Delivering Quality Bulk Marine Gasoil to Offshore Installations

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Contents

1. Introduction

The supply of fuel to offshore locations is the responsibility of a number of stakeholders including the supplier, transporter and ultimate end user of the fuel.

Unnacceptable levels of contamination in fuel cargoes or microbiological contamination (MBC) may cause potentially serious consequences in power generation equipment.

Contamination of fuel may happen at any point in the supply chain; for example, during refining, onshore storage, transportation between storage depots, carriage and storage on the supply vessels and during storage on offshore installations or vessels.

Additionally, vessels transitting from other parts of the world to the North-European area should pay particular attention to the characteristics of fuel bunkered, particularly with respect to the effect cold temperatures may have on the fuel quality. Issues such as waxing may occur if the ambient temperature reduces to near or below the Cold Filter Plugging Point (CFPP) of the fuel in use. This could have catasptrophic consequences.

1.1. Scope

This document is applicable to vessels carrying Marine Gasoil as cargo to offshore installations operating in the United Kingdom Continental Shelf (UKCS), but the principles can be applied elsewhere. Vessel Owners may choose to apply this guidance to fuel intended for ships use only.

1.2. Aim

This document provides practical guidance on delivering quality Marine Gasoil to offshore locations with a view to operating to a common standard throughout the offshore UKCS supply chain to achieve common specification requirements for maintenance and testing standards.

1.3. Glossary of Terms

Term	Definition
ISM	International Management Code for the Safe Operation of Ships and for Pollution Prevention
MARPOL	International Convention for the Prevention of Marine Pollution from Ships
MBC	Microbiological contamination
MGO	Marine Gas Oil
PPB	Parts Per Billion
PPM	Parts Per Million
FAME	Fatty Acid Methyl Ester
TVC	Total Viable Count
UK	United Kingdom
UKCS	United Kingdom Continental Shelf

Table 1: Glossary of Terms

2. Background Information

Figure 1 provides an overview of the supply chain of fuel to offshore installations and the potential areas of contamination from water.

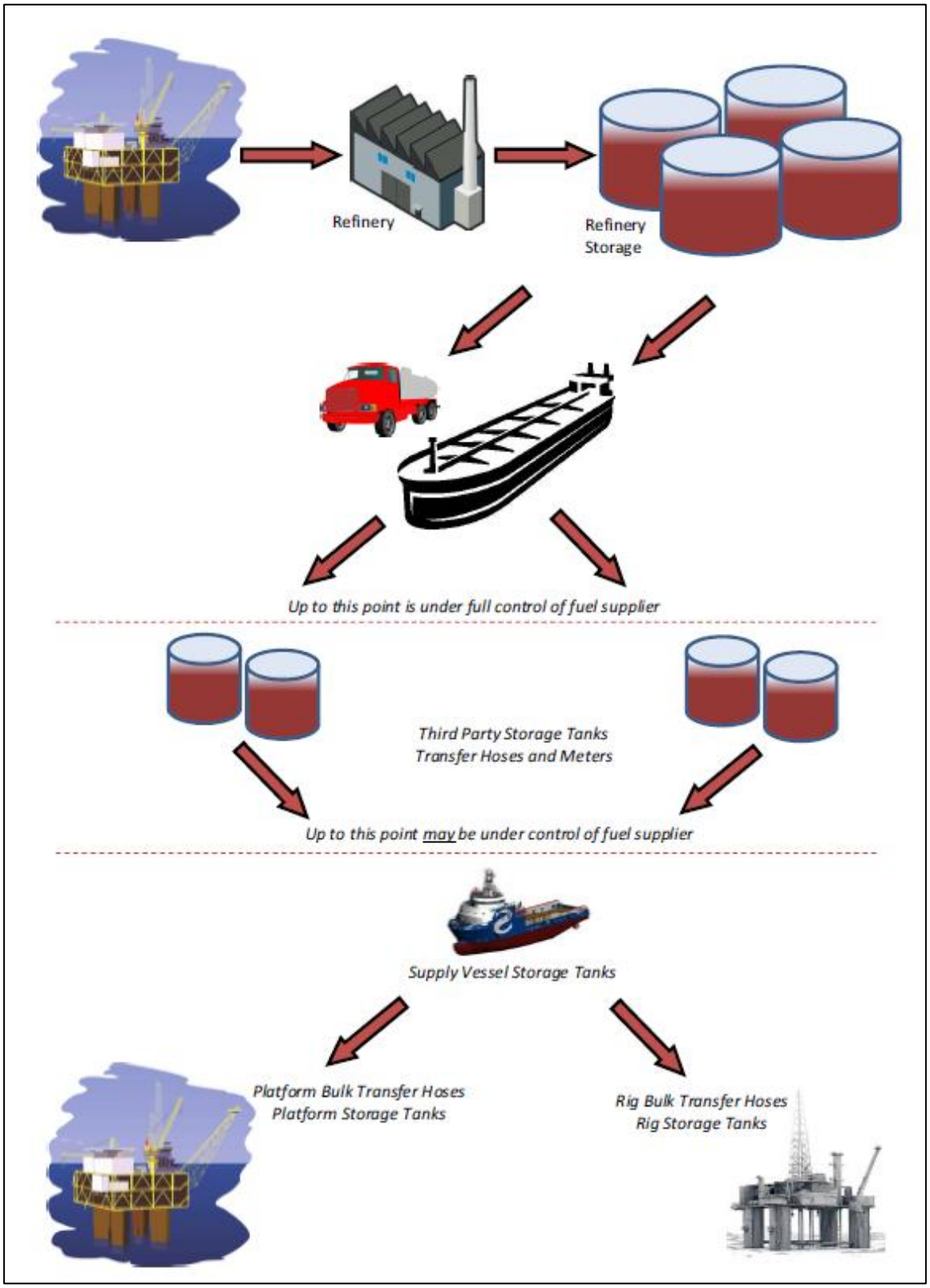


Figure: 1 – Schematic of Fuel Supply Chain and Responsibility Changeover Points

2.1. Underlying Principles

For the purposes of this document, it is assumed that the fuel provider is supplying a quality product and that this guidance applies to the supply chain from arrival at the quayside onwards to the end user.

The standards that apply to good quality fuel supply for offshore use are:

BS ISO 8217:2017 Class DMA

This particularly applies to special areas such as the North Sea which is part of the Emissions Control Area (ECA) where ultra low sulphur content is required.

Where there is a risk of contamination, control measures are required to minimise this risk. Sections 3,4 & 5 are structured to reflect the steps in the supply chain where control measures will be applicable. Control measures include, in order of importance, but are not limited to:

- Management
- Maintenance
- Monitoring (includes sampling)
- Treatment
- Records

3. Practical Guidance – Shore-Side Systems

3.1. Shore-Side Storage Tanks

3.1.1. Design and Construction

Tanks will be, in the main, above-ground, vertical cylindrical mild steel storage tanks. Built in accordance with relevant British Standards (BS) but where appropriate it also can make use of commonly accepted international standards and codes, such as American Petroleum Institute (API). Normal tank standards are BS 2654:1955, BS EN 14015:2004, API 620, API 650, DIN 4119-1, CODRES, and G0801. Pipelines will be predominately designed to ASMI and of mild steel construction to Schedule 40 or above.

3.1.2. Management & Maintenance

The tank operator will have in place a management system to manage the life time of the storage tanks, pipelines and ancillary equipment. This will include operator routines, operational risk assessments, planned inspections to accepted guidance (such as EEMUA or API), maintenance, corrosion protection and management roles and responsibility. Inspections can be prescriptive or risk-based using predictive degradation rates from previous inspections or published guidance.

All tanks should be managed to reduce water content to as low as possible to control levels of microorganisms, as they require free water (water that has separated from the oil) to live in. It is good practice to dip tanks for water content at least monthly as well as following delivery into the tank. Where free water is found during these dips the tanks should be de-watered immediately. Observed water levels should be trended for abnormal variations in accumulation of free water and these should be investigated.

Free water accumulates in storage tanks through 3 main causes:

- Fuel oils naturally contain levels of suspended water which can drop out. The only way to manage this is through regular checks and dewatering when required.
- Water can be imported from oil tankers, although this is now less likely since modern tankers now have separate ballast tanks and it may be possible to show that an extensive settling time is not required; however, without this evidence, a rule of thumb of 24 hours settling time may be suitable.
- Since the fuel's ability to hold water decreases with decreasing tempartures, free water typically increases as fuel cools. Some free water coalesces on the tank skin . The balance that does not remain suspended in the fuel drops out and accumulates on the tanks floor.

It is also good practice that tanks are cleaned out on a regular basis at a frequency that is dependent on the rate of turnover, size of tanks, product stored and whether the tank is lined.

Consideration should be given to representative sampling prior to loading to supply vessel from tank valve and then at pipe end.

3.1.3. Monitoring

Fuel held in storage tanks will be regularly sampled and tested, either directly from the storage tanks or from the fuel hydrants/manifolds whilst bunkering takes place. The samples will be retained for a period of three months and can be sent for sampling to independent laboratories as appropriate. Microbial growth in storage terminals is best monitored by routine (e.g. one to six monthly depending on risk) tests of tank bottoms/drains.

The recommended minimum tests to be carried out are defined in section 7 in this document

3.1.4. Records

A management system, which should include the retention of tank photographic evidence, should be developed to include, as a minimum, maintenance schedules, inspection and cleaning routines, fuel condition, fuel treatment methods, sampling and testing methods frequency and results. These records should be readily available for periodic audit and be retained for a period of 3 years.

3.2. Barges,Road-Tankers, Manifolds, Hoses, Bunker Trolley/Meters

3.2.1. Management

In the main, all Marine Gas Oil (MGO) supplied to vessels is via dedicated manifolds directly from the main storage tanks and delivered directly to the manifold. The manifold will have caps covering the connections to mitigate any ingress of dust or moisture.

Only dedicated, uniquely identified, fuel hoses should be used for the transfer of fuel either from the delivery tanker or as part of the bunkering process. The hoses should be fit for purpose, be in test and open ends capped when not in use in such a way as to avoid water ingress. End caps must be inspected, cleaned and replaced as required. Hoses must always be visually inspected before use.

3.2.2. Maintenance

Manifolds and hoses must be inspected before each use and this recorded on the appropriate check sheets. Flexible hoses should be used only where appropriate to the risk. For guidance refer to the Energy Institute publication “Guidelines for the Management of Flexible Hose Assemblies”, and covered by written documentation. Testing of the hoses should be to a defined standard such as BS-EN-ISO 1402:2009. Fittings should be in good condition, clean, tight-fitting and leak free.

3.2.3. Records

Records should be retained for a defined period of 3 years.

4. Practical Guidance – Shipboard Systems

4.1. Cargo Tanks

4.1.1. Management

Cargo tanks, used for transporting fuel, must be managed specifically for that purpose. Efforts should be made to minimise the storage duration of fuel in any tank to avoid build-up of condensation, as condensation may lead to microbial growth.

Vessels with multi-specification tanks require additional control measures to ensure adequate cleanliness of the systems after a change of product.

Good practice should be to discharge oldest stock first, ensuring individual fuel parcels are not mixed, and that fuel is not retained onboard for more than 30 days. Fuel that has been onboard in excess of 30 days should be tested and proven as fit for supply to offshore installations (such fuel should be quarantined pending test). When rotating product, consider both the tank and piping systems to ensure the full quantity has been rotated such that all product remains fresh.

4.1.2. Maintenance/Planned Maintenance System (PMS)

Maintenance requirements for fuel cargo tanks and systems should be contained within the vessel Planned Maintenance System and audited under the International Safety Management (ISM) Code.

The Planned Maintenance System must cover scheduling and scope of inspections, tank fabric maintenance, cleaning and test routines on board.

Internal visual inspection of cargo tanks should be carried on a frequent basis but, if possible and practical, at least annually and thorough cleaning must be carried out as and when required. Good practice would be to maintain a short written report and record of photographic evidence from every tank inspection, to monitor condition and to revert to, should there be any issues with the said tank in the future. Where contamination, sediment, deposits and damaged/worn coatings are identified, the corrective actions must include but not be limited to the below:

- Physically clean tanks to remove contamination such as biofilm, sediment and debris
- Touch-up tank coatings as necessary, if inspections highlight any damage. Coatings should be applied as per manufacturer's recommendations and guidelines. Care must be taken to ensure effective curing of tank coatings before the tank is returned to use. Coatings must be specifically designed and approved for fuel.

Affected tanks must be thoroughly inspected (including the suctions and drainage holes) and the fuel that is subsequently loaded into the tank tested and results obtained prior to returning the tanks to service.

In addition, Vessel Owners/Managers should plan to undertake preventative maintenance including thorough cleaning and re-coating where necessary, of all fuel tankage within their dry-dock cycle.

For non-coated tanks, the above applies but also consider condition of steel plating.

Consideration should be given to the provision of dedicated sample points at suction level on each fuel tank and also on delivery pipework for new build vessels. The high-level alarms must be inspected as per the Planned Maintenance System.

4.1.3. Treatment

No treatment (biociding) of fuel carried as cargo is to be initiated without express instructions from the Charterer. For any fuel not carried as cargo and designated solely for vessel consumption, treatment may be carried out at owner's discretion (It is strongly recommended that Specialist advice is sought before any Biocide is considered).

Where Biocide or additives have been applied to a fuel supply, records should be maintained and declared at time of charter. Biocide should only be added following an incident where significant microbial contamination has been identified. The presence of biocide may cause further problems such as sludge build-up.

Where a tank has had Biocide applied it should be thoroughly cleaned before cargo fuel is loaded.

4.1.4. Monitoring

Sampling and visual inspection of fuel shall be carried-out before, during and upon completion of loading to make sure the fuel is of the required specification.

Fuel oil cargo tanks to be used for delivery of fuel to offshore installations, should be sampled at least on a quarterly basis by a 3rd party and analysed. An individual certificate for each tank should be produced to show whether the fuel and tank meets the requirements or if remedial action is required.

It is recommended that quarterly fuel samples are analysed against the following parameters from each tank in line with ISO 8217:2017 or BS 2869:2010.

- Appearance including Water Content and Particles
- Flash point
- FAME

Although not specified in ISO 8217:2017 or BS 2869:2010, it is recommended a test for microbiological contamination is also conducted at least on a quarterly basis. Appropriate microbiological test methods and guidance on acceptable levels of contamination are provided in section 7.

Test results marginally outwith the parameters above are not always an indication of poor quality fuel and guidance from an independent competent 3rd party should be sought.

Additional checks can be carried out at the owners discretion or upon charteres request, but the above is the minimum criteria that should be followed as failure of the above tests could result in loss of fuel efficiency and/or equipment damage.

Fuel testing and monitoring can be carried out in conjunction with the quarterly 3rd party testing frequency. To guarantee quality of fuel refer to Appendix 2 of this guidance and for further information on microbial testing see Appendix 7.

It is considered good practice that owners/operators of all types of vessel subscribe to a recognised fuel testing regime to ensure consistent good quality of fuel.

4.1.5. Records

Planned maintenance routines and records must be kept up-to-date and include comprehensive details of the work carried out and outcome. Consideration should be given to keeping photographic records to support the written report. Records should be retained for a period of 3 years.

It is recommended that in order to provide trend indications, expired fuel test certificates be retained onboard as archives for a minimum period of 12 months. It is also considered to be good practice to retain Fuel Quality Certificates and Bunker Delivery Notes for a period of 12 months after loading.

4.2. Pipework / Manifolds

These should be treated in a similar way as tanks, with annual inspections to ensure cleanliness and integrity.

Manifolds and caps should be inspected before and after use. All valves are to be operational and kept closed when not in use.

Planned maintenance routines and records must be kept up-to-date and include comprehensive details of the work carried out and outcome. Consideration should be given to keeping photographic records to support the written report. Records should be retained for a period of 3 years.

4.3. Tank Vents, Screens and Sampling Points

These should be treated in a similar way as tanks, with inspections in line with the vessels Planned Maintenance System to ensure cleanliness and integrity.

Any defects should be repaired as soon as possible.

Planned maintenance routines and records must be kept up-to-date and include comprehensive details of the work carried out and outcome. Consideration should be given to keeping photographic records to support the written report. Records should be retained for a period of 3 years.

4.4. Hoses

Although very uncommon within the offshore sector of the North-West European area, where vessels provide their own hoses, the Owners should follow the guidance for shore-side hoses contained within this publication.

4.5. Fuel Meters

These should be treated in a similar way as tanks, with inspections in line with the vessel's Planned Maintenance System to ensure cleanliness and accuracy.

Any defects should be repaired as soon as possible.

Verification by an approved surveyor should take place annually to ensure accuracy or to identify discrepancies. Where it is not practicable to send the unit to an approved test facility then verification against another meter that has recently been calibrated can be carried out. It is recommended that formal calibration should take place as per the manufacturer's recommendation.

Verification records should be retained for inspection.

5. Practical Guidance – Offshore Installations

It is recommended that Offshore installations follow guidance contained within Section 3 of this document for onboard storage and transfer systems and Guidelines for Offshore Marine Operations (www.G-OMO.info) for bulk transfer hoses.

6. OPERATIONS

This section considers the process of bunkering and transporting fuel to offshore installations

6.1. Chartering

It is considered good practice that all vessels utilised for the carriage of fuel to offshore installations ensure that there is a regime for an accredited third party to sample and test fuel quality on a three monthly cycle to prove effective management and fitness for purpose of the system.

Vessel Owners should verify that any newbuilding vessel utilised for the carriage of fuel to offshore installations is delivered with tanks that are thoroughly cleaned, that tank coatings are intact and that the tanks and associated pipework has been inspected as being free of any debris.

Extra consideration should be given to vessels that have not been operationally active in the carriage of fuel to offshore installations for more than three months. It is conceivable that tank systems may not meet the required cleanliness standard or fuel remaining on board may no longer be fit for purpose. Good practise would be to consider such vessels in the same manner as new-build vessels (above).

Failure to provide such information may affect the suitability for charter of the vessel.

In order for a vessel to prove quality of fuel supply at the commencement of a charter, comprehensive records are essential to verify the source and specification of any residual fuel.

Good practice dictates that fuel tanks should be emptied as much as possible at delivery to an offshore installation to limit or avoid co-mingling of packages.

Where short term hire of a vessel is undertaken, the Charterer should ensure that they are satisfied by examination of records of the quality of fuel remaining on board and should, whenever possible, utilise empty tanks for their product.

If the last test results are more than 6 months old, then those tanks containing residual fuel should be quarantined until the fuel contained can be analysed. However, it is good practice for charterers to only order enough fuel for their immediate requirements to avoid long term storage issues.

Prior to commencing term charters, the vessel must be able to produce test results for all fuel tanks, otherwise tests must be carried out and tanks quarantined until results available.

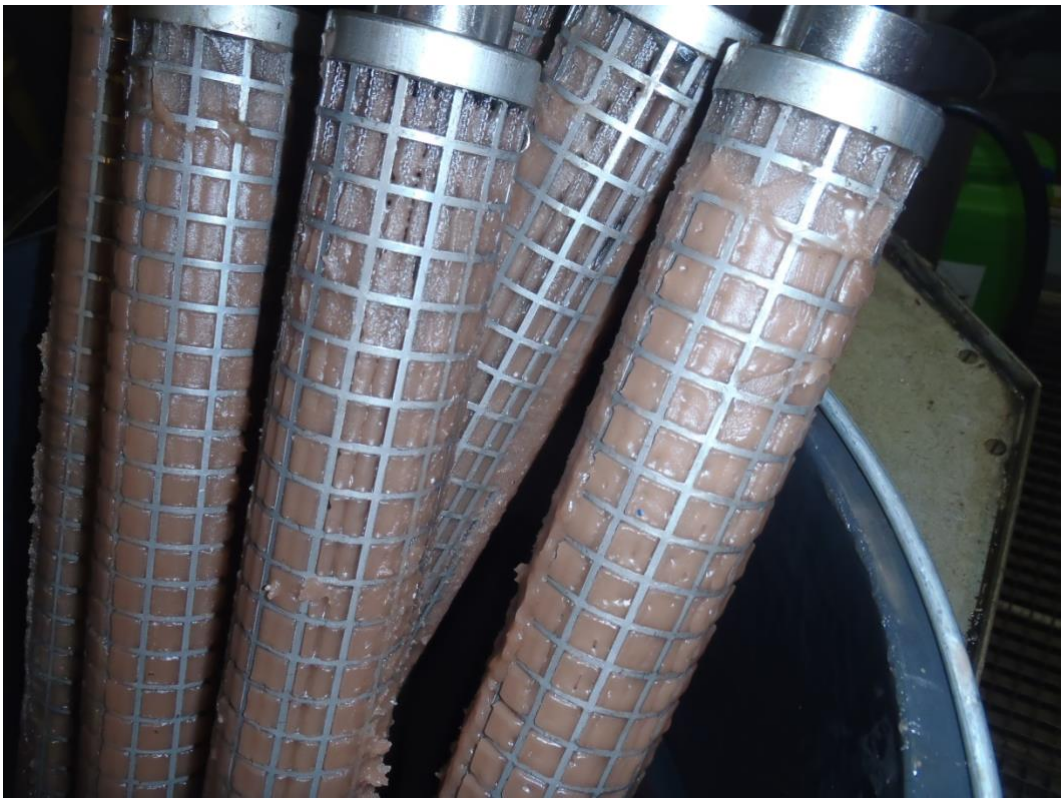
However, if adequate records of good quality exist, then risk assessment shall determine if the product can be shipped.

6.2. Fuel Quality (Detail from SUPPLIER)

Appearance	The appearance of a sample should be assessed by visual inspection in good light as 'clear and bright'. Initial test is an operational local assessment at ambient temperatures which gives an indication of whether any issues may be present. If the test raises any concern then the sample should then be laboratory tested at 20-25 degrees Celcius (°C). In rare cases where, for example, a non-transparent dyed product means visual assessment cannot be made, a recognised alternative is to test the water content is under 200ppm. Refer to Appendix 1 for further guidance.
Sulphur	Sulphur levels must be below a value set by various legislation. For example, Offshore Installations in the North Sea fall within a Sulphur Emission Control Area (SECA) that limits ships to use fuel with a maximum sulphur content of 0.1%.
Flash Point	According to the International Convention for Safety of Life at Sea (SOLAS) the Flash Point must be a minimum of 60°C.
Cold Flow Characteristics	It is up to the purchaser to confirm that the cold flow characteristics are suitable for the intended use. To help with this, MGO is sold in the NNS as Summer grade from the 16th March - 15th November and Winter grade from the 16th November to 15th March. The liquid wax in marine fuel is an essential component, because it gives the fuel its 'Cetane Value'. However, during the cold winter months, there is a risk that wax particles may crystallise and solidify, collecting on fuel tanks and clogging filters. It is therefore vitally important that fuel that will not clog up in the cold is purchased.
Pour Point	Pour point is the lowest temperature at which a fuel will continue to flow when it is cooled under specified standard conditions. It is the only characteristic to have a maximum specification in ISO:8217. This is 0°C in summer and -6°C in winter.
Cold Filter Plugging Point	CFPP is the value below which fuel will not pass through a specified filter size. It is considered of greater relevance than Pour Point and many suppliers will adhere to the BS:2869 specification over and in addition to ISO:8217. The BS:2869 specification is -4°C in Summer and -12°C in Winter.
Cloud Point	Cloud point is the temperature below which, under standard cooling conditions, wax crystals may begin to form in the fuel which can be detected by the human eye. These tend to disappear when the fuel is taken back above this temperature and do not tend to affect the burning characterisitics of the fuel. The 2017 revision of ISO:8217 introduced a requirement for suppliers to report the Cloud Point and CFPP but did not specify maximum values.
Further information on the above and additional specifications can be found in ISO:8217	

TABLE 2. Explanation of *Criteria* used to define quality fuel

Some examples of “waxing” are shown below;



6.3. Bunkering Shore to Vessel

Before loading can take place, a bunkering checklist should be completed to ensure, as a minimum, that the following is in place:

- Safe access/egress to and from the vessel.
- Suitable and functioning equipment for the bunkerng operation.
- Sufficient ullage to accept the required fuel.
- Emergency and spill response equipment available at site.
- A clear communication plan for the duration of the bunkerng operation.

There will be variations on the methodology to bunker the vessel but all are likely to involve flexible hoses which must be subject to a pre-use check, various connections which must be secured and a meter which is likely to be a positive displacement meter which should have been independently calibrated. In addition, three representative samples should be taken as close to the point at which the product transfers ownership, normally at the meter on the quayside. These samples will be a MARPOL sample plus one for each party which should be retained for a period of at least 3 months.

As a minimum, all suppliers should have available a Method Statement or Procedure; Risk Assessment, which should include the risks to or from Simultaneous Operations and Environmental Conditions; a Certificate of Quality and a Material Safety Data Sheet.

Bunkering must be a continuously manned operation at both ends of the delivery hose and for large parcels of fuel, it may be appropriate to conduct periodic checks during the loadout to ensure continuity of supply.

6.4. Vessel Carriage of Fuel

- Fuel transfer between cargo tanks should be discouraged unless absolutely necessary for the safety of the vessel.
- Records of any transfers of fuel are to be recorded in the Oil Record Book.
- In order to minimise co-mingling of product and loss of identity of the product parcel, it is recommended that tanks are stripped prior to each loading, using the smallest bore and capacity pump available, to the ships own use tanks. This is to remove as much old fuel as possible prior to loading new fuel.
- For the reason above, it recommended that Fuel cargo is not loaded on top of any fuel already onboard.
- A rotation schedule shall be developed and in place to ensure the fuel loaded first is discharged first. Tank management is important to ensure continuity of supply.
- Where cargo fuel remains onboard in excess of 4 weeks, the charterer shall be notifed and consideration should be given to sampling and quarantine of the product until proven as ‘fit for purpose’.
- It is recommended that a fuel sample is taken from the installation manifold or line at commencement of fuel transfer to the installation. This should be repeated if more than one tank is to be used or if tanks are changed during the transfer. This sample is purely to check appearance and may be disposed of once the installation has completed their sample test on each tank being transferred.
- It follows therefore that the installation shall be notified following any tank changes during the fuel transfer and requested to take a fuel sample for testing following each tank change.
- No biociding shall be undertaken unless requested and approved by Charterer and it is strongly recommended that Specialist advice is sought before any Biocide is considered.
- A formal process should exist for fuel to be quarantined on-board if the vessel cargo fuel pump strainers and/or offshore installation bunkering line filters (where fitted) are found to be clogged or contaminated. This would as a minimum entail cessation of the transfer operation and investigating the problem. Particular care should be taken when bunkering fuel from different geographical areas as compatability may be an issue.

Consideration should be given by Vessel Owners to the installation of sampling points on discharge manifolds. This may provide positive proof of quality of product from individual tanks prior to transfer to the bunker hose.

The installation must prepare hoses used for the transfer of fuel in line with the requirements of current industry guidance for offshore marine operations (please see www.G-OMO.info)

Wherever possible, fuel should be sampled and analysed by installation crew prior to the bunkering operation to confirm that the fuel is of suitable quality, i.e. Clean and Bright.

7. Quarterly Microbiological and Water Content Testing

For further information on the problems microbial contamination causes in marine fuels and the test methods used to detect it, see the Energy Institute "*Guidelines for the investigation of the microbial content of liquid fuels and for the implementation of avoidance and remedial strategies"*.

The focus of routine microbiological testing should be on assessing the status of tanks and infrastructure rather than directly assessing the "microbiological quality" of the fuel. Therefore, a few priority sampling points should be identified and tested; they should be selected on the basis that they are the most likely locations where microbial growth will first appear, typically system low points and tank bottoms. It should be appreciated that samples from these locations will not be representative of bulk fuel phase but will be 'worst case' samples. If routine testing of the selected sample points shows that no significant contamination is present this provides reasonable assurance that the bulk of fuel in the tank or system is also not significantly contaminated. Conversely, if significant contamination is found in any of the selected sample points, it indicates a potential for problems and the results should be acted on at the earliest convenient opportunity.

7.1. Test Methods

Several IP and ASTM standard methods have been specifically developed for assessment of microbiological contamination in fuels and these are listed in Table 2 below. It is recommended one or more of these is used when conducting microbiological testing. The different microbial test methods differ in the manner in which they detect microbes and, consequently, they will also differ in the way the result is reported. Some of the methods, namely IP385/ ASTM D6974 and IP472 can only be conducted in a laboratory by specifically trained personnel. However, the other methods can also be conducted in the field or on-board and do not require any specialist training or laboratory equipment.

Other microbiological methods or test kits are available but may have limitations and provide unreliable results when testing fuel samples. For example, Dip-slide test kits can be used to test water or fuel water interface samples from tank bottoms but provide erratic results when used to test fuel samples directly. Additionally, Dip Slide tests are usually contained in polystyrene tubes which are not compatible with fuel; the tubes can distintegrate exposing users to potential hazardous microbial cultures.

7.2. Monitoring shore based storage tanks

It is recommended that routine microbial monitoring of tank bottom, lower level or drain samples takes place on a scheduled basis. Typically, this will be conducted every one to six months, depending on the tank's history (water ingress, fouling, corrosion etc.), the effectiveness of water draining and product settling practices and the height of the tank suction level (i.e. the risk of delivering fuel contaminated with microbial growth from the tank bottom).

A suction level sample or bulk fuel layer samples may additionally be tested when microbial test of a bottom or drain sample indicates the presence of heavy contamination. Ideally, these samples should be taken immediately after any standard settling protocols have been applied to best reflect the microbial content in fuel delivered from the tank.

7.3. Monitoring Ships' Bunkers and Fuel Tanks On-board

It is common practice for ship and platform operators to subscribe to a routine bunker analysis service and there are a number of global providers. Although not stipulated in marine fuel specifications, some operators choose to include checks for microbial contamination in the suite of tests conducted on marine distillate fuels. Additional routine microbiological testing of drain samples from on-board fuel tanks such as settling tanks, day tanks and auxiliary tanks for generators, lifeboats, cranes and other equipment can establish whether microbial growth is occurring subsequent to bunkering fuel. Many platform operators have an on-board monitoring program utilising either contract laboratories or field test kits. Typically, this will be conducted on a monthly to quarterly basis depending on the perceived risk and operational experience.

It is also good practice to test diesel before and after diesel filters or coalescers and to check fresh deliveries of batches of diesel fuel.

Typically on newer tonnage with a double hull where fuel tanks are situated above the tank top, a sample point will be located adjacent to the tank sump drawing a sample via a goose neck arrangement from the sump by gravity.

Single Fuel Sample Point

Multiple Fuel Tank Sample Point

On older tonnage where sampling points are not fitted, fuel can be circulated using ship's pumps to transfer bottom line contents from the tank being sampled, to a slack ship's use tanks, always ensuring that there is sufficient spare tank capacity/ullage space to complete bottom sampling as required. Once a fresh sample is received at the pump/filter or drain cock, the pump is stopped and a sample can be drawn. The process will be repeated for each tank to be sampled.

7.4. Guidance Limits for Marine Gasoil

Although marine fuel specifications, such as ISO 8217, do not include microbial contamination limits, guidance limit values have been widely applied for marine distillate fuel supplied and used by ships and offshore platforms. Table 3 shows recommended limit values for distillate fuel, including fuel supplied to and used by offshore platforms for gas turbine power generators, diesel generators, lifeboats, fire pumps, cranes and other equipment. They are based upon extensive industry experience. The limits are applicable to routine tests of supply tank and day tank drain or low point samples tested periodically for microbiological contamination. The limits should be considered in conjunction with assessment of visual appearance by ASTM D4176 (or equivalent 'clear and bright' test) and water content by IP 438 or equivalent. Additionally, tests for fungal fragment content, assessed by IP 472, and/or filter blocking tendency, assessed by IP 387 (or equivalent), are frequently conducted for marine Gasoil. Particle counting by ASTM D7619 can also give a good indication of overall fuel cleanliness. Tests will typically be undertaken by service laboratories or by the platform chemist as part of an on-board monitoring programme.

The guideline limits shown in Table 3 can be used to indicate whether excessive levels of microbial growth are occurring within the diesel fuel system, and highlight the need for remedial measures. It should be

noted that, even when significant microbiological contamination is present, it is not always accompanied by detection of abnormally high water content or visible particulates. Also, microbiological test results should not be used alone to make direct inferences about fuel quality or fitness for use and even when results are 'poor', as defined in Table 3, it is possible that the bulk of fuel might still be fit for use on a short-term basis providing specific precautions are taken. However, failing to take appropriate actions to resolve contamination will usually lead to onset of operational problems such as filter plugging and corrosion in the long term.

If 'moderate' contamination, as defined in Table 3 is detected, firstly, diesel should be allowed to settle then dewatered by a suitable treatment (draining, coalescers, filters or centrifuge). Most engines can accept some water content for short periods so, if the results are marginal and confined to a single batch, it might be deemed acceptable. It is recommended that the machinery manufacturers' specifications are consulted.

Diesel heavily contaminated with microbes may require treatment with a specialised biocide for fuel systems with due regard to the necessary precautions and specialist advice. In severe cases, tank cleaning may be needed before biocide treatment. After treatment, further testing should be conducted to determine whether measures were effective. The use of biocides may render the fuel unacceptable to the end user so it is important to use with extreme caution.

Where it is necessary to test samples of representative bulk fuel (e.g. from delivery lines, cargo tank manifolds, or Upper, Middle, Lower samples from storage tanks) the guidance limits will typically be more stringent than shown in Table 8 for bottom/drain samples.

TABLE 3 (below). Guidance limits for microbial contamination and related parameters in drain or low point samples of middle distillate fuel (e.g. marine diesel, gas oil).

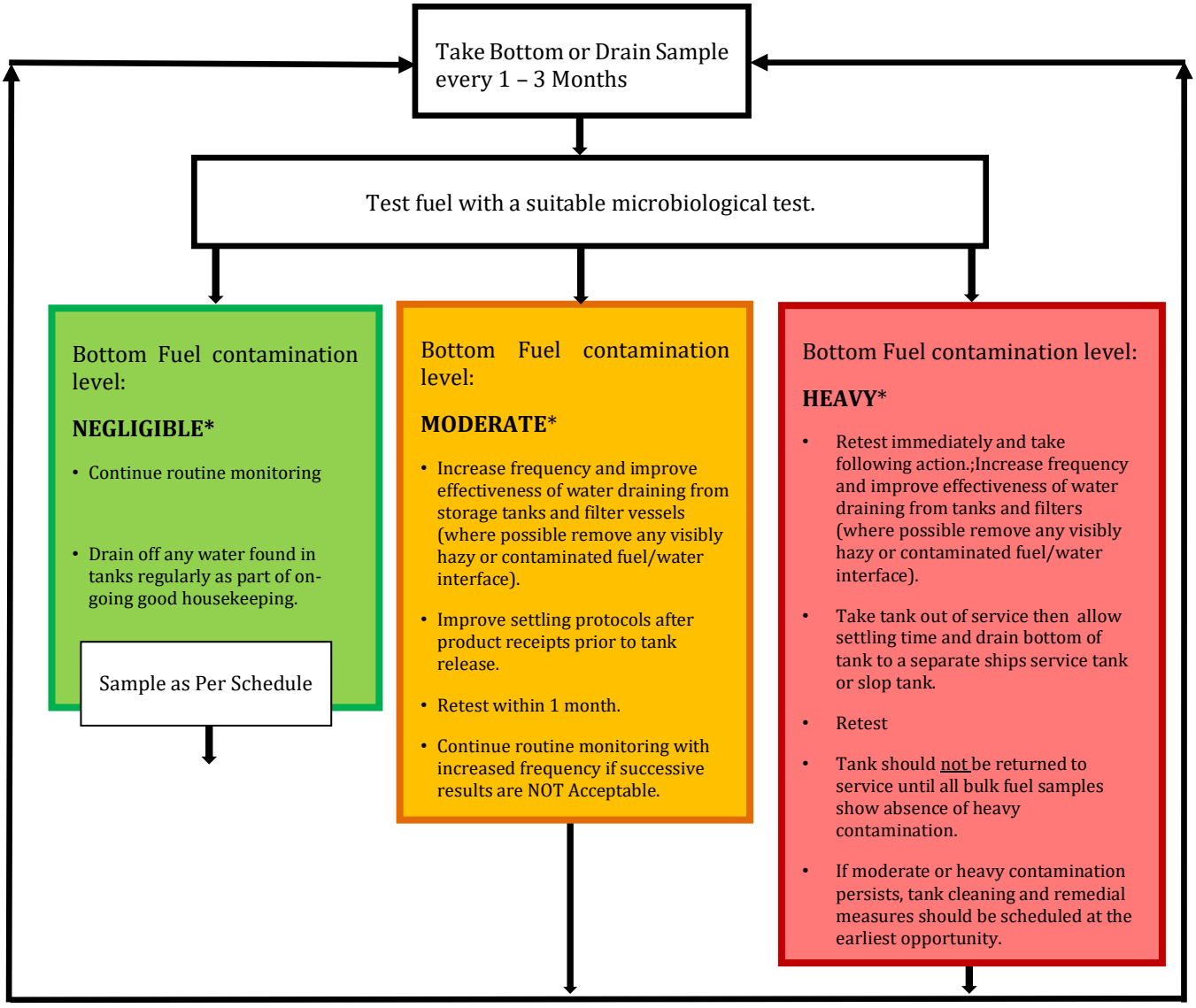
Please note that the below limits are indicative only and should not be seen as pass or fail criteria. What it indicates is that more investigation may be required and action may be needed.

Test Method	Neglible	Moderate	Heavy
Visual Appearance			
Clear and bright test (e.g. ASTM D4176)	Clear and bright	No more than very slightly hazy. No more than trace of particulate. No free water.	Dark and/ or hazy and/or significant amounts of particulate or free water.
Water Content			
Water content (e.g. by IP438)	<100 mg/kg	100 - 200 mg/kg	>200 mg/kg
Microbial Contamination			
Total Viable Count of culturable bacteria, yeasts and/or mouldsa (e.g. by IP385 / ASTM D6974 or IP613)	<104 CFU/Litre	104 - 105 CFU/Litre	>105 CFU/Litre
Fungal fragments (e.g. by IP472)	<5000 fragments/Litre	5000 – 100,000 fragments/Litre	>100,000 fragments/Litre
ATP (by ASTM D7463)	<1000 RLU/Litre	1000 - 5000 RLU/Litre	>5000 RLU/ Litre
ATP by ASTM D7687)	<10,000 cATP/Litre	10,000 – 100,000 cATP/Litre	>100,000 cATP/Litre
Immunoassay by ASTM D8070	Not detected (<150 µg/L in fuel or <33 µg/mL in water)	Low (150 - 750 µg/L in fuel or 33-166 µg/mL in water)	High (>750 µg/L in fuel or>166 µg/mL in water)

[a] For the IP 385 and ASTM D6974 the total count of fungi and bacteria should be considered.

FIGURE 2 - FLOWCHART FOR TYPICAL ROUTINE MICROBIAL MONITORING

(Refer to Section 4.1.4)



APPENDIX 1 - SAMPLING PROCEDURE

Do's and Don'ts

When taking samples for microbiological analysis, hygiene around the sampling activity is vital.

- Sampling equipment and sampling valves should be clean.
- If possible, decontaminate sampling equipment and sample cock.

Sample containers used for sampling must be clean; preferably they will be sterile but, in practice, it is sufficient to use clean previously unused containers.

Samples can be considered in two broad categories:

1). Representative bulk fuel samples and line samples

- These samples are required for confirming overall fuel quality and/or its compliance with specifications.
- Care should be taken to ensure the sample represents the entire parcel of fuel under consideration. When taking spot samples, a suitable number of samples should be taken from layers within the tank. A single tank composite sample can be made where appropriate.
- When taking line samples during a fuel transfer, take a suitable number of samples covering the beginning, middle and end of transfer. A single line composite sample can be made where appropriate. Alternatively use continuous drip samplers – these should ideally be configured to ensure they sample in an area of turbulent flow and avoid unrepresentative samples due to laminar flow effects within the delivery line.
- For further information refer to IP 475 Petroleum liquids - Manual sampling (ISO 3170)

2). Bottom / low point samples

- Tank bottom and low point samples provide the best and most consistent early indication of developing microbial growth. They also enable visual checks for presence of free water.
- Sample tank bottoms as described in section 7.3 in this document.
- Ensure consistency in the sampling procedure;
- Sample from the same point and in the same manner on each occasion.
- As far as practicable, tanks should be sampled under similar conditions – e.g. after filling and settling and prior to service.
- For **routine monitoring** for microbial growth, flush the sample point to ensure that line contents and any visible water or hazy product have been removed prior to taking a sample for testing.
- It is critically important that fuel tested is free of settled or suspended water as the microbe levels in associated free water can be more than 1,000 times greater than in the fuel phase.
- This leads to false positive results and inconsistent trend analysis
- For **investigative analysis for microbial contamination**, the first water to come from the tank (after flushing the drain line only) can also be tested.

APPENDIX 2 – EXAMPLES OF TYPICAL OFFSHORE FUEL SPECIFICATION

Certificate of Quality

Tank:
Sample Date/Time:
Blend:
Sample ID:

Product:
Formula:

Customer:
Address:

Ship Date:
Conveyance ID:

	PROPERTY	TEST METHOD	RESULT	UNITS
	APPEARANCE	ASTM_D4176	C&B	
	DENSITY AT 15C	IP_365	882.7	kg/m3
	KINEMATIC VISCOSITY AT 40C	ASTM_D445	4.263	cSt
	SULFUR CONTENT	IP_336	0.073	wt%
	ASH	IP_4	0.002	wt%
	MICROCARBON RESIDUE 10%	IP_398	<0.10	wt%
	CETANE INDEX	IP_380	42.1	
	POUR POINT (UPPER)	INFERRED_FROM_IP_309	<=-16	deg_C
	50% RECOVERED	ASTM_D86	306.0	deg_C
	95% RECOVERED	ASTM_D86	370.2	deg_C
	FLASH POINT PMCC - PROC A	ASTM_D93	82.0	deg_C
**	OXIDATION STABILITY	IP_388	2	g/m3
	TOTAL ACID NUMBER	ASTM_D664_METHOD_A	0.1	mgKOH/g
	LUBRICITY - HFRR	IP_450	329	micron
	ISO8217 ANALYSIS WITNESSED BY	WITNESS	INTERTEK	
	COLD FILTER PLUGGING POINT	IP_309	-16	deg_C

Responsible Party:

Created by:

It is certified that the product detailed hereon has been inspected, tested and unless otherwise stated, conforms in all respects with the EXXONMOBIL PRODUCT SPECIFICATIONS, ISO8217:2012 class DMA.

The tests methods quoted in this Certificate are those used to verify the quality of the production of batches against the specification limits and are in accordance with latest published versions (unless otherwise stated). Where alternative methods are used, these test methods have been verified to give equivalent results, with the same or better precision, versus those required by the relevant standard. In case of arbitration the methods quoted in the relevant standards are to be used.

Test method results have been rounded to comply with the specification and/or regulation.

The product detailed hereon is guaranteed to have a Hydrogen Sulfide level of less than 2mg/kg when tested by IP 570.

* Tested by an ISO certified independent testing laboratory.

** This is a periodic test which may not have been performed on this particular batch of fuel. Periodic tests are performed on batches of fuel at pre-determined frequency based on a statistical risk assessment. Typical test results are available upon request.

MOD Slight deviation from the specified analysis. It however does not alter the precision of the quoted method.

Certificate Of Quality

Sample Name	Tank APT8	**Serial Number**	2
Vessel / Train		**Customer**	
Product	APT-G2W	**Transferred From**	
Grade	BS 2869 Class D plus BS ISO 8217 Class DMA	**Tonnage**	
Sample Date	03/02/2018 13:10		
Sample Number	2909948		
Certificate Number	225821		
Sample Type	Composite Sample Taken From APT Tankage After Transfer		

Test	Result	Units	Method
Appearance	C&B		Visual
Appearance Test	Pass		
CFPP	-17	deg C	EN 116
Cloud Point	-9	deg C	EN 23015/ISO 3015
ASTM Colour	1.0		ISO 2049
Conductivity	140	pS/m	ISO 6297
Temperature	20	deg C	
DCN	48.1		EN 15195
Density	0.8570	kg/l @15C	EN ISO 12185
Fatty Acid Methylic Esters	<0.05	%vol	BS EN 14078
Flash Point (PMC)	72.5	deg C	EN ISO 2719
Wear Scar Diameter	411	Microns	EN ISO 12156-1
Sulphur	0.025	%wt	EN ISO 8754
Viscosity	2.87	cS @ 40C	EN ISO 3104
CCI	45.5		EN ISO 4264

Cetane improver may have been added to meet the Cetane Number Specification
Latest test methods used unless otherwise stated.
Certified this product conforms to APT-G2W

I have checked this CQ and confirm that the results which are shown conform to APT Specification for the Product.

Certificate Produced by

Date

The above product was loaded to the Vessel

Serial Number

Page 1 of 1

APPENDIX 3 – AUDIT CONSIDERATIONS

It is good practice to have a self-auditing process to ensure good quality of fuel carriage.

When considering criteria for audit the following should be considered as a minimum;

- Tank Coating maintenance
- Tank Content Rotation
- Cargo Segratation
- Tank Inspections and Records
- Tank Gauging
- Flowmeter Calibration
- Routine Sampling and Records
- Procedures and Documentation

APPENDIX 4 – MINIMUM STANDARD FOR BUNKERING CHECKLISTS

From Shore-side station to Vessel

NOTICE OF READINESS & BUNKERING CHECKLIST

VESSEL _____ **TIME & DATE** _____

BERTH _____ **PORT** _____

On behalf of the Owners/Charterers I hereby confirm m.v. _____

is ready, in all aspects, to load _____ **m³ of** _____

Signed: ..... Print: .....

Rank: ..... Time: ..... Date: .....

		SHIP	SHORE
1	Is Vessel Securely Moored?		
2	Is There Safe Access Between Vessel and Shore?		
3	Have Bunker Handling Procedures Been Agreed? (Emphasis on agreed communications). Please State:		
4	Has Emergency Shut Down Procedure Been Agreed?		
5	Is Fire Fighting Equipment Ready For Use?		
6	Are Smoking Regulations Being Observed?		
7	Are Naked Light Requirements Being Observed?		
8	Are Unused Cargo/Bunker Connections Blanked?		
9	Are Scuppers Effectively Plugged?		
10	Are Bunker Tank Lids Closed and Secured?		
11	Max Flow Rate Agreed _____ m³		
	Remarks		

CHECKED BY ..... **FOR VESSEL** .....

CHECKED BY ..... **OPERATOR** .....

For office use only

Delivery Note No_____ Commenced _____Hrs

Operators Initials _____ Completed _____Hrs

VESSEL – TOP COPY OFFICE - BOTTOM COPY

From Vessel to Installation

Please refer to “Guidelines for Offshore Marine Operations” (www.G-OMO.info)

APPENDIX 5 – REFERENCES

The following documents have been referenced in this publication;

API 620 Design and Construction of Large, Welded, Low-pressure Storage Tanks

API 650 Welded Tanks for Oil Storage

ASTM D4176 Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels (Visual Inspection Procedures)

ASTM D7619 Standard Test Method for Sizing and Counting Particles in Light and Middle Distillate Fuels, by Automatic Particle Counter

ASTM D7463 Standard Test Method for Adenosine Triphosphate (ATP) Content of Microorganisms in Fuel, Fuel/Water Mixtures, and Fuel Associated Water

ASTM D7687 Standard Test Method for Measurement of Cellular Adenosine Triphosphate in Fuel and Fuel-associated Water With Sample Concentration by Filtration

ASTM D8070 Standard Test Method for Screening of Fuels and Fuel Associated Aqueous Specimens for Microbial Contamination by Lateral Flow Immunoassay

BS 2654:1955 Specification for manufacture of vertical steel welded storage tanks with butt-welded shells for the petroleum industry

BS EN 14015:2004 Specification for the design and manufacture of site built, vertical, cylindrical, flat-bottomed, above ground, welded, steel tanks for the storage of liquids at ambient temperature and above

BS ISO 8217 Petroleum products -- Fuels (class F) -- Specifications of marine fuels

BS 2869 Fuel oils for agricultural, domestic and industrial engines and boilers

CODRES Code for Construction of Vertical Cylindrical Storage Tanks

DIN 4119-1 Above-ground Cylindrical Flat-bottomed Tank Installations of Metallic Materials; Fundamentals, Design, Tests

Guidelines for Offshore Marine Operations (www.G-OMO.info)

Guidelines for the investigation of the microbial content of liquid fuels and for the implementation of avoidance and remedial strategies - Energy Institute-ISBN 978 0 85293 448 7

IP 385: Determination of the viable aerobic microbial content of fuels and fuel components boiling below 390 °C - Filtration and culture method

IP387: Determination of filter blocking tendency

IP 438: Petroleum products - Determination of water - Coulometric Karl Fischer titration method

IP 472: Determination of fungal fragment content of fuels boiling below 390 °C

IP 475: Petroleum liquids - Manual sampling (ISO 3170)

IP 613: Determination of the viable aerobic microbial content of fuels and associated water - Thixotropic Gel Culture Method

ISGOTT – International Safety Guide for Oil Tankers and Terminals (5th Edition)

MAIB Safety Bulletin SB1/2017 June 2017 and

CIMAC Guideline 01/2015 – Cold flow properties of marine fuel oils

APPENDIX 6 – CONTRIBUTORS

ASCo UK Limited

BP Exploration and Production Operating Company

Certas Energy

Chevron Upstream Europe

ECHA Microbiology

Equinor UK Limited

Geos Group

London Offshore Consultants

Maersk Oil North Sea UK Limited

Maersk Supply Ships UK Limited

Marine Safety Forum

Peterson UK Limited

Solstad Offshore

V-Ships