1	2PM	2PM	2PM	2PM	2PM
Vacuum gas oil #	2P	2P	1	2P	2P	2P	2P	2P
Medium and heavy fuel oil	2P	2P	1	2P	2P	2P	2P	2P
Low sulphur fuel oil	2P	2P	1	2P	2P	2P	2P	2P
Light fuel oil	2P	2P	1	2P	2P	2P	2P	2P
Crude oil, condensate †	2	1	1	1	1	1	2	1

Table 4 Cleaning recommendations (continued)

Grade discharged (continued)								
Loading (continued)	**Natural gasoline NGLS**	**Kerosene (undyed)**	**Kerosene (dyed)**	**Gas oil (undyed)**	**Gas oil (dyed)**	**Ultra low sulphur gas oil/diesel**	**Diesel blended with up to 5% FAME (B5 or lower)**	**Diesel blended with 5% to 15% FAME (B15 or lower)**
Aviation gasoline #	2M	2M	2M	2M	2M	2M	3M	3M*
Aviation turbine gasoline #	2M	1	2M	1	2M	1	3M	3M*
Aviation jet fuel and components #	2PM	1	2M	1	2M	1	3M	3M*
Motor gasoline containing oxygenates (ethanol or MTBE etc.)	1	1	1	1	2PM	1	1	1
Motor gasoline (unleaded) †	1	1	1	1	2	1	1	1
Ultra low sulphur motor gasoline (unleaded) †	2PM	1	2PM	1 (see note 5)	2M	1	1	1
Motor gasoline (leaded) †	1	1	1	1	2	1	1	1
Naphtha (lead free) †#	1	1	1	2	2	2	2	2
Natural gasoline (ngls) †	1	1	1	1	1	1	1	1
Kerosene (undyed)	2P	1	2	1	2	1	1	1
Kerosene (dyed)	2P	1	1	1	1	1	1	1
Gas oil (undyed)	2P	1	1	1	2	1	1	1
Gas oil (dyed)	2P	1	1	1	1	1	1	1
Ultra low sulphur gas oil/diesel	2PM	1	2M	1 (see note 5)	2M	1	1	1
Solvents and white spirit † #	2PM	1	1	1	2M	1	1	1
Lubricating oil	2PM	1	1	1	1	1	1	1
Vacuum gas oil #	2P	1	1	1	1	1	1	1
Medium and heavy fuel oil	2P	1	1	1	1	1	1	1
Low sulphur fuel oil	2P	1	1	1	1	1	1	1
Light fuel oil	2P	1	1	1	1	1	1	1
Crude oil, condensate †	1	1	1	1	1	1	1	1

Table 4 Cleaning recommendations (continued)

Grade discharged (continued)								
Loading (continued)	**FAME (fatty acid methyl esthers) or diesel blended >15% FAME (B15 or higher)**	**Solvents**	**White spirit**	**Lubricating oil**	**Vacuum gas oil**	**Medium, heavy, low sulphur fuel oil**	**Light fuel oil**	**Crude oil and condensate**
Aviation gasoline #	X*	2PM	2PM	X*	X*	X*	X*	X*
Aviation turbine gasoline #	X*	2PM	2PM	X*	X*	X*	X*	X*
Aviation jet fuel and components #	X*	2PM	2PM	X*	X*	X*	X*	X*
Motor gasoline containing oxygenates (ethanol or MTBE etc.)	2PM	1	1	3PM	3PM	X	X	X
Motor gasoline (unleaded) †	2	1	1	3	3	X	X	X
Ultra low sulphur motor gasoline (unleaded) †	2	3PM	3PM	X	X	X	3M	X
Motor gasoline (leaded) †	2	1	1	3	3	X	3	X
Naphtha (lead free) †#	2	1	1	1	3	3	3	X
Natural gasoline (ngls) †	2	1	1	1	3	3	3	3
Kerosene (undyed)	2	1	2	2	X	X	3	X
Kerosene (dyed)	2	1	2	2	X	X	3	X
Gas oil (undyed)	2	1	2	1	3	3	3	3P
Gas oil (dyed)	2	1	2	1	3	3	3	3P
Ultra low sulphur gas oil/diesel	2	3PM	3PM	X	X	X	3M	X
Solvents and white spirit † #	1	1	1	X	3M	X	3M	X
Lubricating oil	1	3PM	3PM	LU	X	X	X	X
Vacuum gas oil #	1	2P	2P	1	1	1	1	3P
Medium and heavy fuel oil	1	2P	2P	1	1	1	1	3P
Low sulphur fuel oil	1	2P	2P	1	1	1	1	3P
Light fuel oil	1	2P	2P	1	3	3	1	3P
Crude oil, condensate †	1	1	1	1	1	1	1	1

Table 4 Cleaning recommendations (key)

Code	Cleaning recommendations
X	Not to be loaded without special cleaning instructions.
X*	Not to be loaded without special cleaning instructions. Three clean product/zero biological content intermediate cargoes recommended.
1	Drain tanks well. If tank coating is breaking down or previous cargo shows signs of instability or oxidation (dark colouring or broken down from sediment) then use code 2M.
2	Wash with cold sea water and drain well.
3	Wash with hot sea water and drain well.
3M*	A stringent hot water wash, drain and mop may be sufficient if tanks are in good condition. As an alternative one clean product/zero biological content intermediate cargo is recommended, followed by hot water wash, drain and mop. Fresh water rinse required if seawater is used.
P	Purge to below 2 % hydrocarbon by volume.
M	Gas free, lift scale and mop.
#	Fresh water rinse after any salt water wash when loading these products.
LU	Reduced cleaning may be permitted depending on lubricating oil specification. Otherwise apply code 3M.
Notes	1. Additional cleaning may be required for tanks with extensive coating breakdown or where specified in the charter party. 2. † Benzene may be present in any petroleum product but may be present in higher concentrations in those products marked †. Refer to ISGOTT for precautions in handling cargo suspected of having a benzene content and prior to entering a space which has contained such a cargo. 3. In case the FAME content in diesel is unknown, it has to be assumed to be 15 %. 4. Comments regarding FAME also apply to FAEE. 5. For high sulfur gas oil Code 2 should be used.

ANNEX A
GLOSSARY OF TERMS

For the purposes of these EI guidelines, the terms used should be understood to have the following meanings:

Aviation jet fuel:

conventional: hydrocarbons for use in aviation turbine engines and derived from the following conventional sources: crude oil,natural gas, liquid condensate, heavy oil, shale oil and oil sands.

synthetic: hydrocarbons for use in aviation turbine engines and derived from alternative sources such as coal, natural gas,biomass and hydrogenated fats and oil by processes such as gasification, Fisher-Tropsch synthesis and hydroprocessing.

Ballast: water taken on board when a vessel is empty or partially loaded/discharged to increase draught so that the propeller is fully immersed, stability and trim are maintained, and stresses minimised. Specific ballast terms are as follows:

departure ballast: ballast taken on board prior to departure. If loaded into tanks that have previously contained cargo it may contain traces of oil and be termed *dirty ballast*.

clean ballast: ballast contained in cargo tanks that have been COW'd (where appropriate) and thoroughly water washed. It may be discharged to sea and meets MARPOL requirements.

segregated ballast: ballast that is contained in dedicated ballast tanks serviced by dedicated ballast pumps and lines with no permanent connection to the cargo system.

heavy weather ballast: additional ballast loaded into cargo tanks to enable the vessel to maintain a safe sea-going condition under extreme weather conditions.

Black oils: petroleum products containing residual components which make them dark in colour.

Blended biodiesel: diesel fuel which is a blend of biologically derived components (e.g. FAME or FAEE) and petroleum diesel. The percentage of biological component is often designated in the grade name, e.g. B15 indicates 15 % biological component.

Bottom wash: washing operations restricted to the lower parts of the tank bulkheads, internal structures and bottom of tanks. This can only be carried out by vessels equipped with programmable tank washing machines.

Clingage: material which adheres to the surfaces of tank walls and structures, both horizontal and vertical, within empty and part empty tanks, other than bottom surfaces.

Crude oil: for the purposes of these guidelines crude oil types have been sub-divided into:

aromatic crude oil: see *high viscosity crude oil*.

high viscosity crude oil: a crude oil which due to its viscosity alone requires heating

during transportation, COW or discharge. These types of crude oil generally have a high aromatic content and may have the designation aromatic crude.

volatile crude oil: crude oil, having a high concentration of components boiling below ambient temperature (Gas C1 to C4), which results in excessive gas evolution if used as a COW medium.

waxy paraffinic crude oil: a crude oil which, by function of its total wax content, requires heating to prevent sludge deposition during transportation and discharge.

Crude oil washing (COW): the use of a high pressure stream of the crude oil cargo to dislodge or dissolve clingage and sediments from the bulkheads, bottom, and internal tank structures of a vessel during the discharge operation.

Fatty acid ethyl ester (FAEE): sometimes referred to as biodiesel or B100 (not yet widely used but properties similar to FAME).

Fatty acid methyl ester (FAME): sometimes referred to as biodiesel or B100.

Flash point: lowest temperature of the test portion, corrected to a barometric pressure of 101,3 kPa , at which the application of an ignition source causes the vapour of the test portion to ignite and the flame to propagate across the surface of the liquid under the specified conditions of test.

Full cycle washing: washing operation in which the complete cargo tank is washed, either by programmable or non-programmable machines.

Gas free: a tank, compartment or container is gas free when sufficient fresh air has been introduced into it to lower the level of any flammable, toxic, or inert gas to that required for a specific purpose, e.g. hot work, entry, etc.

Inert gas (IG): a gas or gas mixture used to render the vapour space in the cargo tank non-flammable.

IMO: International Maritime Organization.

ISGOTT: International Safety Guide for Oil Tankers and Terminals.

ISO: International Organization for Standardization.

MARPOL: the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973, amended 1992.

Oxygenate: an oxygen containing, organic compound such as an alcohol (e.g. ethanol) or ether (e.g. MTBE, ETBE) that can be used as a gasoline component.

Persistent oil: the International Oil Pollution Compensation (IOPC) Fund guidelines consider an oil as non-persistent if, at time of shipment, at least 50 % of the hydrocarbon fractions, by volume, distil at a temperature of 340ºC and at least 95 % of the hydrocarbon fractions, by volume, distil at a temperature of 370ºC when tested in accordance with ASTM D86. A persistent oil is one which does not meet these criteria.

Pour point: the lowest temperature at which a sample of petroleum product will continue to flow when it is cooled under specified standard conditions (see IP 15/ASTM D 97).

Purging: the introduction of inert gas into a tank already in an inert condition with the object of further reducing the existing oxygen content and/or the existing gas content to a level below which combustion cannot be supported if air is subsequently introduced into a tank.

Remaining on board (ROB): sum of measured liquid volume, including free water, and measured non-liquid volume but excluding vapours, in cargo tanks on completion of discharge.

Saponifier: a solution of organic or inorganic bases (alkalines, e.g. caustic soda) and various agents, such as wetting agents and dispersants, which react with and promote the removal of non-water-soluble contaminants, such as vegetable oils.

Segregated ballast tankers (SBTs): vessels having sufficient dedicated ballast tanks to enable safe sea-going operations under normal weather conditions. See also *heavy weather ballast*.

Slop tank(s): for the purposes of these guidelines tank(s) utilised as a reservoir for COW medium and receipt of tank washings.

Stripping: the removal of the final contents of a cargo tank, possibly using equipment additional to the main cargo pumps.

Trim: The difference between the fore and aft draught of the vessel. When the aft draught is greater than the forward draught, the vessel is said to be trimmed 'by the stern'. When the aft draught is less than the forward draught, the vessel is said to be trimmed 'by the head'.

True vapour pressure (TVP): the absolute pressure exerted by the gas produced by evaporation from a liquid, when the gas and liquid are in equilibrium at the prevailing temperature.

Viscosity: a measurement of a fluid's resistance to flow at a prescribed temperature. In this document the unit of Kinematic Viscosity, the centistoke (cSt) has been used which is equivalent to mm^2/s.

Wax: a mixture of long chain hydrocarbons that crystallise at different temperatures as the overall fluid temperature falls.

White oils: clean, refined petroleum products which are not dark in colour such as motor spirit, kerosene, gas oil, diesel fuel and blending components.

ANNEX B
REFERENCES

The following Standards and papers have been used in the preparation of this document:

HM40 *Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being transported by sea*, latest edition, published by the Energy Institute.

Regulations for the prevention of pollution by oil, Annex 1 and Annex II of MARPOL 73/78 including amendments, published by IMO.

Crude oil washing systems, revised 1983, published by IMO.

International convention for the safety of life at sea (SOLAS), 1974, including amendments, Chapters 11 and 12, published by IMO.

International safety guide for oil tankers and terminals, 5th edition, published by Witherby.

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