Bunkering - A Compendium

September 2019

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Foreword

The 2020 IMO Sulfur Cap (as the impending MARPOL regulations are frequently described) has over the recent past been the source of unrelenting commentary and debate within the global shipping community. Some of that commentary has sought to enlighten; some has sought to generate controversy; yet other commentary has offered prognostications ranging from the apocalyptic to the banal as the full force of Annex VI bears upon the industry as 2020 begins.

Whatever the future might in practice hold following the implementation of the new regime after January 1 next year, there can be no denying that shipowners and operators have been made well aware of the challenges the regulations will entail. Indeed, the American Club has been active over recent months in adding to the supply of information, by way of Circulars and Member Alerts, on developments in this important area, mainly through drawing attention to the work of various industry coalitions which have themselves provided their own guidance on complying with the new rules.

Although a recent focus has of course been the 2020 Sulfur Cap, this Compendium is intended to supply guidance not only to issues arising from the new regulations but also in regard to best practice generally in the conduct of bunkering operations. It seeks to provide a comprehensive approach to loss prevention initiatives demanded both by the new regulations and generally by supplying guidance on operations and management, both ashore and afloat, aimed at obviating exposures with both a P&I and FD&D insurance implications. As Dr. Moore and Ms. Anber-Kontakis note in their preface, this guidance has been supplemented by training animations posted to the American Club's website specifically targeted at seafarers to assist them in the discharge of their own duties onboard ship in a manner designed to minimize risk of every kind.

My colleagues and I are particularly proud of this document and trust that the Club's Members and other friends across the global shipping community will agree that pride to be justified. In expressing that sentiment, I offer sincere thanks to those who have labored so diligently in composing this impressive document over recent months. The distinguished contributors to this notable enterprise are listed toward the end of the Compendium. Their considerable experience and expertise speak for themselves. They form the legacy of excellence upon which the exemplary work of producing this document has been based.

I believe that this Compendium will remain one of the most significant loss prevention initiatives which the American Club has undertaken in recent years. But even more significantly, it is my earnest hope that its acknowledged value to the Club's Members will stand the test of time, and in itself be testimony over the years ahead to the great work which was undertaken to produce it.

Joseph E.M. Hughes
Chairman & CEO
Shipowners Claims Bureau, Inc.
New York, New York

Preface

The risks for shipowners and charterers related to the bunkering of ships are broad in scope. They bear upon operational safety, the potential for environmental damage as well as exposure to negative financial consequences under contracts for the supply of bunkers. These risks are compounded further by the forthcoming sulfur cap related requirements contained in Annex VI to the MARPOL Convention to take effect on January 1, 2020.

Classification societies, marine engine manufacturers, P&I clubs, flag and port administrations, the International Maritime Organization (IMO), non-governmental organizations (NGOs) and the maritime legal community have issued a significant volume of quality guidance for shipowners and charterers in preparation for January 1, 2020 as well as general guidance on preventing bunker incidents and disputes.

The primary objective of this compendium is to provide guidance on shipboard operations and management, and shoreside management focused on the prevention of P&I and FD&D related incidents and claims. This guidance is supplemented by training animations posted to the Club's website on bunkering best practices specifically targeted at seafarers to ensure that shipowners' best interests are protected, and to prevent disputes.

We hope that this guidance will increase awareness regarding relevant aspects of bunkering, and that it will ultimately become a useful resource for all involved in this critically important aspect of operating ships. Members are encouraged to refer to the American Club's website at: https://www.american-club.com/page/bunker-fuels.

Dr. William H.Moore
Senior Vice President
Global Loss Prevention Director
Shipowners Claims Bureau, Inc.
New York, New York

Müge Anber-Kontakis, LL.M.
Vice President
Global FD&D Manager & Counsel
Shipowners Claims Bureau, Inc.
New York, New York

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We would also like to thank Messrs. Donald Moore, Richard Swan and Richard Hamilton and Ms. Jana Byron of the Shipowners Claims Bureau, Inc. for their dedication and professional expertise and assistance in bringing the Compendium and the associated website to fruition.

Disclaimer

The information presented in *Bunkering - A Compendium* is for general guidance information purposes only. While the American Club makes every effort to ensure that the information contained in the document is accurate, neither the American Club nor its Managers warrant that the information is correct or timely and no reliance is to be placed on the information.

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Bunker Fuels: How We Got Here

From early records of human history, it is apparent that ships and boats were propelled by various configurations of oars manipulated by men. It can therefore perhaps be stated, not unreasonably, that the first fuel to propel ships was food; the food consumed by sailors to provide the energy needed for them to power the oars needed to row a ship.

Speed and/or distance was undoubtedly proportional to the amount and quality of food consumed but it can certainly be said that since the earliest days of waterborne transportation to the present, the fuel required has changed from carbohydrate to hydrocarbon!

The natural power of the wind was later harnessed by sail, initially for local trade then bigger ships with bigger sails to travel to all corners of the world.

Wooden sailing ships grew in size eventually becoming iron-clad, then iron hulled when the steam engine was fitted to sailing ships then replaced the sails completely as power increased, as did the size of empires and trading areas and the need for speed. This all then needed a vital resource - fuel.

Eventually, through to the 1950's "external combustion" - boilers and steam turbines - held sway because of their ability to burn the dregs of the oil refineries.

But then the diesel engine, first doing its thing with "internal combustion" in the 1930's with distillate fuels eventually became the nemesis of the steam turbine plant when engineers figured out how to burn the same stuff in diesel engines that was being consumed in the boilers of steam-plants which were commonly referred to at the time at the incinerators of the refining industry.

The average 34% thermal efficiency of a steam turbine plant soon succumbed to the diesel plant that had North of 50% thermal efficiency – and now burning the same fuel.

The rest is history, as they say but of late we have seen numerous problems arising from the latest environmental demands on emissions causing serious conflicts with the diesel engine technology required to meet those demands whilst consuming the very product that refineries want rid of - and at times corrupted by unscrupulous disposal of chemical waste that the present day engines cannot digest.

John Poulson, CEng, CMarEng
Director & Chief Surveyor
Atlantic Marine Associates
New York, New York

Chapter 1 is a general guide on how to protect ships, their crew and the environment from the effects of sub-standard and/or contaminated bunkers that find their way into ships. This guidance is further supplemented by a five-part series of animations providing guidance to seafarers on bunkering best practices. The animations address best practices generally as well as those specific to forthcoming requirements under Annex VI to the MARPOL Convention and can be found at https://www.american-club.com/page/bunker-fuels.

Chapter 2 summarizes three bunker contamination incidents, their causation, damages and repairs as required, and the immediate costs that were incurred due to the incident.

As an option, shipowners have installed or are considering the installation of exhaust gas cleaning systems (i.e. “scrubbers”) dependent upon technical, operational and commercial factors to comply with the lower sulfur emission standards. Such costly investments require careful consideration and planning. Thus, **Chapter 3** provide an overview of the practical considerations for the installation of shipboard scrubbers.

Ensuring the quality of marine fuel oil has been a challenge for the maritime industry for decades. The reduction of sulfur content to less than 0.5% m/m will compound those challenges particularly to ensure bunker fuel stability and compatibility. **Chapter 4** is a synopsis of the current state of affairs and challenges for shipowners to not only meet the January 1, 2020 standards, but also ensuring that the composition of marine fuels they acquire and consume are safe and reliable.

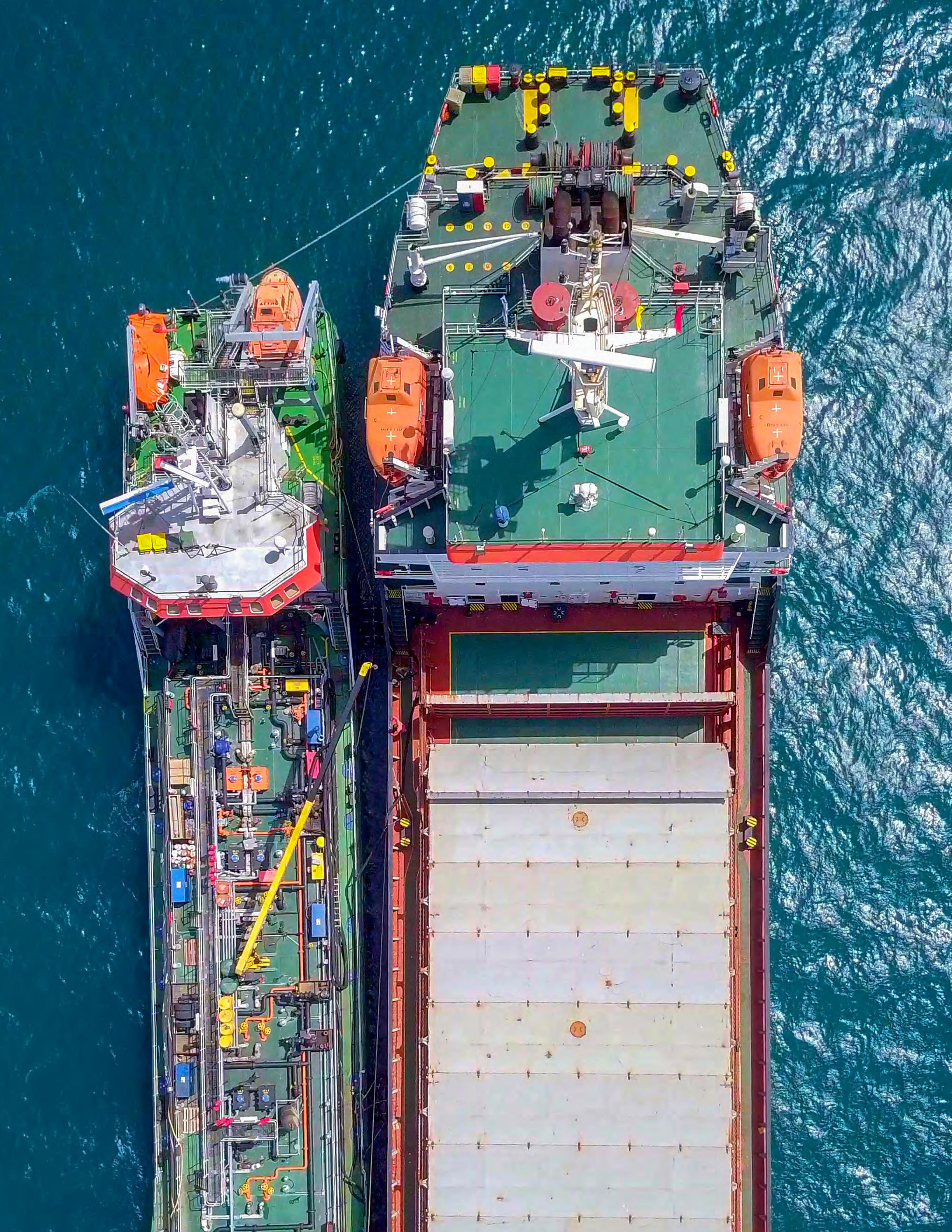
In 2018 a major bunker fuel contamination incident occurred that affect more than 100 ships that had stemmed bunkers in the Gulf of Mexico. As a result, the shipping industry and their P&I clubs has been flooded with off-specification bunkers related claims. Many of these disputes are very similar and have served to highlight two broad issues:

1. the unsatisfactory nature of charterparty terms which deal with how parties should manage off-specification bunkers; and
2. the very one-sided nature of bunker supply contracts.

Therefore, the ways by which case parties have handled such cases is instructive in a consideration of how parties are likely to handle similar disputes after the low sulfur fuel era takes effect after January 1, 2020.

Chapters 5 through **8** provide information and guidance from multiple jurisdictions, including United Kingdom, United States, China and Singapore.

Members are recommended to contact the Managers, if they suspect off-specification bunkers onboard. For further guidance and information on issues or claims involving off-specification bunkers, please refer to the Club’s website at https://www.american-club.com/page/bunker-fuels and contact your Managers’ FD&D department, which is available at all global offices, for assistance.



John Poulson, CEng, CMarEng
Director & Chief Surveyor
Atlantic Marine Associates

1.1 Introduction

It seems inconceivable, certainly unbelievable, that having paid up to millions of dollars for fuel for a vessel to operate, the owners of the vessel and/or the charterers then should have to check themselves that the fuel is actually of a standard that complies with regulations and what they paid for!

The whole concept seems upside-down but unfortunately this is the situation that still exists when a vessel takes on fuel, commonly referred to as *bunkers*.[1] Until such time as there is a major shift in emphasis of responsibility, we are stuck with a certain regime of sampling and testing of fuel oil bunkers loaded into ships.

Below, follows a general guide on how to protect ships, their crew and the environment from the effects of sub-standard and/or contaminated bunkers that, unfortunately, still find their way into ships. Under any circumstances, all bunkering procedures are to comply with the company's and shipboard safety management system (SMS) as part of compliance with the International Safety Management (ISM) Code.

Members are also reminded that guidance animations for bunker testing best practices are available at https://www.american-club.com/page/bunker-fuels.

1.2 General

Bunkering operations, while routine in many parts of the world, do in fact pose different risks to those encountered during normal ship operations. Bunkering operations can be conducted while vessels are at anchor or at a berth and will quite often be conducted concurrently with cargo operations.

This adds some additional risk to bunkering operations and the personnel involved, for which additional precautions are necessary. General procedures associated with bunkering operations are as follows below.

1.3 Overall Responsibility

The Master of a vessel always has overall responsibility for the safety of the vessel and its crew. But the Chief Engineer has specific responsibility for the safe reception on board and handling of the vessel's fuels.

Responsibility for correct implementation of a detailed bunkering plan is assigned to:

- the designated Person In Charge (PIC) usually the Chief Engineer or the Second Engineer if the Chief Engineer is otherwise occupied and customarily involving the Fourth Engineer. In any event, the responsibility falls on the most senior engineer

1 The term "bunkers" originates from steamships which when coal-fired, stored their coal in wooden shuttered "bunkers" in the boiler room.

onboard;

- engineers of the watch; and
- senior deck officer.

1.4 Liability & Responsibility for Fuel Handling & Treatment

IMO conventions place responsibility on the ship's crews and shipowners. However, Annex VI, regulation 18 of the MARPOL Convention also directs responsibilities onto the fuel suppliers fuel oil quality declaration, via the *bunker delivery note* (BDN) and requiring fuel oil sampling at the receiving ship's manifold.

Annex VI of the MARPOL Convention also contains instruments to encourage port States to ensure that suppliers fulfill their obligations. Owners should therefore:

1. provide the BDN and samples, certified by the fuel oil supplier that the fuel oil meets the relevant specifications;
2. retain a copy of the BDN for at least three years for inspection and verification by port State inspectors as necessary;
3. take action as appropriate against fuel oil suppliers that have been found to deliver fuel oil that does not comply with that stated on the BDN;
4. inform the flag Administration of any ship receiving fuel oil found to be noncompliant with the requirements of regulations 14 or 18; and
5. as per regulation 18.7(f) of the Parties to the MARPOL Protocol of 1997, inform IMO for transmission to of all cases where fuel oil suppliers have failed to meet the requirements specified in regulations 14 or 18.

However, despite the suppliers' responsibilities and the mandatory statutory instruments available, previous experience from port State inspections indicate that it is advisable for owners/managers to ensure compliance themselves.

In order to assist ships in ensuring that the operational requirements are met, clauses related to compliance with Annex VI of MARPOL Convention should be included in bunker contracts, charter parties and agreements with suppliers, as well as charter parties.

For vessels taking part in a fuel testing scheme, it is advantageous to include a clause referring to the fourth sample taken at the receiving vessel's manifold as the retained sample in case the supplier is not in a position to comply with the procedural requirements stated in MARPOL Annex VI.

1.5 Implementation

Owners should ensure that there is a vessel-specific 2020 implementation plan on board as recommended by IMO under *MEPC.1/Circ.878, Guidance on the Development of a Ship Implementation Plan for the Consistent Implementation of the 0,50% Sulphur Limit Under MARPOL Annex VI*. As part of which the Chief Engineer should indicate to the Master the PIC for fuel oil transfer operations. The Master should appoint the PIC, in writing, either by name or by position on board the ship. The PIC should approve any change or relief of personnel assigned to bunkering operations in progress and should inform the Master accordingly.

1.5.1 Safety

Announcements through the vessel's public address system should be done before starting operations to remind to all persons on board that smoking on outside decks, including balconies will be prohibited for the entire duration of bunkering.

1.5.2 Documentation

When accepting bunkers by barge or shore pipeline, the Chief Engineer should always check the local supplier's documents to make certain that the bunkers which the ship is to load conforms in all respects with the terms of quantities and fuel specification which has actually been ordered, either by owners or charterers.

Additionally, a BDN should be produced by the supplier to verify details of the fuel oil for combustion purposes delivered and to be consumed on board. The BDN is to comply with the requirements as set forth in Appendix V to Annex VI of the MARPOL Convention. A copy must be maintained on board to be exhibited upon request.

1.5.3 Bunkering schedule

The Chief Engineer should discuss with the Master the best possible bunkering plan so that trim/stability can be calculated to the ships best advantage. Fuels from different supply ports should be segregated unless this is impossible due to the fuel tank arrangement.

1.5.4 Quality and samples

The Chief Engineer should check from documentation that bunkers to be loaded do not contain any unacceptable amounts of water. The maximum allowable water being 0.05% for gas oil, 0.25% for marine diesel oil (MDO) and 1.0% for intermediate fuel oil (IFO) 180 and above.

Additionally, the sulfur content of any fuel oil used on board ships should not exceed values as established by codes and local regulation as applicable, which from January 1, 2020 is 0.5% worldwide unless alternative arrangements such as exhaust gas systems or "scrubbers" (see **Chapter 2**) are fitted to the vessel.

1.5.5 Note of Protest

Should the fuel supplier fail to provide the BDN, the Marine Safety Data Sheet (MSDS) for each fuel product to be bunkered as per requirements of SOLAS Chapter VI regulations and *Resolution MSC 286(86), Recommendations for Material Safety Data Sheet (MSDS) for MARPOL Annex I Oil Cargo and Oil Fuel*, should be obtained for the sealed and signed sample of the delivered bunkers.

Should the Chief Engineer realize that the sulfur content stated in the BDN exceed the values established by codes and applicable regulations, a written statement should be issued by the Master. One copy of the Note of Protest should also be maintained on board to be provided to authorities in case of inspections.

1.5.6 Bunkering operations

The Chief Engineer is responsible for the bunkering operations. The Chief Engineer, or in case of his absence the first or second engineer, must be onboard the vessel during bunkering and a delegated engineer officer will be in charge while bunkering is in progress.

The Chief Engineer should also verify the grade of product to be delivered, the pumping rate and the precise means of communication, including the method of stopping the barge pumping. It is important when bunkering that each fuel tank should be filled to no more than 90% capacity or to whatever the company policy may be but always to a safe level. Furthermore, the operation should be carried out in such a manner and at a rate to allow the tanks to vent safely.

1.5.7 Verification of quantities

When the bunkering operation has been completed, the engineer in charge should ensure that the fuel main manifold is dry and not become pressurized. Although bunkered quantities can be checked on meter readings, it is best practice to take soundings of tanks and temperature before starting and at the end of bunkering operations, especially when bunkering from a barge. The Chief Engineer will verify then that the quantities taken are those indicated in the manifest from the barge and the one obtained from calculation, and if there is a difference, it must be noted in the delivery receipt.

1.5.8 Sampling procedures

As set forth in paragraph 3.1.1 of the *MEPC.1/Circ.875/Add.1, Guidance on Best Practice* *for Fuel Oil Suppliers for Assuring the Quality of Fuel Oil Delivered to Ships*, bunkers are to be delivered at the point of custody at the ship's rail or manifold and is to be drawn continuously throughout the bunker delivery period. The term "continuously drawn" is specified to mean a continuous collection of drip sample throughout the delivery of bunker fuel. Sampling methods are further clarified as either; (1) manual valve-setting continuous-drip sampler, (2) time-proportional automatic sampler, or (3) flow-proportional automatic sampler.

Furthermore, paragraphs 11.5(1) through 11.5(7) of *MEPC.1/Circ.875/Add.1*, specify that sample bottle labels are to contain the following information:

- location at which, and the method by which, the sample was drawn;
- date of commencement of delivery;
- name of bunker tanker/bunker installation;
- name and IMO number of the receiving ship;
- signatures and names of the supplier's representative and the ship's representative;
- details of seal identification; and
- bunker grade.

The vessel should collect a representative sample of the fuel being bunkered from the point of custody transfer (ship's manifold). The vessel should not, under any circumstance, accept pre-filled samples provided by the supplier as being representative of the fuel being delivered.

The sample is to be processed using supplies provided by the fuel testing vendor. Samples are to be delivered, the same day, to the ship's agent to be sent from the ship directly to the testing lab.

The testing company should provide kit boxes to transport the fuel oil samples from the ship directly to the testing company. These kits normally include at least three (3) 400 ml sample bottles, addressed mailers and seals. Prepaid courier airway bills should be provided to the ships to forward samples. The vessel should provide all of the information requested by the lab and mail it along with the sample.

Each bunker operation will generate, at a minimum, three (3) samples:

- one sample is for retention on board the ship;
- the second sample is for the supplier; and
- the third sample is to be sent to the lab for analysis.

The labels on each of the sample containers is to be countersigned by the supplier's representative at the time of the sampling.

The fuel samples will be thereafter be analyzed according to regulation 18 of Annex VI to the MARPOL Convention and ISO 8217 and a report will be forwarded to the owners and/or charterers. The report should also contain guidance on the optimal on-board processing of the bunkers. For the fuel sample to be properly analyzed, the lab will also need the following information:

- date of bunkering;
- name of the vendor providing the fuel;

- type of fuel;
- bunkering port; and
- other bunker quantity and quality information required in the bunker supply receipt.

Bunkered fuel oil, marine gas oil or marine diesel oil, etc., if at all possible, should not be consumed until the results of analysis arrive on board.

1.5.9 Sample testing & analyses

All sample testing should be to the requirements as set forth by the shipowner's and charterer's (if and as applicable) agreed ISO 8217 standard. Non-standard, additional tests may include for those contaminants as listed in **Section 4.2** and:

- trace metals analysis (nickel, cadmium, mercury, etc.);
- heavy distillates testing and inspection; and
- contamination detection and analysis.

1.5.10 Sample inventory

Samples should be kept in a safe, cool and sheltered storage location, outside the ship's accommodation and where personnel would not be exposed to vapors which may be released from the sample as well as not be exposed to direct sunlight. A suitable locker (with opening ensuring adequate air flow) in an adequately ventilated area of the engine room located at a safe distance from ignition sources and hot surfaces may be considered suitable. The ship's Master should develop and maintain a system (e.g. log book) to keep track of the retained samples.

1.5.11 Fuel oil transfers

The Chief Engineer should ensure that all engineers are fully conversant with the complete fuel oil transfer system, including high/low level alarms and auto-stops. Engineers should only to transfer fuel oil on direct and clear instructions from the Chief Engineer.

1.5.12 End of operations

After bunkering is completed the engineer in charge will stop the pump, drain the fill line, blanking of the hose before passing the hose back to the barge, shore, or truck station.

All fuel bunker transfers are to be logged in the Oil Record Book (ORB), including start and stop timings.

At the end of operations, all used shipboard hose pipes (if any) must be drained, disconnected and manifolds must be blind flanged.

End of operations must be communicated to the Officer On Watch (OOW) on the bridge, to the engineer on watch in the engine control room and must be recorded in the relevant engine room log books accordingly.

1.5.13 Retention – documents & samples

As a reminder, Chapter 3, regulation 17.2.5 of Annex I to the MARPOL Convention requires the basic details of time, location, quantity and tanks where bunker fuel is maintained in the ORB. The ORB entries should be retained and made available for inspection, if requested, for at least 3 years. Furthermore, the BDNs should be retained for a minimum of 3 years while bunker samples should be secured and kept for a minimum of 12 months.

1.5.14 MARPOL 73/78 Annex VI fuel oil samples (retained sample)

As regulation 18 of Annex VI to the MARPOL Convention requires, every BDN is to be accompanied by a representative sample of the fuel oil delivered that is referred to as the “retained sample”.[2]

The retained sample is to be sealed and signed by the supplier’s representative and the Master or officer in charge of the bunker operation on completion of bunkering operations and retained under the ship’s control until the fuel oil is substantially consumed. In any case, the retained sample must be kept onboard ship for a period of not less than 12 months from the date of delivery.

Although the resolution specifies that the volume of the sample bottle should be no less than 400 ml, due to potential need for repetitive testing, testing laboratories generally recommend that the sample volume is not less than 750 ml.

It should be noted that the practical purpose of the retained sample is to enable port State control authorities to verify the sulfur content of the fuel, as well as to verify that the fuel oil quality is in accordance regulation 18 of Annex VI of the MARPOL Convention.

Annex VI specifies that the sample is not to be used for commercial purposes. For ships already participating in a fuel oil quality testing scheme, a separate sample should be taken for that purpose.

In case the supplier is not in a position to comply with the procedural or documentary requirements as stated in Annex VI of the MARPOL Convention, the following actions should be taken by the ship’s crew:

- produce a Note of Protest explicitly specifying non-compliance with MARPOL Annex VI requirements should be issued. The Note of Protest is to be forwarded to the relevant port State authorities;
- reference to the Note of Protest is to be made in the BDN (if supplied);
- if the supplier does not provide a MARPOL sample, the ship’s crew should propose their own representative; and
- request counter-signing and sealing by the supplier. If this is accepted by the supplier, a Note of Protest should not be deemed necessary.

1.5.15 Third party inspections

Class surveyors, port State inspectors and possibly also vetting inspectors may scrutinize onboard documentation and records (e.g. sampling procedures, change-over procedures, engine room log books, BDNs, sample inventory log books etc.), as well as the fuel oil sample inventory.

2 IMO Resolution MEPC 96 (47), Guidelines for the Sampling of Fuel for Determination of Compliance with Annex VI of MARPOL 73/78.

Consultations with port States indicate that analysis of the onboard Annex VI samples will be carried out upon suspicion, e.g. in case of an accident or near accident.

Testing of the representative sample should be conducted in accordance with *MEPC.1/Circ.882, Early Application of the Verification Procedures for a MARPOL Annex VI Fuel Oil Sample (regulation 18.8.2 or regulation 14.8)*, the forthcoming amendments to Appendix VI to Annex VI of the MARPOL Convention. Based on experiences with port State inspectors scrutinizing of ORBs related to sludge and oily bilge water inventory and balance, owners and managers can expect that similar practice could be applied with respect to high sulfur and low-sulfur fuel movements and consumption when operating in Emission Control Areas (ECAs), Sulfur Emission Control Areas (SECAs) or other local or regional port State authorities.

It is therefore advisable that ships' crews are instructed and trained to thoroughly verify that the supplied quantity is in accordance with that specified in the BDNs, or alternatively that independent bunker quantity surveyors are hired for this purpose.

It needs be emphasized that currently, the MARPOL Annex VI representative sample is only required to be retained under ships' control and not tested. However, fuel oil quality testing represents a pro-active approach, both in terms of verifying compliance prior to any port State control inspection, and more importantly as a safeguard against the adverse effects of poor fuel oil quality in combustion machinery. Third parties may also consider test reports from a reputable and accredited independent testing laboratory as equivalent to additional testing of onboard samples.

1.6 General Guidelines for Bunkering Operations

1.6.1 Heavy weather

Wind. Vessels should not come alongside in preparation for bunkering at anchor or pier side if sustained winds are at or exceed 34 knots or wind gusts exceed 40 knots. If bunkering operations have already begun when sustained winds reach 34 knots or gusting over 40 knots, personnel in charge of bunkering operations should continuously monitor environmental conditions and take any additional measures necessary to reduce risk of injury, vessel damage or pollution, and prepare for worsening weather. If sustained winds reach 40 knots bunkering operations should cease and hoses drained and disconnected.

Sea state conditions. For bunkering operations from one vessel to another vessel while at anchor, operations should cease, with hoses drained and disconnected when waves or swells reach 3 ft (1m).

Sheltered waterway. The foregoing wind and sea condition guidelines may not be applicable when a receiving vessel is being bunkered at a wharf or pier in a sheltered waterway. A waterway is considered to be sheltered when area around the "Zone of Concern" is protected from the prevailing wind or sea conditions. The criteria for securing a bunkering operation in these types of locations would be dependent upon adverse movement of either the receiving vessel or delivering vessel caused by the prevailing wind or sea conditions.

1.6.2 Personnel/safe access between vessels

The delivering vessel and receiving vessel should each have a designated PIC that oversee the transfer on their respective vessels. The receiving vessel should provide safe access to facilitate face-to-face communications between the receiving and delivering vessels for purposes of a pre-transfer conference and other required communications. The accommodation ladder should be the first choice, but if the ladder is inaccessible from the delivering vessel, a Chapter V, regulation 23, SOLAS Convention approved pilot's ladder, should be used instead. A Jacob's ladder is not an appropriate means of access between vessels.

1.6.3 Mooring equipment

All parties should use fenders of sufficient size and type to prevent steel to steel contact between the two vessels. Mooring lines should be of sufficient size and type to hold the delivering vessel alongside the receiving vessel during expected tidal, wave, and wind conditions.

1.6.4 Tug availability

During bunkering operations in moderate to heavy weather conditions involving vessels at anchor, tug availability should be considered ready to render assistance until bunkering is completed, and all hoses are disconnected and returned aboard their respective vessels. The attending tug(s) should have sufficient horsepower to maneuver and control at least the delivering vessel involved in the bunkering operation under all conditions. This recommendation may not necessarily apply to delivering vessels that are self-propelled.

1.6.5 Flow rate, topping off & gauging procedures

Flow rates, topping off and gauging procedures should be conducted in accordance with the most up to date version of the Oil Companies International Marine Forum's (OCIMF) *Ship to Ship Transfer Guide*.[3]

1.6.6 Watchkeeping

A qualified PIC should be on watch and monitor the bunker operation on the receiving and delivering vessels of which they are in charge at all times.

A qualified deck officer should maintain a navigation and anchor watch on the bridge of a vessel that is anchored. The receiving vessel and the attending PIC of the delivering bunkering barge/tank vessel should ensure the monitoring and maintaining of sufficient mooring for all conditions as required.

3 Members are reminded that the American Club maintains a ship-to-ship e-learning training module at *https://www.american-club.com/page/education-training-tools*.


NO
SMOKING

IMPACTS OF BAD OR CONTAMINATED FUELS ON SHIPBOARD MACHINERY SYSTEMS: SELECTED CASE STUDIES

John Poulson, CEng, CMarEng, FIMarEST
Director & Chief Surveyor
Atlantic Marine Associates

William Moore, Dr Eng
Senior Vice President, Global Loss Prevention Director
Shipowners Claims Bureau, Inc.

2.1 Introduction

Contamination of bunker fuels that have a direct physical impact upon shipboard machinery systems is not a new phenomenon. The MARPOL Annex VI requirements for 0.5% sulfur emission limitation does bring further uncertainty to the industry regarding compatible and stable low sulfur fuels post January 1, 2020 as further discussed in **Chapter 4**.

This chapter provides a summary of three problematic fuel case studies and their impact upon shipboard machinery systems, their causes and immediate costs relevant to the incident and repair. Any additional costs associated with loss time or disputes with charterers or any other party are not included.

2.2 Case Study 1 – Damage to Generators from Contaminated Bunkers Stemmed in the United States

2.2.1 Summary of events

In March 2018, a 58,000 gross ton bulk carrier had bunkered 1,300 metric tons (MT) of intermediate fuel oil (IFO) 380 centistokes (cSt) in the U.S. for its forthcoming voyage to the Eastern Mediterranean and thereafter, transit though the Suez Canal bound for its next port of call. The vessel began consumption of the bunkers that it had stemmed 47 days prior in the U.S.

Within a matter of hours, an increase in the frequency of diesel generator automatic fuel filter back flushes began occurring. However, further incidents occurred for another 10 days when the number 3 diesel generator experienced an issue with sticking fuel pumps.

The situation worsened over the following five days until the generator completely failed. Conditions worsened during the three days that followed that led to a dead ship condition that occurred after failures of the two remaining diesel engine generators.

As per the vessel's design, upon loss of electrical power as none of the three generators were operational, the main engine shut down automatically and that led to a dead ship condition. The shipboard engineering crew were unable to restore any of the vessel's power or main propulsion.

The vessel's Master requested tug assistance as the vessel was drifting. Luckily, tug assistance arrived on time, made fast on and eventually towed the vessel to an outer anchorage at the port of Suez. The following day, a generator barge was connected to the vessel to supply required power onboard. Given the size of the vessel and high winds, at Suez additional tug assistance was required during their period of repair to keep them on station.

Service engineers for the main engine and diesel generator engines attended the vessel while at anchorage. From the date of the vessel's complete loss of power to the date the vessel was able to regain power and no longer considered off hire was eleven days.

2.2.2 Causation

Bunker samples were sent to the laboratory that showed that the density of the bunkers was 992.2 kg/m3 whereas the recommended upper limit was 991.0 kg/m3 for fuel oils with the noted characteristics.

However, upon further testing in the laboratory, it was determined that the dominant problem was contamination by chemical waste. The higher density of oil also led to a high concentration of sludge that affected the stability reserve due to a high concentration of asphaltenes.

The enhanced testing of the fuel revealed the presence of contaminants typical of chemical waste in the fuel, the nature of which are known to cause sticking and damage to fuel injection equipment. It was further determined that the fuel had been stemmed in the U.S.

2.2.3 Damages, cleaning & repair

The vessel returned to the U.S where the bunker suppliers had agreed to receive the contaminated bunkers back from the vessel, amounting to approximately 850 MT stored in the vessel's no. 7 starboard double bottom fuel tank.

A portion of this fuel was previously stored in the no. 5 port side double bottom fuel tank. The vessel's managers dispatched a team of shore-based cleaners to attend the vessel at port of original bunkering to remove the remaining fuel, which was un-pumpable and clean the bottom of the subject tank to prevent possible contamination of the replenishing bunkers.

The same cleaning work was then carried out on the no. 7 starboard double bottom fuel tank. In addition to the cleaning work, the auxiliary engines had random cylinder heads removed, in order to assess the condition of the cylinder liners.

Figures 2.1 through **2.3** show some of the damages after seizure of the generator fuel pumps.

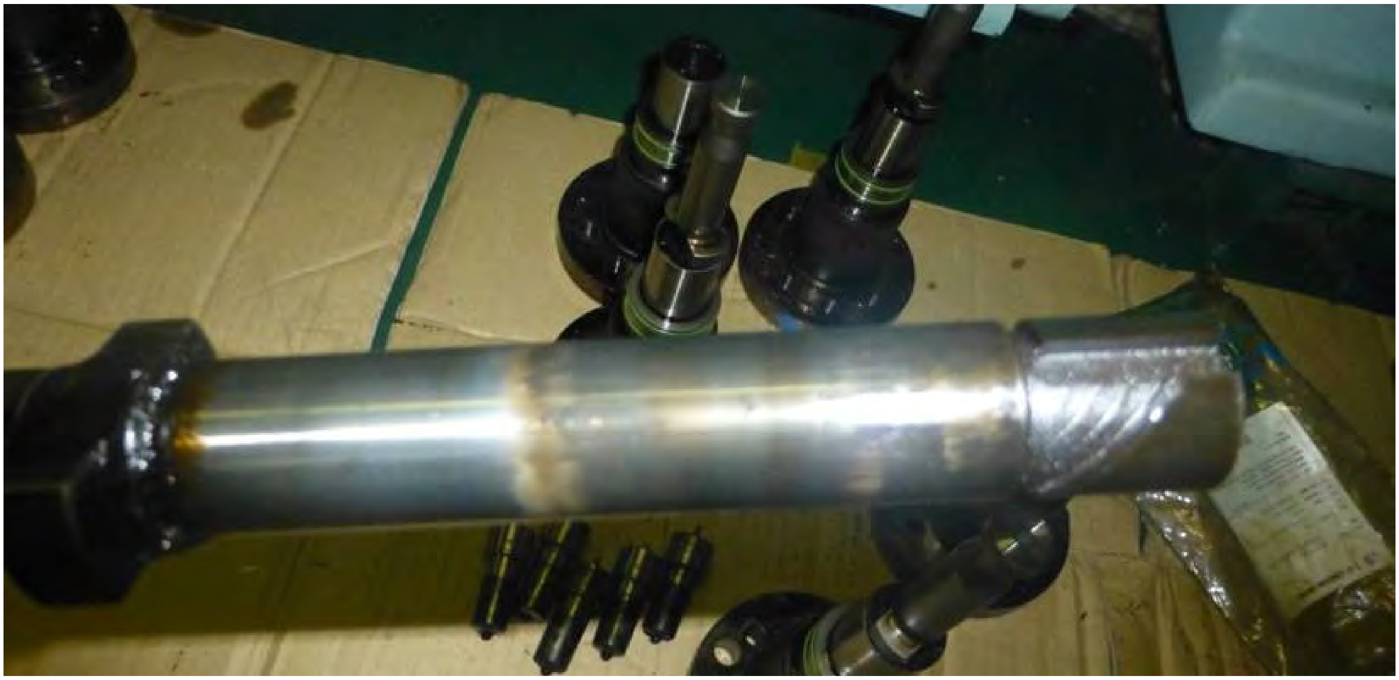


Figure 2.1 | Generator fuel pump plunger showing evidence of seizure

Figure 2.2 | Clean and new fuel pump plungers and injection nozzles ready for replacement of the damaged components

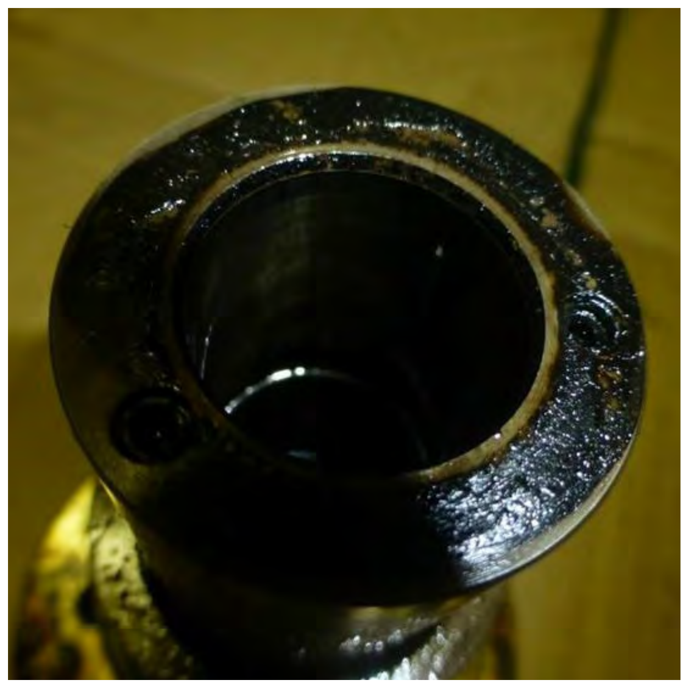


Figure 2.3 | Fuel oil pump barrel heavily deposited with residuals from contaminated bunker fuel

2.2.4 Costs

The vessel was out of service for 11 days. Costs of tug assists, cleaning of bunker tanks and repairs from damages, cleaning and repairs as described in **Section 2.2.3** were approximately US$ 1,100,000.

2.3 Case Study 2 – Main Engine and Turbocharger Damages due to Bad Bunkers in Durban

2.3.1 Summary of events

In November 2008, a 10,500 GT general cargo ship had bunkered 550 MT of residual marine fuel (RMF) at 180 cSt as supplied by charterers in Durban, South Africa for its forthcoming voyage to Camden, NJ via Dakar. One of the bunker tanks had been comingled in Durban with 126 MT of the new bunker with 4 MT of bunker previously stemmed at Las Palmas.

The vessel had just completed dry docking that included classification society surveys. During the course of the drydocking period, various aspects of main engine maintenance was carried out including overhaul of the vessel's main engine's (M/E's) no. 4 cylinder unit (there were nine cylinder units in total), overhaul of turbochargers, the air coolers were cleaned and partially re-tubed, the scavenge space cleaned and scavenge valves were checked and overhauled where necessary. In addition, double bottom bunker tanks had been opened and cleaned out for survey by the classification society.

During the voyage to Camden, the vessel began consuming the bunker from the tank of comingled bunker first. Soon after, the vessel's turbochargers began to surge and did so increasingly until the engine revolutions were reduced to 138 rotations per minute (RPM) while sailing though heavy swell. The turbochargers' RPM consequently reduced from 5,000 to 4,300 RPM.

Three days later as sea conditions worsened to Beaufort scale 7-8, a scavenge space fire broke out in the no. 6 cylinder unit. The vessel's M/E was slowed, cylinder lubrication increased, boundary cooling applied by using water hoses on the unit. Later the M/E's speed increased to 110 RPM. Exhaust temperatures were fluctuating, and intermittent firing of M/E units was also observed.

A day later, a further scavenge fire (see **Figure 2.4**) occurred again at the M/E's no. 6 cylinder unit and which was again dealt with as previously. The engine was then stopped and the scavenge space opened for inspection whereupon large amounts of sludge were found in the scavenge space. The scavenge valves were changed together with the fuel valve and the fuel pump for the unit.

The M/E was restarted thereafter, but the maximum achievable speed was 80 RPM. The scavenge temperature was noted to be high from gases due to blow-by. The no. 6 cylinder unit was then pulled, and the piston rings found seized and heavily carbonized.

The piston rings were renewed and the cylinder unit re-assembled. Thereafter, the M/E could then achieve only 40 RPM with heavy fuel knocks from other cylinder units. The scavenge spaces, valves and air cooler were cleaned and completed three days later but with no improvement. Fuel valves were tested but it was concluded the engine was suffering from a general lack of compression.

The vessel was able to complete its voyage under its own power albeit significantly delayed resulting from slow sailing.

Figure 2.4 | Scavenge space charred after fire

2.3.2 Causation

Damage to the M/E was alleged to have been sustained because of consumption of suspect quality bunkers stemmed in Durban. The charterer's supplied RMF 25 bunker fuel at 180 cSt which was evidently allowed under the charter party, as opposed to RME 25 depending upon that fuel's availability. ISO 8217 allows Conradson carbon residue (CCR) percentage for RMF fuel up of up to maximum of 20%.[4] This fuel had a 17.2% rating by analysis after bunkering.

This is an instance of a fuel, whilst being compliant with ISO 8217 produced a very poor fuel from an ignition and combustion point of view due to the combination carbon and asphaltene levels; the conditions found in the engine were consistent with consumption of such fuel. Unfortunately, normal purifier treatment on board would not rectify this problem.

2.3.3 Damages, cleaning & repair

The vessel required significant repairs including the replacement of turbocharger bearings, diffuser (stator) guide vanes and other turbocharger associated parts and cleaning. Regarding the M/E, fuel pump plungers and barrels also required replacement. Replacement of lubricating oil was also required. Additional costs were also incurred for additional classification, survey and technical expertise to oversee the cleaning and repair including the M/E stuffing box as seen in **Figure 2.5** and piston crowns and rings as seen in **Figure 2.6**.

4 *Conradson carbon residue* is a test performed in a laboratory that measures coke forming tendencies of nonvolatile petroleum products that decompose on distillation at atmospheric pressure.

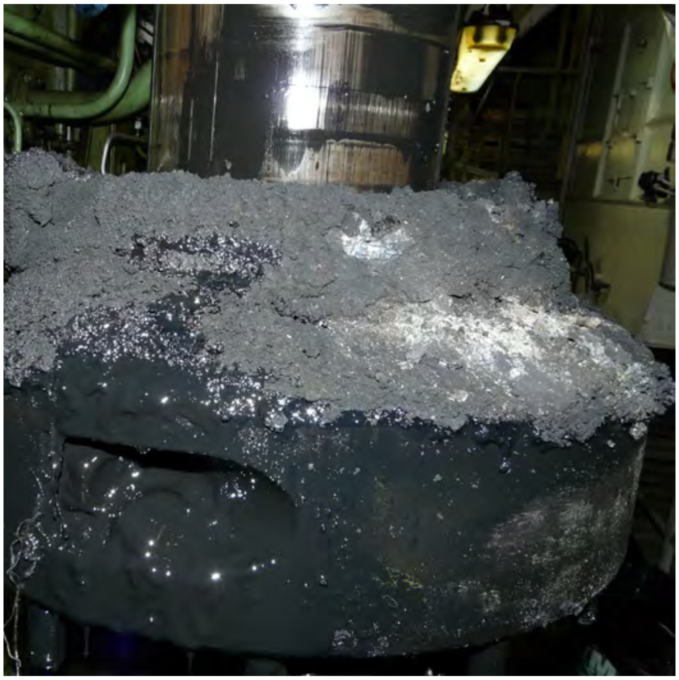


Figure 2.5 | Main engine stuffing box carbonized

Figure 2.6 | Piston crown & rings heavily carbonized

2.3.4 Costs

In this instance, the costs associated with those activities as noted in **Section 2.3.3** cost US$ 300,000.

2.4 Case Study 3 – Bad Bunkers Discovered During Switch Over to Low Sulphur Fuel

2.4.1 Summary of events

In August 2018, a 31,500 GT bulk carrier had stemmed a consignment of high sulphur fuel oil (HSFO) fuel oil in Algeciras, Spain on a loaded passage to Newark, NJ. The vessel departed Algeciras and had sailed to territorial waters without incident. However, in preparation for entering the North American Emission Control Area (ECA), whereby it is required to consume bunker fuel with no more than 0.1% mass on mass (mass/mass) sulfur content. The HSFO being consumed at the time was changed over to low sulfur marine gas oil (LSMGO). This led to the stoppage of the M/E and loss of propulsion resulting in the vessel drifting without power.

The initial alarm indicators reported engine control system cylinder failure, M/E injection quantity piston failure of no. 3 cylinder unit, M/E fuel pump actuator failure and a M/E slow down pre-warning. Engineers thereafter commenced trouble shooting the problem under the advice and guidance of shore side managers and engine manufacturers. Overhauling and cleaning of the no. 3 injection control unit and fuel quantity (FQ) piston to determine the cause of the alarms was performed that led to the activation of further alarms that the M/E fuel rail pressure was low and engine control system fuel command limiter was active. These tests resulted in finding it difficult to pressurize the fuel and hold the fuel rail pressure under operation using LSMGO.

Twelve hours later, engineers reverted back to using the HSFO and the M/E started successfully. The engineers then tested the M/E swapping alternatively between the HSFO and LSMGO for an eight hour period. Thereafter, the M/E was stopped manually on the HSFO.

The following day, the crew effected further repairs on the M/E including removing no. 5 cylinder unit and the injection control unit (ICU) was replaced. For nos. 1 through 5 cylinder units, the fuel oil pipes were removed, their sealing faces were ground to improve sealing and the fuel oil pipes were replaced to prevent any further leakage during fuel change over. The no. 1 main fuel oil pump cam follower roller and guide and pump rack were checked for proper movement.

The ship thereafter conducted various maneuvering tests, but the M/E failed to start. Two days later, the no. 2 main fuel oil pump was replaced with a spare pump and the original ICU was refitted to the no. 5 cylinder unit. Thereafter the engine was restarted and was able to run on full ahead but would not run at dead slow.

The shoreside managers instructed the vessel to start the engine on HSFO given they had drifted away from the ECA. Upon five miles from arrival distance from the ECA, the vessel tested the M/E and were tested ahead and astern but failed to start.

The following day, the M/E was stopped and tested prior to arrival Newark and failed to start showing the alarm condition "Main Engine Fuel Rail Pressure Very Low". Following further shore side managers instructions, the common fuel-oil rail pressure control valve (PCV) and safety valve were replaced with spare parts, but the M/E again failed to start. At that point while, the vessel drifted, the shoreside managers arranged for towage of the vessel to destination at Newark.

2.4.2 Causation

Laboratory analysis of the vessel's bunker fuel detected several phenolic compounds, naphthol compounds and another compound which are not normally found in residual fuels. In particular, the phenolic compound, 4-cumyl-phenol, found during the analyses, 4-cumyl-phenol, does not originate from normal petroleum refining. The compound has many industrial uses, including the manufacture of epoxy resins and as an emulsifier in pesticides, both of which utilize the adhesive (sticky) qualities that 4-cumyl-phenol exhibits. Other phenolic compounds that exhibit similar adhesive characteristics were also found during the analysis.

Microscopic observations revealed that the surface of ICV spindle and distance pin in the old no. 5 ICU was abnormally worn by corrosion as seen in **Figures 2.7** and **2.8**, though the duration of its use was only 1,500 hours. Regarding the cause of M/E starting failure, it is presumed the fuel rail pressure could not be maintained due to larger fuel leakage than usual after changing over to LSMGO, which is low viscosity, since the inside parts ICV spindle and distance pin of ICU had been already worn by corrosion during using HSFO. In consequence, the lifetime of the ICVs were much shortened compared with their estimated lifetime in normal operation which is normally approximately 36,000 hours.

As a cause of corroded internal parts of ICU, it is suspected that some chemical components, which are high corrosive, may be mixed in HSFO, which have been used for M/E on the vessel. Analysis results by laboratory testing confirmed the suspicion that contaminants were present in the bunker fuel whereby the phenolic compounds and saturated fatty acid compounds which are not normally found in residual fuels are contained in this fuel.

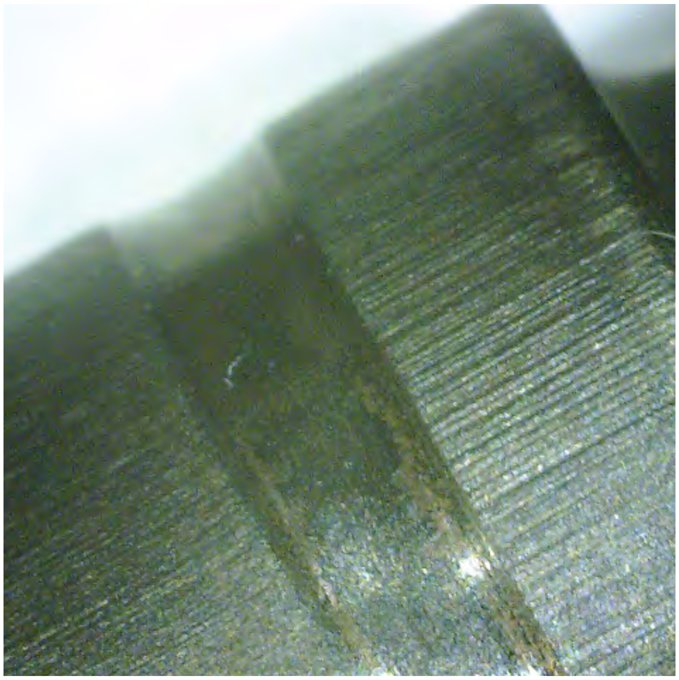


Figure 2.7 | Examples of corrosion damage to fuel injection system due to contaminated bunkers

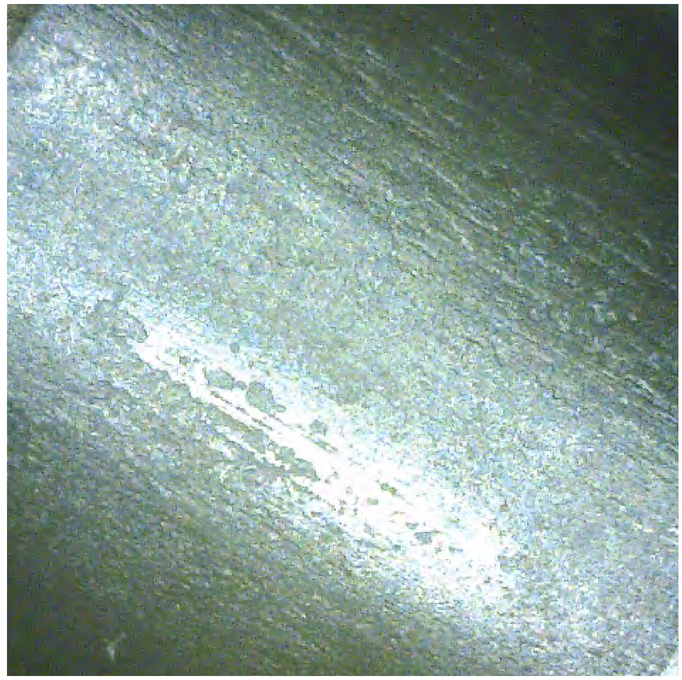


Figure 2.8 | Further example of corrosion damage to fuel injection system due to contaminated bunkers

2.4.3 Damages & repair

Upon repairs, it was noted that the use of the unsuitable HSFO had led them to replace any and all suspect parts. For the fuel injection system, the repairs required the replacement of six sets of ICUs, two fuel oil pump sets, one set of pressure control valves and a safety valve.

2.4.4 Costs

In this instance, the costs associated with those activities as noted in **Section 2.4.3** cost US$ 450,000.

2.5 Conclusions

Taking proper precautionary measures as set forth in **Chapter 1** and as demonstrated in the American Club's guidance animations for bunker testing best practices are available at https://www.american-club.com/page/bunker-fuels can assist in preventing and mitigating such incidents.

Gareth Burton, Dr Eng
Vice President, Technology
American Bureau of Shipping

Alex Huo
Manager, Technology
American Bureau of Shipping

3.1 Overview

The International Maritime Organization (IMO) 2020 global sulfur cap requirements come into effect on January 1, 2020. Common compliance options to address the requirements are the use of compliant fuels, the use of alternative fuels with a sulfur content less than 0.5% m/m such as liquid natural gas (LNG), or the installation of an exhaust gas cleaning system commonly known as a scrubber. This document introduces the regulatory requirements and outlines items to be considered during the planning, procurement, engineering, installation, commissioning and operation of scrubbers.

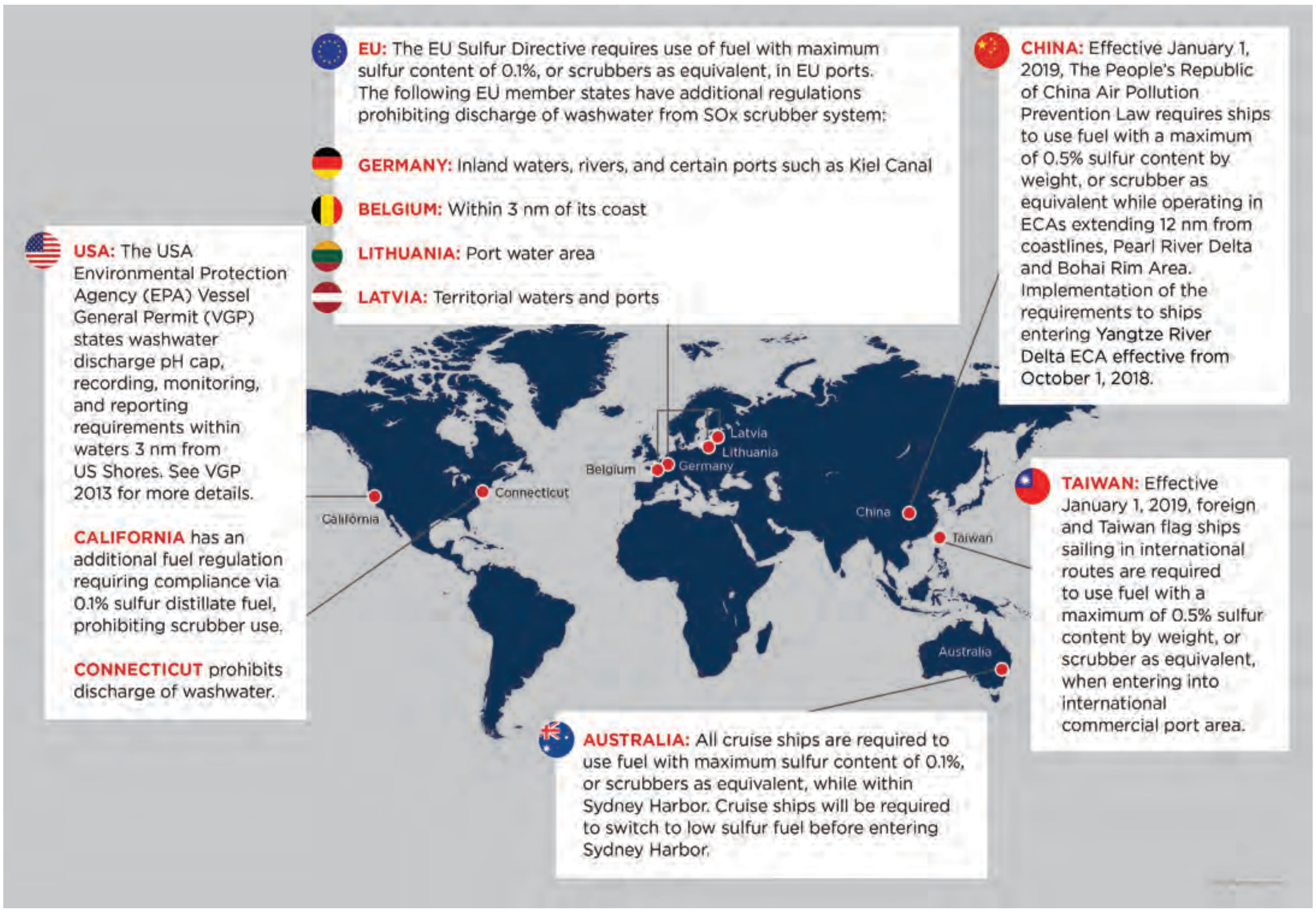


Figure 3.1 | Examples of regional and local scrubber related regulations

3.2 Regulatory requirements

In designated Emission Control Areas (ECAs), compliance with a sulfur limit of 0.1% m/m has been effective since January 2015. Starting from January 1, 2020, a global 0.5% m/m sulfur cap is effective. Additionally, regional and local authorities have introduced requirements that differ from the IMO requirements. **Figure 3.1** below shows the major regional and local regulations.

3.2.1 Scrubber as equivalency

As indicated in the **Figure 3.1**, an approved scrubber system is commonly accepted as an equivalent alternative for meeting the fuel sulfur limit requirements.

The most common installation is a wet scrubber system with following three option types: open loop, closed loop and hybrid.

The three scrubber types operate on the same principle: the washwater is injected into the scrubber tower through the spray nozzles arranged in an optimized pattern to create a turbulent environment to maximize the surface area of sprayed water in contact with the exhaust gas. Sulfur oxides (SOx) in the exhaust gas is absorbed in the water and becomes acidic which is neutralized by the naturally existing or artificially added alkali in the washwater to form sulfites and is further oxidized to a sulfate.

In open loop system, seawater with naturally existing alkali is used for scrubbing and discharged back to sea. Treatment of the washwater effluent is typically optional provided the washwater effluent meets the criteria for discharge in the applicable IMO or regional/national requirements which includes pH, polycyclic aromic hydrocarbons (PAH) and turbidity. The system is typically incorporated with an automation system to adjust the washwater flowrate to make the SOx emission level and washwater within the required limit when operational parameters change such as increase of engine load which increases the exhaust gas flowrate.

A closed loop system uses treated fresh water, typically by adding sodium hydroxide (NaOH) to achieve the required alkalinity, for scrubbing and neutralization. The washwater effluent will be treated before being re-circulated to scrubber and any losses made up with additional freshwater. A small quantity of the washwater effluent is bled off to a treatment plant before discharge to sea, or to a holding tank if overboard discharge is prohibited. Sludge removed by the treatment plant will be stored onboard for disposal ashore. For closed loop systems, the washwater circulation rate typically remains unchanged. When operational parameters such as engine load changes, the automation system will adjust the dosing amount to the circulation washwater.

In addition to scrubber and associated auxiliaries, a closed loop system will include equipment for washwater treatment, sludge handling and chemical (typically sodium hydroxide, NaOH) dosing.

Hybrid systems can operate in either open or closed loop mode as needed.

3.3 Planning

Effective planning for installation of a scrubber onboard a vessel should consider a feasibility evaluation, lead time for the supply of the scrubber, scope of structure and system modification, engineering evaluation and class approval, fabrication, installation and integration, and testing, commissioning and demonstration of compliance.

The installation of scrubbers typically involves the shipowner, scrubber supplier, engineering company and shipyard. It is important to have defined roles for each party during the various stages of installation. As an example, the equipment provider may deliver the basic design and system material specification, the engineering company or shipyard may develop construction drawings, while the shipyard carries out equipment installation and system integration.

For existing vessels, the amount of time it takes to retrofit a scrubber system depends on several factors with the equipment supply lead time and the availability of retrofit yard often being on the critical path. Effective planning may allow some of the required steps to be performed concurrently with the possibility for much of the work to be completed before the ship arrives at the retrofit yard. Appropriate pre-planning can significantly reduce time in the yard.

Drydocking needs to be taken into consideration if it is necessary to enlarge the existing seachest, or an additional seachest is needed to meet the demand for washwater for the scrubber. If feasible, the retrofit activity may be aligned with the statutory renewal survey or other modification work.

Figure 3.2 | Scrubber

Two major items to be addressed during the initial planned phase are space constraints and power availability.

3.3.1 Space constraints

Scrubbers, as seen in **Figure 3.2**, are large pieces of equipment. Space to accommodate a scrubber and its auxiliaries is one of the challenges of scrubber retrofitting.

Typically, closed loop and hybrid systems are more complicated than open loop systems. More space is required for the storage of dosing chemicals, circulating water, bleed-off water and washwater residues. Additional space is necessary to accommodate equipment such as heat exchangers and water treatment units. The capacity of a circulating water tank is typically the volume of water pumped by a circulation pump in 1.5 minutes with 10% margin, plus the pipe volume of the circulation system. The bleed water holding tank could be a few hundred cubic meters depending on the duration that the system operates in zero discharge mode when overboard discharge of washwater is prohibited.

To accommodate the scrubber towers and gas sampling equipment, enlargement of the funnel is often required.

3.3.2 Power availability

Power availability onboard an existing vessel is another key factor to be considered. Typical additional power demand can be around 1.5% of the rating of the engines the scrubber serves.

An in-house electrical load analysis will help to determine if the ship's existing power plant has adequate capacity for the additional power demand of the scrubber. The evaluation is to consider various operation modes of the ship, including normal sea going, maneuvering and cargo loading/offloading. If it is determined that an additional generator is needed, the installation of a scrubber may not be a viable compliance option.

3.4 Procurement

Since a scrubber system is a ship-specific solution for sulfur emissions, the procurement process should ensure the system is suitable for the vessel needs. This should consider the operating profile of the candidate vessel. Key items to be addressed are:

- Technical limitations and operational restrictions
- Emission monitoring technology
- Footprint and weight
- Power requirement under all operating conditions
- Materials of scrubber chamber and accessory components/systems
- Regulatory approval status
- Redundancy and worldwide service availability

3.5 Engineering

Key considerations to be addressed during the engineering phase include material suitability, backpressure and handling sludge arrangements.

3.5.1 Materials

The materials used in the construction of the scrubber and the accessory components are important for the reliability and durability of the system. They should be suitable for the potential high temperatures and corrosive operational conditions.

Table 3.1 summarizes typical materials for different systems, equipment and components.

Table 3.1 | Common scrubber materials

Component	Common material
Scrubber reaction chamber	Super austenitic stainless steel - SMO 254 (6 Moly)
Washwater lines (effluent, bleed-off)	• Glass reinforced plastic (GRP • Super duplex stainless steel
Water lines (scrubbing, cooling, reaction, make-up water)	• Glass reinforced epoxy (GRE) • Carbon steel with polyethylene (PE) lining
Alkali (NaOH) supply	Stainless steel as per SS 316L grade
Sludge tanks	• Plastic • Steel with synthetic coating
Sludge lines	GRE, fiber reinforced plastic (FRP) or GRP
Valves (exhaust, bypass, isolation)	Nickel alloys

3.5.2 Backpressure

The installation of a scrubber may impact the operation of the engine if excessive exhaust backpressure is generated. It is important to verify during the evaluation of a candidate scrubber system that the backpressure is within the limits set by the engine manufacturer. Increase of exhaust backpressure may result in additional fuel consumption due to lower turbocharger efficiency, increased component temperatures, and cause increased wear. In addition, nitrogen oxides (NOx) emission may be increased. Exhaust gas fans may be used at the scrubber outlet to compensate for any additional backpressure, however the addition of more equipment increases the required maintenance over the life of the system.

3.5.3 Integration & safety measures

Multi-inlet scrubbers are typically installed so one scrubber can serve multiple engines and boilers. Such integrated systems require isolation and bypass arrangements so that any engine not in operation can be isolated, or in case of scrubber failure, the scrubber can be bypassed if they are not designed for operation in a dry condition. As illustrated in **Figure 3.3**, the isolation valve (tag no. 7) and bypass valve (tag no. 6) should not both closed, otherwise,

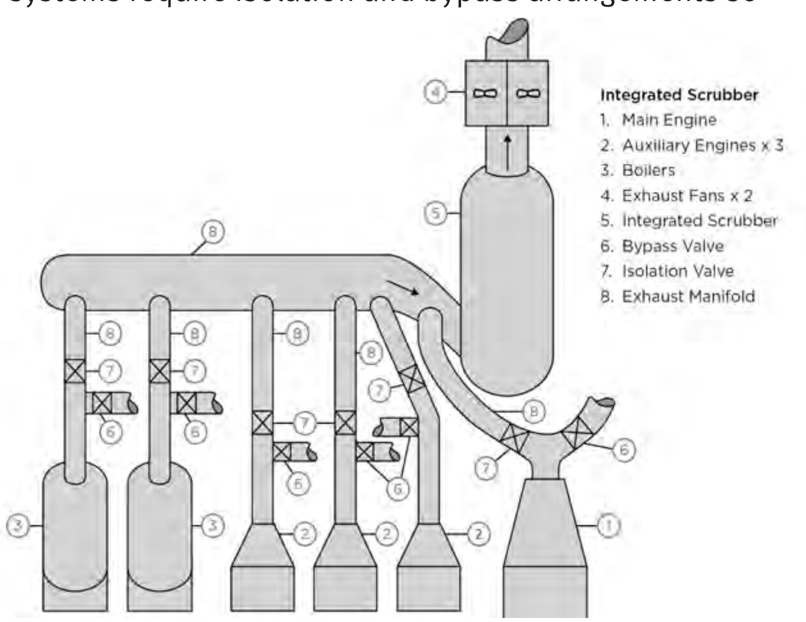


Figure 3.3 | Scrubber

the excessive backpressure may cause the engine to stall. A proper control logic and interlock arrangement should be provided.

The scrubber system design is to consider any abnormal condition that may occur during the operation, for example, excessive high temperature, lack of washwater or potential of scrubber flooding. Automatic shutdown should be incorporated in the monitoring and control system as a safety measure.

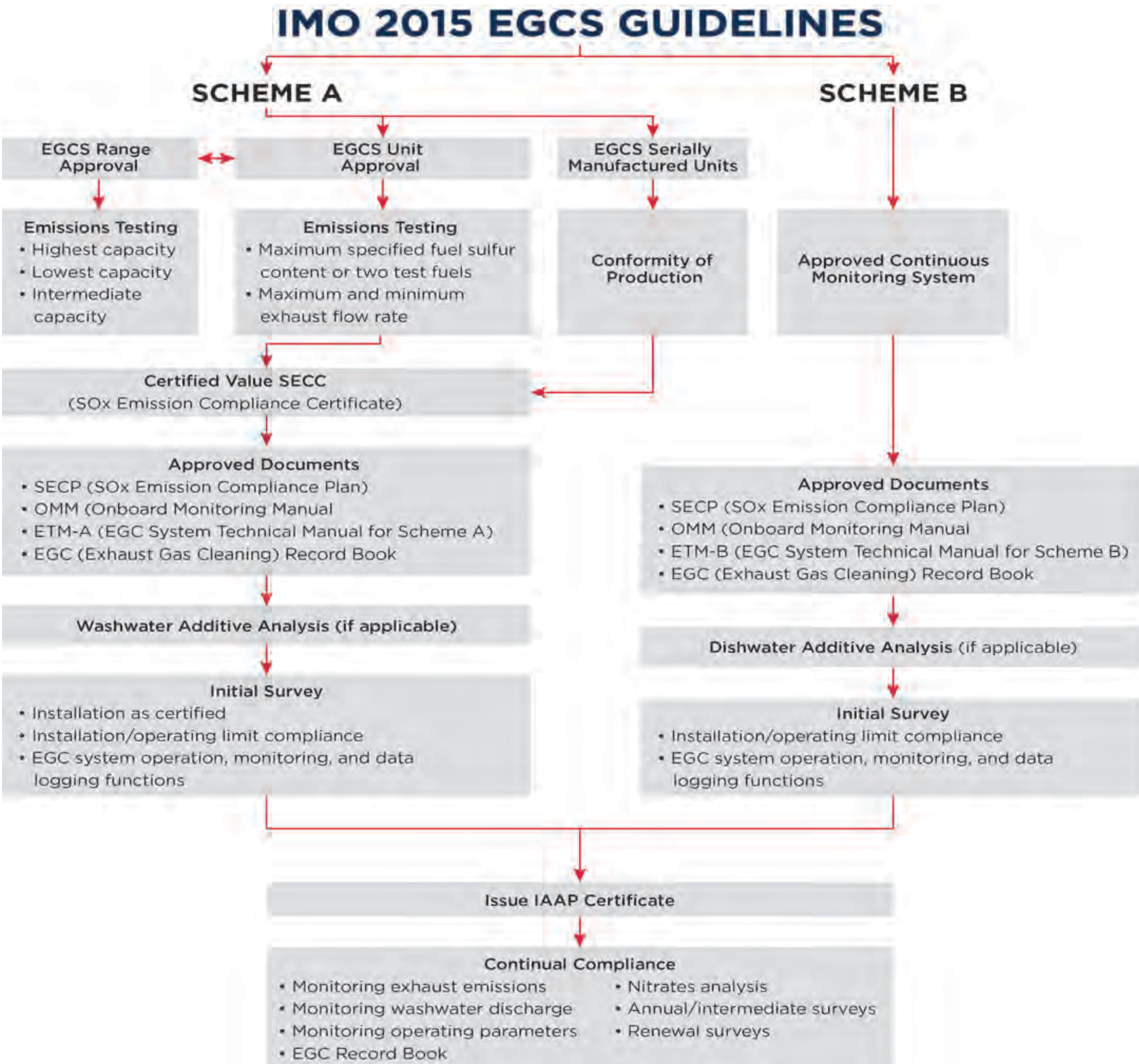


Figure 3.4 | Outline of exhaust gas cleaning system approval scheme

3.5.4 Sludge handling

For closed loop or hybrid systems, sludge will be generated from the washwater treatment system. As set forth in the *IMO Guidelines for Exhaust Gas Cleaning Systems, MEPC.259(68)*, such sludge is not to be discharged to sea or incinerated onboard.

Typical tanks of 0.5 to 1 cubic meter per megawatt (MW) of engine power are specified. A sludge dewatering system may be provided to dry the sludge and minimize the volume, eliminating the need for a sludge tank on board. Sludge can be stored in Intermediate Bulk Containers (IBC) or barrels and transferred ashore.

3.5.5 Classification & statutory approval

A scrubber system requires approval from both a statutory and class perspective and includes the review of the equipment as well as the review of the onboard installation.

From a statutory perspective, the *MEPC.259(68), 2015 Guideline for Exhaust Gas Cleaning Systems*, outline the process including approval Scheme A (unit certification with parameter and emission checks) and Scheme B (continuous emission monitoring with parameter checks) systems as shown in **Figure 2.4**. Scheme B is typically used for the approval of scrubber installations on both new construction and retrofit projects.

Compliance with the SOx emission limit is through in-service continuous monitoring of the sulfur dioxide/carbon dioxide (SO_2/CO_2) ratio in the exhaust gas, and the condition of discharged washwater.

Upon satisfactory initial survey of the installation, and verification of the performance of the monitoring system, with the concurrence of the flag Administration, the scrubber will be included in the Supplement to the International Air Pollution Prevention (IAPP) certificate as the equivalent means for meeting fuel sulfur limit requirements.

The flag Administration is to notify their acceptance to the IMO for inclusion in the IMO Global Integrated Shipping Information System (GISIS) database, as found at gisis.imo.org, for each ship-specific approval.

From a classification society perspective, the requirements in the *ABS Guide for Exhaust Emission Abatement* related to the safety aspects of the system include:

- configuration and vessel integration;
- exhaust by-pass arrangement;
- prevention of flooding;
- vessel stability;
- electrical load analysis;
- piping system;
- NaOH supply system; and
- safety shutdown.

3.6 Installation

For existing vessels, preparation for installation can be completed onboard while the vessel is in operation, onshore before the vessel arrives at the yard, or when the vessel is in the yard. The work onboard will typically require modifications to the structure, electrical and piping systems.

3.6.1 Onboard preparation

Some preparation work onboard may be carried out while the vessel is in operation. This includes the installation of piping, cabling and foundations for seawater pumps as shown in **Figure 3.5** and sealing air fans that are used to provide air to the space between valve discs of an isolation valve or bypass valve as seen in **Figure 3.3** to prevent gas leakage from coming to idle engine. This can help reduce the time required for retrofitting at the yard.

Figure 3.5 | Seawater pumps for scrubber system in engine room

3.6.2 On shore preparation

Typically, when a new funnel block is required, it is common practice to have the block constructed with the scrubber and associated piping and electrical installed within the new block. Piping for the engine room can be prefabricated for installation.

3.6.3 Work in dry dock & at quayside

The additional water demand for scrubber systems may require the existing seachest to be enlarged, or an additional seachest to be added. In such cases, dry docking may be necessary.

Integration of the scrubber system with the shipboard system include the exhaust piping system and the control and monitoring system. The control and monitoring panel is typically installed close to the engine control station. Depending on the scrubber system, an engine load signal may be needed as input to the scrubber system for adjusting the washwater flowrate through variable frequency driving (VFD) pump or throttling valve in washwater supply line.

Due to the corrosive nature of washwater effluent, FRP (or other similar material) is commonly used. Plastic pipe connection work should be in accordance with the manufacturer's installation guidelines and carried out onboard by qualified personnel.

3.6.4 Structure

Structural modification associated with scrubber retrofitting is typically related to creating the space needed for the scrubber system's installation. Commonly, the funnel requires modification to accommodate the scrubber and the associated exhaust bypass pipes. Equipment, piping and ventilation ducts may need to be rearranged for the installation of accessory equipment/system. For closed loop systems, additional required storage space may take up some cargo space.

3.6.5 Electrical

In addition to electric load analysis, an electrical coordination study and short circuit analysis to verify the integrity of the power supply system may be needed.

3.6.6 Piping and seachest

Piping modification involves sea chest enlargement or adding additional sea chest if existing sea chest cannot meet the water demand of the scrubber system. Overboard discharge for washwater will need to be added. The pipe between overboard discharge valves and the side shell need to be of metallic material as required by class rules. This pipe could be subject to severe corrosive effluent. Carbon steel with plastic lining or high-grade stainless steel should be considered.

3.6.7 Stability

Stability and lightship weight need to be evaluated due to the additional weight of the scrubber system. In general, if the change in lightship displacement exceeds 2% of the lightship displacement from the most recent approved lightship data and/or the change in lightship Longitudinal Center of Gravity (LCG), relative to the most recent approved lightship data, exceeds 1.0% of the Length Between Perpendiculars (LBP), a stability test may be required on the vessel and stability calculations would need to be revised to indicate the changes.

3.7 Commissioning

Commissioning of a scrubber system includes calibration of the monitoring and control system, functional testing, and performance evaluation of the complete system. Crew training may also be conducted during the system commissioning phase.

Commissioning can be time consuming. One option is to separate the commissioning and installation process. Once installation in the yard is completed, the ship may return for service with commissioning planned in the future. This can help to decrease the off-hire time. Arrangements would need to be made to ensure the vessel was operated in compliance during the interim period.

Preparation for commissioning should consider:

- development and review of a test plan by the classification society;
- onboard verification of the monitoring and control system sensors. These sensors should be preset at the manufacturer's plant; however, they may require some calibration once the system is installed onboard the vessel, such as zero and span calibration to confirm gas analyzers;
- availability of fuel with the sulfur content corresponding to the design sulfur limit of the scrubber system for performance evaluation; and
- availability of the sampling kit for the washwater effluent, typically provided by the testing laboratory.

Functional testing is to be carried out to verify the integrity and operability of the system including the control, monitoring, alarm and safety system. This includes the interlock arrangement on the exhaust pipes bypassing the scrubber.

Performance testing will involve testing at quay side and during sea trials. Although not required for the Scheme B approval approach under the IMO Guidelines, many owners/operators have chosen to carry out testing to evaluate the performance before the scrubber system is put into operation. This includes the measurement of the SO_2 to CO_2 ratio, and the properties of washwater including pH, PAH, turbidity and nitrates.

The test for emission limit verification can be time consuming. Section 4.3.6 of the IMO Guidelines require the test to be done for at least 4 engine load points. At each load point, it may take proximately 20 to 30 minutes to get the load steady, and an additional

10 to 15 minutes to get the stabilized reading on the emission monitor. Scrubber system commissioning has taken two to three days during sea trials for some past projects.

The accuracy of the emission monitor may be validated by testing the exhaust gas sampled at the exhaust stack with a portable analyzer.

The pH value of washwater could be measured 4 meters from overboard discharge at quay side when the vessel is stationary with generator engines in operation. The corresponding pH value measured at overboard discharge is set as the minimum pH limit. Alternatively, the pH limit monitored at the overboard may also be determined by calculation method following IMO Guideline criteria. This is the IMO approach. For U.S. Environmental Protection Agency's (EPA's) requirements, the pH value needs to be measured at the overboard discharge.

3.7.1 Lessons learned

Key lessons learned from scrubber installation projects completed to date are summarized in **Table 3.2**.

Table 3.2 | Key lessons learned from scrubber installation projects

Observation	Possible Causes	Recommendation
Washwater carryover by exhaust gas	• Inappropriate exhaust gas flow path	• Improve flow path • Modify demister design
Operation interruption (e.g., wash water supply)	• Clogging of filter in supply piping	• Consider redundancy • Complete Failure Modes and Effects Analysis (FMEA)
Unexpected high exhaust gas backpressure	• Glass reinforced epoxy (GRE) • Carbon steel with polyethylene (PE) lining	• Improve design, incorporate design verification and simulation for back pressure evaluation
Out of compliance performance (wash water pH, SO_2/CO_2 ratio)	• Inadequate wash water • Low pH of supply water • Wash water/gas contact	• Improve design • Verify through CFD simulation • Verify supply water pH
Reliability of monitoring system including instrument malfunction	• Not for marine application • Lack of calibration • Inappropriate installation	• Use approved monitoring system • Use proven product • Follow makers instructions
Loose nozzles, water/gas leak	• Poor workmanship	
Extended test period	• Lack of test plan/pre-commission	• Follow approved test plan • Complete pre-commissioning

3.8 Operation

3.8.1 Manning and crew intervention

In service operation planning should consider manning and crew intervention, demonstration of compliance, contingency measures, maintenance and repair, and calibration of instrumentation.

Designated crew need to be assigned responsibility for the operation of the scrubber system, however they do not need to be dedicated. Crew intervention will typically only be required during the start-up and shutdown of the scrubber system, or in the case of a hybrid system, when switching between open and closed loop. This is generally a one-push button task. Crew intervention will also be necessary whenever an alarm condition occurs. It is important that the responsible crew is aware of the operation limitation and able to interpret the alarm conditions, such as out of tolerance sulfur limit, water level, pressure or temperature.

The crew's intervention may also be required in case operational limits are exceeded (e.g., if the sulfur content of fuel used exceeds the design limit).

3.8.2 Demonstration of compliance

For systems under the IMO Guidelines' Scheme B approval approach, demonstration of compliance is through the continuous monitoring of emission level SO_2 (ppm) to CO_2 (% v/v) ratio, and the monitoring of washwater discharge properties.

The SOx Emission Compliance Plan (SECP), Exhaust Gas Cleaning (EGC) Technical Manual Scheme B (ETM-B) and Onboard Monitoring Manual (OMM) are to be used as guidance documents for the operation of the system.

Daily spot checks of the operational parameters should be recorded in the EGC Record Book or Electronic Logging System.

Whenever the scrubber system is operational, the emission level and washwater properties are to be automatically monitored and recorded by the continuous emission monitoring system. The recorded data needs to be retained for at least 18 months from the date of recording and be made available as required.

3.8.3 Contingency measures

Regulation 3.1.2 to MARPOL Annex VI provides criteria for exemptions and exceptions for vessels that experience noncompliance with the emission standards set forth in regulation 14 of Annex VI to the MARPOL Convention as a result of damage to a ship or its equipment.

Under that criteria, a shipowner needs to follow regulation 5.6 and notify their flag Administration for guidance as to necessary measures to be taken. In the case of SOx scrubber installation, switching to compliant fuel is typically expected until scrubber repairs are completed. For the exemption to be granted by the flag Administration, the owner would need to demonstrate that due diligence had been exercised in both design and operation. In addition, national/regional guidance has also been issued on the topic. For example, the United Kingdom have issued a *Marine Guidance Note, MGN 510 (M+F)*, Use of exhaust gas cleaning systems, that addresses potential non-compliance of scrubber systems.

3.8.4 Maintenance & repair

To operate properly, the sensors for a scrubber monitoring and recording system need to be calibrated periodically in accordance with manufacturer's guidelines. Since these sensors can be expected to fail at times, maintaining adequate spares and having a resupply arrangement in place is important.

Commonly identified failures/malfunctions with scrubbers include:

- clogging of the sampling tubing with soot, which prevents proper SO2/CO2 analyzer readings;
- clogging of the pressure transducers at the bottom of the pipe run with debris due to the inappropriate location of the sensors; and
- malfunction of the demister in the scrubber chamber due to the build-up of deposits. Periodic steam cleaning of the system following the maker's recommendations will help to prevent the deposits.

Operational experience indicates that low grade stainless steel, e.g. SS316, will not withstand the corrosive operational environment within the scrubber chamber. Fittings of such material installed inside the chamber readily corrode and could require replacement within 3 years.

Service restriction include wash water discharge restriction, and low wash water alkalinity in certain trade routes or trade areas. In such scenarios, the system will need to operate as a closed loop systemwith the following needs to be taken into consideration:

- handling and disposal of sludge;
- storage of bleed-off water; and
- handling and storage of chemical dosing (typically caustic soda).

Other operational issues include possible noise caused bysealing air fans. Appropriate location of the fans may help to reduce the noise affecting the crew.

3.9 Summary

The forthcoming implementation of the global sulfur cap on January 1, 2020 has brought a level of uncertainty to the marine industry. It is expected this uncertainty will continue in the months following the implementation date.

Currently, approximately 2,700 vessels have installed or have contracted to install scrubbers. By 1 January 1, 2020, the Exhaust Gas Cleaning Systems Association predict approximately 4,000 scrubbers. This will address a small portion of the world fleet. Alternative solutions being considered for the rest of the world fleet to address the sulphur sulfur cap requirement include the use of compliant fuel. As with the installation of a scrubber, the use of compliant fuel has commercial implications and requires significant planning to ensure compliance can be obtained in an efficient and safe manner.

ABS Scrubber-related Publications

- ABS *Advisory on Exhaust Gas Scrubber Systems* (July 2018): This Advisory summarizes the regulatory requirements applicable to scrubbers and provides an overview of available technologies.

- ABS *Exhaust Emission Abatement Guide* (September 2017): This Guide outlines the requirements to be applied to exhaust emission abatement systems fitted to ABS classed vessels primarily covering SOx scrubbers, Selective Catalytic Reduction (SCR) systems, Exhaust Gas Recirculation (EGR) arrangements, and Exhaust Emissions Monitoring

Systems (EEMS) associated with the aforementioned emission abatement systems.

Ram Vis, PhD
Founder
VISWA Group

Ganesh Vaideeswaran
Chief Operating Officer
VISWA Lab

> *"Without laboratories men of science are soldiers without arms."*
>
> \- Louis Pasteur

4.1 Introduction

January 1, 2020 will bring on a series of mandatory regulatory changes for the use of marine bunker fuels relevant to content, testing, management and usage for virtually all ships. In particular, Annex VI, regulation 18 of the MARPOL 73/78 Convention sets forth requirements for the quality of marine fuel oils. Regulation 18.3.1.3 explicitly requires that fuel oils cannot contain any added substances or chemical wastes that may increase the risks to personnel safety or adversely affect the performance of shipboard machinery.

Added substances and chemical wastes to fuel oils that cause machinery problems are not new. However, the new requirements for vessels to burn low sulfur fuels of no more than 0.5% m/m sulfur content have brought to the forefront concerns regarding stability, compatibility and others such as cold flow properties of these fuels.

Furthermore, experience has shown that the current testing regime as per the requirements of ISO 8217 do not necessarily identify nor quantify harmful substances from chemical wastes introduced into bunker fuel.

In light of these challenges, this article discusses and summarizes the current state of affairs relevant to bunker fuels, forthcoming risks and challenges for shipowners to not only meet the January 1, 2020 standards, but also ensuring that the composition of marine fuels they acquire and consume are safe and reliable.

4.2 What Type of Streams From Which Chemical Contaminants are Seen in Bunker Fuels?

Apparently, several waste streams from a number of petrochemical plants were collected and offered to some of the suppliers as low cost "cutter stock". Cutter stock is generally a clean light petroleum distillate used to reduce the viscosity of high viscosity residual fuel oils in order to bring the fuel to "on specification". However due to economic reasons, blenders/suppliers allegedly do switch to cheaper alternatives of cutter stocks. Unfortunately, cutter stock tends to be the source of marine fuel contamination. From our experience, several well-known contaminants seen in waste streams include are but not limited to:

- *ethylene crackers* – styrene, dicyclopentadiene (DCPD) and indene;

- *shale oil* – phenols and resorcinols;
- *tall Oil* – alpha pinene, beta-pinene and limonene;
- *organic chlorides* – tetrachloroethylene, dichloroethane, chlorotoluene, carbon tetrachloride;
- *solvents used in polymer industry* – tert butylphenol, phenols, ethylhexanol, phenylethanols, etc.;
- *monomers* – styrene, DCPD; and
- *coolants* – ethylene glycols.

4.3 The International Organization for Standardization (ISO) 8217 and Marine Bunker Fuels

The bunker fuel industry has seen many changes in the composition of fuels. Bunker fuels are formulated from the residual portion of a crude oil distillation process. The residual portion of the crude oil is normally blended with a lower viscosity product to formulate blends with different viscosities. The ISO 8217 standards determine various properties of the blends and the refiner/blender chooses to use different blend stocks to formulate different grades. In the earlier days, with the use of simple refining procedures, the blends were made from straight run components from the refinery. For example, atmospheric bottoms mixed with distillates (middle distillate) to constitute particular grades of bunker fuel.

Currently, several complex refining procedures have been introduced that affect the quality of the residual products (e.g. vacuum distillation, catcracking, thermal cracking, visbreaking, etc.). Further, due to the growth in the maritime industry the demand for bunker fuel has increased steadily.

As the industry expanded with more players coming into the business, cheaper blend stocks were used. In the earlier days the blend stocks employed were simply distillates from the refinery and now complex blend components such as residues from ethylene crackers, shale oil, off-spec biodiesel, light cycle oil and other refinery wastes. Such usage of products from waste streams has resulted in several contaminants found in bunker fuels. These are difficult to detect using a conventional ISO 8217 test package resulting in the employment of Gas chromatography–mass spectrometry (GC-MS) analysis to detect multiple chemical contaminants in bunker fuels.

Unfortunately, the current ISO 8217 standards do not consider chemical contaminants, including those as specified in **Section 4.2** above. Nor does it specify to conducting GC-MS analysis on fuels to determine the presence and quantification of contaminants. MARPOL Annex VI, regulation 18 addresses the presence of chemical contaminants in bunker fuels. When a fuel is found to have chemical contaminants at certain levels, it is a violation of both MARPOL Annex VI and ISO 8217 standards.

4.3.1 How are the new fuels classified under ISO 8217?

In anticipation of the forthcoming January 1, 2020 0.5% sulfur limit, ISO has released a Publicly Available Specification (PAS), *Considerations for fuel suppliers and users regarding marine fuel quality in view of the implementation of maximum 0.50% sulfur in 2020*. The objective of the PAS is to provide fuel suppliers and user information on marine fuel quality with the introduction of 0.5% sulfur fuels albeit no new fuel standards have been introduced. Those standards as set forth in ISO 8217:2017 will still apply as ISO notes the insufficient time to develop an updated ISO 8217 standard to meet the January 1, 2020 deadline.

The PAS addresses a number of important technical parameters for these fuels including the kinematic viscosity, cold flow properties of distillate fuels, stability, ignition characteristics and catalytic fines.

As the new fuels are expected to have very low asphaltenes, the issue of comingling of fuels and their stability have been addressed in greater detail in the PAS. In particular, additional test methods and indicators to evaluate stability and compatibility of the fuels have been included. While the ASTM D4740 spot test is well known, three more methods (namely ASTM D7060, ASTM D7112 and ASTM D7157) are now accepted. Each of these tests has an instrument specifically developed to conduct the tests.

In summary, the PAS does not consider any new characteristics for the standard. Tables 1 and 2 of the current ISO 8217 will still be applicable with regards to maximum and minimum value of various other parameters.

4.3.2 Is quantification important when chemical contaminants are found in bunker fuels? Why is it important?

Yes, the quantification of chemical contaminants in bunker fuels is important. It is necessary to determine at what concentration levels any identified contaminants are likely to cause problems for shipboard machinery systems. ISO 8217 limits the presence of any chemical contamination in bunker fuel. There may be some contamination due to unavoidable circumstances during transfer of fuel in the refineries, barges, between storage tanks etc. However, this contamination could be at a very low level. VISWA Lab have been testing bunker fuels for presence of harmful adulterants for over 15 years. With enough data at its disposal, VISWA Lab has developed empirical rules to detect levels of single contaminant of combination of contaminants that are likely to cause problems to machinery.

4.4 Stability & Compatibility of Fuel Oil Blends

The stability of marine fuel oils is the ability of the fuel to be stable and remain in an unchanged state when circumstances such as blending, heating may cause it to become unstable. The stability measures the resistance of an oil to break down and for the asphaltenes present to precipitate and accumulate to clog fuel oil systems.

Fuel compatibility refers to the suitability of mixing fuels and any possible adverse effects as a result. As fuel oil blend formulations are expected to vary widely across global geographical regions. Therefore, ships must, as they do today, consider the risk of incompatibility when using consecutive fuels from different ports and regions. Compatibility between different fuels cannot be guaranteed by the suppliers as it is the responsibility of the crew.[5] Recognizing that some degree of mixing of different fuel oils onboard the ship cannot be avoided; many ships today have already procedures in place to minimize commingling of fuel oils with bunker segregation being always the first option and are encouraged to evaluate further their segregation policy.[6]

To exemplify this concern, note there are five fuel oil samples shown in **Figure 4.1**, each

5 Animations of best practices to be followed by ships' crews can be found at www. https://www.american-club.com/page/bunker-fuels.

6 See *IMO MEPC.1/Circ.878, Guidance on the Development of a Ship Implementation Plan for the Consistent Implementation of the 0.5% Sulphur Limit Under MARPOL Annex VI*.

Figure 4.1 | Range of <0.5% sulfur samples including marine fuel oil, vacuum tower bottom (VTB), two distillates and ultra-low sulfur distillate.

of them meeting the standard of a 0.5% maximum sulfur content standard. However, the difference in coloration, content and clarity are strikingly diverse.

The risks to fuel oil stability and compatibility post January 1, 2020 have not escaped the industry. as noted above in **Section 4.3.1**.

4.5 Separating Fact From Myth Regarding Key Marine Fuel Oil Issues

VISWA Lab has been in the forefront in identifying problem fuels and quantifying the contaminants and developing empirical formula to determine at what levels what damages can be expected. Anticipating the introduction of 0.5% sulfur fuels, many labs have begun GC-MS testing. But without a proper data bank and a track record in the usage of this instrument, these labs some providing several misleading information to the marine industry as listed in **Table 4.1**.

> *"Science and technology revolutionize our lives, but memory, tradition and myth frame our response."*
>
> \- Arthur M. Schlesinger, Jr.

There is an attempt to confuse people and obfuscate issues about diagnosing and predicting problems in marine fuels. It is our objective to clarify the issues, dispel the myths, and establish that the potential problems due to poor quality fuels can be detected and diagnosed in advance thereby enabling preventive steps to be taken quickly. The higher purpose of a marine fuel oil testing laboratory is to help the suffering fuel user from the complications caused by adulterated fuel by accurately identifying the source and cause of the problem.

Table 4.1 | Myths versus facts about bunker fuels

Myth	Facts
Filter blocking is mainly due to compatibility issues, so it is the fault of the ship.	Compatibility is one of the many reasons for filter blockage from a fuel quality point of view. We have observed that the presence of excess styrene, indene, DCPD (in combination) can cause filter blockage. In addition, excess FAME content, particularly with high glycerin, can cause filter blocking. Polyethylene and polypropylene in the fuel can also cause filter blocking. Even excess sediment can cause filter blockage. All the above are problems with the fuel and fuel quality.
Marine fuel oil has a very large and diverse number of hydrocarbon configurations and therefore, give rise to different and inconsistent results from different labs.	This is patently untrue. The most common test to detect chemical contaminants in fuels is by GC-MS testing. Even labs following different test methodologies to detect chemical contamination in bunker fuels, the values of the contaminants found with different test methodologies fall within the same range.
Multiple methods are used by multiple labs and there is no standardized method.	American Society for Testing Materials (ASTM) brought forth the standard to carry out GC-MS (ASTM D7845) and the methods and contaminants identified are all listed. This standard has been in existence for more than 3 years.
GCMS test can be conducted by several techniques.	One of the most common and rapid testing techniques used in the petrochemical industry is by headspace. GC-MS analysis utilizing the headspace technique will be less accurate and less conclusive, because it is carried out in a short time. We find this to be true and that is why we accept only a qualitative assessment of the headspace results. If a certain contaminant is identified as high, in general, when we do a full spectrum GC-MS, the high values are confirmed. It is possible to do headspace to a greater accuracy and a chromatogram can be supplied. It must be noted that the environmental labs and pharmaceutical labs use headspace analysis on millions of samples.

Table 4.1 (cont.) | Myths versus facts about bunker fuels

Myth	Facts
There are nearly 100 million substances in the CAS library. How can you identify the contaminants?	Fortunately, the suppliers have over the years tried to adulterate bunker fuels with a known number of contaminants. By using GC-MS testing methodology these contaminants have been identified and documented. Most of the labs use libraries published by National Institute of Standards & Technology (NIST) to validate their findings. Another common method of confirming these is to calibrate the GC-MS with known contaminants with known levels. It is possible to confirm, and, in fact, most of the fuels do not have the contaminants found in problem fuels. This is a distinguishing factor. Alternately they may be present at very low levels. After conducting thousands of GC-MS studies, VISWA have developed an empirical formula based on which we can not only identify the contaminants but also at what levels they are likely to cause problems. Since the fuels referred for investigation are known to have caused problems, it makes it easy to arrive at an algorithm where a single chemical adulterant or a combination of multiple chemical adulterants each with known levels of contaminants will cause the damage. VISWA has repeatedly stated that when styrene alone is present even at 2,000 ppm level it will not cause a problem. However, if styrene, and indene are present and all three are present at above 100 ppm levels, it can cause problem of polymerization, filter choking, fuel pump seizure etc.
All bad fuels should be debunkered.	We know that debunkering is the last option for all parties involved, since it is the most expensive and the most time consuming choice. We pride ourselves in trying our best to see if the fuel can be made usable by either utilizing additives, blending with a better-quality fuel, or treating the fuel more intensely onboard the vessel.

4.6 Gas Chromatography–Mass Spectrometry (GC-MS) & Marine Bunker Fuels

> *"Chemistry, unlike other sciences, sprang originally from delusions and superstitions, and was at its commencement exactly on a par with magic and astrology."*
>
> \- Thomas Thompson

Gas chromatography–mass spectrometry (GC-MS) is an analytical methodology used to identify and differentiate chemical substances within test samples. The methodology is applicable in many domains such as detecting drugs, environmental analysis, fire and explosives investigations and analyzing other unknown material samples.

The basic principle of this test is the introduction of a vaporized substance into a column (stationary phase) that is placed in a heated system. The vaporized substance is carried over to the column by means of an inert gas such as helium or hydrogen. Separation of a mixture into individual components happens in the column as a function of temperature. Detection of the separated components is done using several detectors.

One of the most common detectors used is a mass spectrometer. Mass spectrometer is one of the most widely used detector coupled to a gas chromatograph. The separated components eluting out of the column are ionized in the mass spectrometer. Detection is done basis the molecular weight of a compound. With the use of libraries, it is possible to easily identify the compounds separated out from the gas chromatograph.

Hence the name *gas chromatography-mass spectrometry*.

In 1991, the United States Environmental Protection Agency (EPA) set up standards for testing-water, wastewater, and soils and GC-MS became an instrument of choice in the investigation process. In 1991, the GC-MS equipment occupied the size of a 10x10 foot room. Furthermore, at that time a single GC-MS analysis cost US$ 3,000. Through the years, the GC-MS instrumentation accuracy and capabilities continuously improved. Right now, the GC-MS instrument has come down to the size of a tabletop computer without sacrificing accuracy and reliability and has become the 'gold standard' for forensic substance identification.

In 2016, to ensure the consistency and reliability of GC-MS results for marine fuels, the American Society for Testing and Materials (ASTM) established the *Standard Test Method for Determination of Chemical Species in Marine Fuel Oil by Multidimensional Gas Chromatography/Mass Spectrometry* (ASTM D7845). ASTM D7845 is the internationally accepted test methodology specially designed to check chemical contaminants in bunker fuels.

The GC-MS instrument itself needs an operator who is not only a highly trained analytical chemist but also an intuitive problem solver. Not every analytical chemist can become a top GC-MS operator and is not a skill that picked up in a matter of months. Apart from the skill of the analyst, it is also the techniques used in the GC-MS that really produce valuable results.

The industry norm was to carry out "headspace analysis" which has certain limitations and produces only qualitative data. Hence this analysis is primarily used as a screening tool. The same is true for GC-MS vacuum distillation. Alternatively, VISWA applied direct liquid injection to marine fuel testing, in addition to the methods listed above. VISWA also cross checked and counter checked where possible with Fourier-transform infrared spectroscopy (FTIR), a technique used to determine chemical contaminants known from the infrared spectrum of different solid, liquid and gas compounds.

GC-MS techniques employed in testing bunker fuels differs in the way a fuel is treated for introduction into the GC-MS instrument. The most common techniques, along with their pros and cons are shown in **Table 4.2**. Each described technique has benefits as well as drawbacks. However, GC-MS analysis by direct liquid injection is considered the most reliable and effective technique for detecting a wide range of chemical contaminants that may be found in marine fuel oils.

4.7 Observations & Recommendations

In summary, there are clearly challenges to be tackled and overcome by January 1, 2020. Many of these challenges cannot be sufficiently addressed until the requirements come into force when there are more bunker fuel streams that are brought online by the industry to meet the not to exceed 0.5% m/m sulfur content requirement.

1. Enough samples should be taken when stemming bunkers to not only comply with the requirements as set forth by regulation 18 of Annex VI of the MARPOL Convention, but

also to perform any additional testing as may be necessary that go beyond the tests of the standard ISO 8217 specifications. Should a consignment of bunker be found to create problems, the sample can be used to identify any contaminants.

2. An updated version of ISO 8217 is scheduled for release before the end of 2019 (ISO 8217:2020). However, the organization has made it clear that there will be no new characteristics added to those currently listed. But ISO is producing guidance, ISO PAS 23263, before the end of 2019 to address concerns regarding fuel oil stability and compatibility.

3. Additional testing beyond those specified under ISO 8217 is best performed through GC-MS techniques by a qualified and reputable laboratory. These techniques do have their benefits and drawbacks based upon applied methodologies as specified in **Table 4.2**. However, they can provide a significant additional insight into any fuel oil composition that may possibly pose risks to the efficient and effective operation of auxiliary and main engine systems.

4. The need for proper testing of bunkers being loaded and onboard the ship cannot be overstated. Shipowners should make a concerted effort to ensure that shipboard crews are properly trained and qualified in procedures for fuel sample collection during bunkering and onboard testing to comply with port State control testing requirements.

Table 4.2 | GC-MS techniques pros and cons

Analytical technique	Description	Pros	Cons
Headspace	A small amount of fuel is taken into a glass vail with a large headspace	• Very quick analysis hence used a screening tool with bunker fuels. • Very sensitive to lower boiling point fractions • Semi-quantitative analysis • Low instrument maintenance and hence able to run samples continuously	• Components that elute into the gas phase are specific to a temperature. (e.g. if headspace extraction is set to 90 deg C, only compounds that can enter gas phase at this temperature are collected) • Decomposition of extracted compounds due to their reactive nature. Hence the analytes that can be tested are limited • Vapor evolved is prone to leaks and hence loss of compounds in sample

Table 4.2 (cont.) | GC-MS techniques pros and cons

Analytical technique	Description	Pros	Cons
Vacuum distillation	A fuel undergoes vacuum distillation at a certain temperature condition. The vacuum distillate collected is then injected into the GCMS system	• Interference due to asphaltenes can be eliminated • Quicker than direct injection • Possible to test more components compared to headspace technique	• Components that elute into the gas phase are specific to a temperature. (e.g. if vacuum distillation is set to 90 deg C, only compounds that can be distilled at this temperature can be tested) • Thermal decomposition of extracted compounds due to their reactive nature. Hence the analytes seen detected may or may not be in their native chemical state in the fuel • Loss of lower boiling fractions • Accurate quantification may not be possible due to possible loss of fractions
Solid phase micro extraction	Polar components (e.g. as fatty acids, esters, etc.) extracted by use of a solid phase extraction cartridge. The extract obtained is tested on the GC-MS instrument	• Efficient technique to check for polar compounds in a fuel (acids) that cannot be easily chromatographed • Technique is sensitive to even lower levels of polar compounds • Highly reproducible • High recoveries	• Too many variables that affect extraction efficiency including: o sample size o surface area of material used for extraction; and o skill and experience of the user • Time consuming • Interferences due to similar component types • Costly
Direct liquid injection	A fuel sample is diluted with an appropriate solvent and injected directly into the GC-MS instrument	• Very sensitive to low level chemical contaminants hence the method of choice in forensic analysis of bunker fuels • Quantification is possible to a greater accuracy • Employing variety of columns, able to test a wide range of chemical contaminants in fuels (from low boiling point fractions to high boiling fractions)	• Time consuming • High instrument maintenance. Asphaltene present in the fuel may clog the column • Expensive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5.1 Introduction

The MARPOL Annex VI provisions that impose the 0.5% sulfur cap on fuel as from January 1, 2020 give rise to a number of issues under English law relevant to existing, ongoing charter parties and contracts of affreightment.

5.2 Time Charter Parties

5.2.1 Seaworthiness/fit for service

Time charter parties for bulk carrier vessels, which are invariably on the NYPE form, contain a requirement for the vessel to be seaworthy on delivery[7] and fitted for the service. By way of example, lines 21-22 of the 1946 edition of the NYPE form require the vessel on delivery to be *"tight, staunch and strong and in every way fitted for the service"*. Materially similar words appear in lines 32-33 of the 1993 edition of the NYPE form. Both forms additionally provide for the vessel to be maintained throughout the charter service (clause 1 of the 1946 edition and clause 6 of the 1993 edition.

This begs the question whether these obligations require the owner to:

1. ensure that the vessel is delivered with a scrubber so as to be able to consume heavy sulfur fuel; and/or
2. modify the vessel during the charter to be fitted with a scrubber.

It seems highly doubtful that these obligations require the owner to do so, particularly since:

1. the simple alternative is for 0.5% sulfur fuel to be provided;
2. the time charterer is under an obligation to provide fuel during the charter as explained below and can simply provide such fuel;
3. it may not be a certainty that the particular scrubber installed will actually perform to specification (compared with the simpler alternative of providing 0.5% sulfur fuel); and
4. any delays arising out of the fitting of a scrubber on board a vessel that is already on time charter to the charterer may itself lead to a number of issues and may be something the time charterer commercially does not want.

Where a vessel is provided with a scrubber, additional issues may arise as to:

1. Whether the owner warrants the working condition of the scrubbers (the answer would appear to be that it does, as with any machinery on board the vessel under a typical NYPE charter party);

7 Where the charter party includes a clause paramount incorporating the Hague or Hague-Visby Rules into the charter party for the owner to exercise due diligence to make the vessel seaworthy on delivery, it is thought that the effect is that, apart from the seaworthiness obligation being converted into one of due diligence on delivery, this also applies before and at the beginning of each voyage under the charter party, by analogy with the Court of Appeal decision in *The Saxon Star* [1957] 1 Lloyd's Rep. 271, where this was held this to be the case for a consecutive voyage charter party.

2. The cost of the scrubbers' additional energy consumption (where the charter party does not make such costs for the time charterer's account, this would presumably be for the owner's account as it would in the case of the cost of operating the remaining vessel machinery);
3. Whether time counts during maintenance of the scrubber (it would seem that such time would be for the owner's account, as in the case of maintenance of any piece of vessel machinery); and
4. Whether the time required to fit a scrubber in drydock is for the owner's account (this will depend on the clause(s) in question).

5.2.2 Time charterer's obligation to supply fuel during the charter

Clause 2 of the 1946 edition of the NYPE form requires the time charterer to "provide and pay for all the fuel". In the 1993 edition this obligation is found in clause 7.

This would presumably require the time charterer to provide 0.5% sulfur fuel that the vessel is permitted to consume after January 1, 2020 as opposed to high-sulfur fuel that it is prohibited.

To date, BIMCO has presented the industry with a suite of bunker clauses for consideration as follows:

1. **BIMCO's 2020 Marine Fuel Content Clause for Time Charter Parties** expressly requires the time charterer to supply low-sulfur fuel:
   a. *For the purpose of this Clause, "Sulphur Content Requirements" means any sulphur content and related requirements as stipulated in MARPOL Annex VI (as amended from time to time) and/or by any other applicable lawful authority.*
   b. *The Charterers shall supply fuels to permit the Vessel, at all times, to comply with any applicable Sulphur Content Requirements. All such fuels shall meet the specifications and grades set out in this Charter Party.*

   The Charterers also warrant that any bunker suppliers, bunker craft operators and bunker surveyors used by the Charterers shall comply with the Sulphur Content Requirements…"
2. **BIMCO's 2020 Fuel Transition Clause for Time Charter Parties** goes hand-in-hand with its other 2020 clause and requires the same thing in advance of, and after January 1, 2020. First it requires the time charterer to supply sufficient 0.5% sulfur fuel before January 1, 2020 to enable the vessel to reach the nearest bunkering port where such fuel is available. Secondly, it requires the time charterer, at its risk, time and expense and with the owner's reasonable co-operation, to remove the pumpable high-sulfur fuel on board as soon as possible after January 1, 2020, and no later than March 1, 2020.

   Finally, it requires the owner, at its risk, time and cost, to ensure that those empty bunker tanks are fit to receive 0.5% sulfur fuel (which would therefore involve them removing any remaining, unpumpable fuel residues at its time, risk and cost), after which no high-sulfur fuel can be loaded in those tanks. Disputes could also conceivably arise if the owner is not happy with the time charterer's removal of fuel under the clause. Leaving this to one side, the clause does seem fair and balanced in apportioning risk and expense/time between the two parties.

3. **BIMCO's 2009 Bunker Quality Control Clause for Time Chartering**, which more generally requires the time charterer to *"supply bunkers of a quality suitable for burning in the Vessel's engines and auxiliaries and which conform to the specification(s) mutually agreed under this Charter…"*, likely requires the same thing.
4. **BIMCO's 2009 Bunker Quality and Liability Clause**, however states that the time charterer *"shall supply fuels of the agreed specifications and grades" and that the fuels "shall be of a stable and homogeneous nature and suitable for burning in the Vessel's engines or auxiliaries and, unless otherwise agreed in writing, shall comply with ISO standard 8217:2010 or any subsequent amendments thereof."* does not deal with 0.5% sulfur fuel post-January 1, 2020 because it concerns compliance with ISO 8217:2017. As noted in **Section 4.3.1** of this compendium, ISO has released the PAS, *Considerations for fuel suppliers and users regarding marine fuel quality in view of the implementation of maximum 0.50% sulfur in 2020*, as guidance for shipowners on this matter.
5. **BIMCO's 2005 Bunker Sulphur Content Clause for Time Charter Parties**, which requires the time charterer to supply *"fuels of such specifications and grades to permit the Vessel, at all times, to comply with the maximum sulphur content requirements of any emission control zone when the Vessel is ordered to trade within that zone"* and to ensure that *"any bunker suppliers, bunker craft operators and bunker surveyors used by the Charterers to supply such fuels shall comply with regulations 14 and 18 of MARPOL Annex VI, including the Guidelines in respect of sampling and the provision of bunker delivery notes"* does not do so either because, despite the reference to MARPOL (in particular regulation 14), it concerns the separate 0.1% sulfur limit applicable in Emission Control Areas (ECAs) as from January 1, 2015 rather than the 0.5% sulfur limit applicable in non-ECA as from January 1, 2020.
6. **INTERTANKO's Bunker Compliance Clause for Time Charter Parties** also deals with 0.5% sulfur fuel. This broad model clause provides owners and charterers with a complete code to prepare their fixtures, and it can be used immediately and post-January 1, 2020. Parties have the flexibility to adapt the provisions of this clause to suit the purposes of their trade. The main elements of the clause are as follows:

    a. It requires the time charterer to supply such fuel (as well as 0.1% sulfur fuel to be consumed in ECA zones) and to ensure that its bunker supplier provides the BDN and representative samples as required by regulation 18 of Annex VI to the MARPOL Convention, failing which it must indemnify the owner.

    b. The owner must in turn ensure, among other things, that the 0.5% sulfur fuel will be kept separate and not commingled with other fuel.

    c. The clause adds that the vessel's speed and consumption warranties will apply to 0.5% sulfur fuel.

    d. The clause additionally states that if the time charterer redelivers the vessel before the January 1, 2020 date (between a range of dates to be agreed by the parties), then the time charterer will ensure that the vessel will not have more than a certain amount (to be agreed by the parties) of high-sulfur fuel and not less than a certain amount (to be agreed by the parties) of 0.5% sulfur fuel.

e. The clause finally states that if the vessel is redelivered on or after December 31, 2019 then the parties will discuss how the tanks must be cleaned by the time charterer at its risk and expense in order to receive 0.5% sulfur fuel; the time charterer will bunker sufficient fuel to enable the vessel to reach the next port at which such fuel can be obtained (failing which the owner can do so at the time charterer's expense); and the time charterer will dispose of high-sulfur fuel before March 2020 or redelivery (whichever is the earlier).

5.2.3 Potential fuel contamination disputes

Mention should be made of the possibility that increased demand for 0.5% sulfur fuel after January 1, 2020 will increase the risk of fuel contamination as blending will increase significantly in order to meet the anticipated high demand for 0.5% sulfur fuel.

BIMCO clauses 1 and 2 above ought to cater for this (as well as BIMCO clause 3 so long as BIMCO clause 1 is also included in the charter party), in addition to the INTERTANKO clause, making this for the time charterer's account (by way of damages for breach of their provisions).

In addition to this, the **BIMCO's Bunkering Operations and Sampling Clause** should assist – requiring co-operation between the crew and bunker suppliers and requiring the time charterer to ensure that the bunker supplier complies with the MARPOL Annex VI sampling requirements and that fuel of different grades are stored separately. The **BIMCO's Bunkering Prior to Delivery/Redelivery Clause** would only have indirect effect in this regard combined with the other BIMCO clauses has mentioned, the risk of fuel contamination should fall on the time charterer.

5.2.4 Owner's obligation to pay for the bunkers on redelivery

The common requirement under time charter parties for bulk carrier vessels is for:

1. the time charterer to purchase and take over the bunkers on board the vessel on delivery;
2. the time charterer to provide and pay for the fuel during the charter as noted previously;
3. the time charterer to redeliver the vessel with about the same bunker quantities on redelivery; and
4. the owner to purchase and take over the bunkers on redelivery.

An example of the obligations referred to in (3) and (4) above can be found in BIMCO's 2009 Types and Quantities of Bunkers on Redelivery Clause, which states:

> *"Unless agreed otherwise, the Vessel shall be redelivered with the same types and about the same quantities of fuels as on delivery; however, the types and quantities of fuels on redelivery shall always be appropriate and sufficient to allow the Vessel to reach safely the nearest port at which fuels of*

the required types are available."

Where the vessel is delivered prior to January 1, 2020 with high-sulfur fuel being used onboard, the time charterer is required to supply 0.5% sulfur fuel after that (during the charter and on redelivery), but the charter party simply provides for the owners to pay for the bunkers on redelivery at set prices without making express reference to 0.5% sulfur fuel, this may lead to a dispute as to the price the owner should pay for this.

5.2.5 Should it be the charter party's high-sulfur fuel price? If not, what price should be paid, and on what basis?

The answer will depend on the precise charter party provisions. These will tend to be the tailor-made charter party rider clauses, in circumstances where the BIMCO bunker clauses make clear that they do not apply to the pricing or quantity(ies) of bunkers (a conscious decision according to the accompanying BIMCO notes).

Clauses have been encountered in practice that are potentially widely-worded enough to encompass 0.5% sulfur fuel as fuel which must be paid for at the charter party's high-sulfur price. By the same token, charter party clauses have been encountered that do not do so.

By way of example, a mere reference to *"FO"* (fuel oil) or *"LSFO"* (low sulfur fuel oil) or *"ULSFO"* (ultra-low sulfur fuel oil) would on the face of it encompass low-sulfur fuel; whereas a reference to *"HSFO"* (high sulfur fuel oil) or *"IFO 380 CST"* or *"IFO 180 CST"* (high-sulfur fuel) would not. Again, though, the remaining provisions of the clause in question, as well as any other applicable charter party clauses, must be borne in mind when construing the apparent meaning acronyms that have been used by the parties.

Moreover, a London arbitration Tribunal or High Court judge – where English law applies, as is invariably the case with time charter parties – will be entitled to take into account any "factual matrix" background evidence which parties in the owner's and time charterer's shoes would have known about at the charter party date.

In the absence of any other applicable charter party clauses where English law governs the charter party, the time charterer may possibly seek to rely on an argument that it should be paid the 0.5% sulfur price on the basis that the owner has been unjustly enriched at its expense. However, such arguments are generally not straightforward under English law and require the party advancing such an argument to show the requisite "injustice"; this would be the case where payment has been made on the basis of a mistake of fact or law or under duress/undue influence, or where there is a total failure of consideration. However, none of these examples would apply here.

5.3 Voyage Charter Parties & Contracts of Affreightment

5.3.1 Seaworthiness/fit for service

As with time charter parties, it seems unlikely that a seaworthiness obligation under a voyage charter party and/or a contract of affreightment (i.e. a charter party for a number of voyages on board vessels to be nominated for cargo shipments between specified dates) requires the owner to provide a vessel fitted with a scrubber on delivery.

5.3.2 Modification of the freight rate on account of the use of 0.5% sulfur fuel

A number of voyage charter parties and contracts of affreightment include clauses adjust the freight rate payable by the voyage charterer by a specified amount, or according to a specified scale, depending on the type of fuel consumed by the vessel and/or the regions in which such fuel is provided (or where the vessel calls).

For example, **BIMCO's Bunker Price Adjustment Clause** states:

> *This Contract is concluded on the basis of a bunker price of USD _____ per metric ton for _____ oil* of _____ grade. If the bunker price per metric ton at _____** on the first day of loading is higher than USD _____ or lower than USD _____, any amount in excess of such increase or decrease shall be payable to Owners or Charterers as the case may be.*
>
> *The agreed bunker consumption for each voyage is as follows: _____*
>
> ** Indicate whether gas oil, diesel or fuel oil.*
>
> *** Port or place (supplier or published index) to be agreed between the parties.*

BIMCO's Bunker Rise Clause for Voyage Chartering sets out a slightly different type of arrangement by which the voyage charterer directly pays for the bunker price differential instead of the freight rate being adjusted:

> *This Charter is concluded on the basis of a price of .... per ton of* .... for bunker** .... oil of .... grade in force on the date of this Charter. If the price actually paid by the Owners during the period of this Charter for the quantity consumed on the contracted voyage(s) should be higher, the difference shall be paid by the Charterers to the Owners on production of the Owner's account therefor.*
>
> ** Insert 1,000 kilos or 2,240 lbs as applicable.*
>
> *** Indicate whether diesel, fuel or gas oil.*
>
> *(NOTE: This Clause is particularly intended for contracts for several voyages).*

INTERTANKO have separately issued a slightly more detailed **Bunker Adjustment Factor Clause for Contracts of Affreightment** that states:

1. *This Contract of Affreightment is concluded on the basis of a bunker reference price of USD XXX.XX per metric ton (the 'Bunker Reference Price') and will remain so for the duration of this Contract of Affreightment.*
2. *The bunker price for the purposes of this Contract of Affreightment and adjustment of freight rates shall be the mid-delivered bunker price per metric ton published by [insert supplier or published index and port or place):*
    a. *Until {insert date} for IFO 380 CST on the date of {firm nomination or bill of lading} [select one} or last published immediately prior to that date*
    b. *After {insert date} for low sulphur fuel oil that is compliant with b. MARPOL Annex VI 2020 regulatory changes (hereby applied in advance of 1st January 2020) on the date of {firm nomination or bill of lading} [select one] or last*

published immediately prior to that date

(the 'Bunker Price'.)

3. *Any difference between the Bunker Reference Price and Bunker Price shall be compensated for in the freight rate using the following bunker adjustment factors:*
   a. *up to USD XX (plus or minus) there shall be no adjustment in the freight rate*
   b. *for every USD 1.00 per metric ton above or below USD XX the freight rate shall be increased or decreased by USD XX cents (USD 0.00) per metric ton*
   c. *the adjustment in the freight rate, whether a surcharge or a credit, shall always be calculated from the Bunker Reference Price.*

INTERTANKO referred to the BIMCO Bunker Adjustment Clause as presented above for those of its members seeking to protect themselves from bunker price volatility when negotiating a single voyage charter party.

5.3.3 Further considerations regarding freight rate adjustment clauses

Issues, and therefore disputes, may arise where the freight rate adjustment clause(s) in question do not expressly refer to 0.5% sulfur fuel:

1. Where a clause simply refers to "FO" or "IFO" (intermediate fuel oil) or "LSFO" or "ULSFO", the case for the freight rate to be adjusted would appear stronger;
2. However, where the clause refers to "HSFO" or "IFO 380 CST", the case would seem much weaker; though
3. In either case, the meaning of any acronyms used will depend on their context along with the other provisions of the clause(s) in question and/or of any other applicable provisions of the charter party/contract of affreightment (COA).

By contrast, such issues would not be expected to arise where the charter party/COA clause expressly refers to 0.5% sulfur fuel, as is now occurring with "bunker adjustment clauses" being drafted with the assistance of lawyers with this consideration in mind.

Finally, whilst BIMCO's Bunker Rise Clause for Voyage Chartering quoted above may be thought to more obviously apply where 0.5% sulfur fuel is provided, this will actually depend on the acronyms inserted in the blanks left by the clause.

5.4 Conclusion

In summary, it is recommended that parties that are negotiating time charter parties, voyage charter parties or contracts of affreightment give serious thought to the BIMCO/INTERTANKO clauses that are in circulation dealing with 0.5% sulfur fuel post-January 1, 2020. The clauses, as a whole, are comprehensive, addressing the different scenarios that could arise leading up to and after January 1, 2020, and they can be adapted for individual needs. Certainty is surely better than uncertainty that carry with it significant litigation risks and associated costs.


NO SMOKING!
BUNKERING
IN PROGRESS

Dimitri Georgantas
Of Counsel
Royston Rayzor

Marc Matthews
Partner
Phelps Dunbar

6.1 Introduction

For owners and/or charterers who have taken off-specification bunkers onboard at a United States ("U.S.") port call, there are two considerations that will immediately come to mind:

1. what to do with the bunkers that are onboard but have not been consumed, and
2. what the options are for recovery of any damages against the bunker supplier or manufacturer.

U.S. law imposes steep hurdles for both considerations.

6.2 The Jones Act Hurdles

A U.S. law known generally as the Jones Act, 46 U.S.C. § 30104, *et seq*., prohibits coastwise trade (the loading and discharging of cargo between U.S. ports) by a foreign-flagged vessel.

The initial consideration in connection with an off-specification bunker situation for a vessel is what to do once a determination has been made that the bunkers are off-specification. When there is confirmation that bunkers loaded at a U.S. port are off-specification, the owner/charterer's options are limited as follows:

1. iIn one scenario, if the vessel is still in the "vicinity" where the bunkers were delivered in the first place, it may be possible (subject to an agreement with the bunker supplier) to make the necessary arrangements to return the bunkers to the "same point" where the delivery took place. The reference to "same point" is significant, as will be explained below. For instance, if the bunker delivery took place alongside the vessel while the vessel is at a dock in Houston carrying out cargo operations, it may be possible for the vessel to return to the same dock and for the bunkering barge to return to the vessel and offload the off-specification bunkers at the exact point where the bunkers were initially delivered to the vessel. This would not constitute a violation of the Jones Act. This of course assumes an agreement between the vessel owner/charterer and the bunker supplier that the bunkers are in fact off-specification and the supplier has agreed to take them back. This approach has proven successful.
2. Similarly, if the vessel received the bunkers at an anchorage—say for instance the Bolivar Anchorage near Galveston, a frequent delivery point for bunkers—then it may be possible for the vessel to return to the "same point" (i.e., Bolivar Anchorage) and offload the off-specification bunkers to a barge at the same location where the bunkers were initially delivered. This again would not be a violation of the Jones Act.

The point of the above two examples is that the general prohibition of the Jones Act is that a foreign-flagged vessel may not conduct coastwise trade whereby she loads in one U.S. port (one "point") and discharges in another U.S. port (another or different "point"). But, if the off-specification bunkers are offloaded at the exact same location where they were initially delivered, then it is not "another U.S. port", and therefore not a violation of the Jones Act.

3. In the absence of the above circumstances, it would not be possible for a foreign-flagged vessel to offload the bunkers at another U.S. port, with one exception. Let's assume a foreign-flagged vessel is scheduled to receive bunkers at the Port of Houston and is then scheduled to sail to the Port of New Orleans. While in Houston the vessel receives bunkers and while she is sailing towards New Orleans her crew determine the bunkers are off-specification and cannot be used. The vessel, for whatever reason, cannot return to Houston (i.e., to the same "point") to offload the off-specification bunkers and must continue to New Orleans. The only possible solution in New Orleans would be to contract with a U.S.-flagged barge or vessel (i.e. a U.S. Coast Guard documented vessel) to take delivery of the off-specification bunkers. If this occurs, then the owner/charterer can offload the off-specification bunkers to the U.S.-flagged barge or vessel even if that offloading takes place at a different point than where the off-specification bunkers were first loaded, because transferring the off-specification bunkers at another U.S. port but to a U.S.-flagged vessel is not a violation of the Jones Act. In this circumstance it would also be advisable to notify the local director of U.S. Customs & Border Protection of the operation. This approach had been taken on a number of cases (in respect to a portion of cargo that had to be offloaded), when, even though the vessel was still at the same dock where the cargo was received, it was not physically or logistically possible to return the cargo to the terminal, so the cargo was offloaded into a U.S.-flagged barge. By using a U.S.-flagged vessel to receive the off-specification bunkers, there would be no Jones Act violation.

6.2.1 Jones Act waiver

In the absence of the above two scenarios (i.e., return the bunkers at the same "point" where they were initially received or offload to a U.S.-flagged vessel), there is next to zero probability of being able to offload them at a different U.S. facility, because the only way to avoid the Jones Act prohibition on doing so would be to obtain a waiver of the Jones Act's restrictions. Generally, Jones Act waivers consists of two different types:

1. any waiver requested by the Secretary of Defense is granted automatically; or
2. any waiver granted by the Secretary of the Department of Homeland Security is discretionary.

The general standard for granting a discretionary waiver is that doing so is "necessary in the interest of National Defense." As one can appreciate, there is virtually no chance that offloading off-specification bunkers from a foreign-flagged vessel would ever constitute a matter necessary in the interest of national defense sufficient to justify the granting of a waiver.

The above comments are limited to the Jones Act issues a foreign-flagged vessel would encounter if she tries to return or offload off-specification bunkers. They do not address the potential economic loss for damages. However, and again in the absence of an agreement between the vessel owner/charterer and the seller or supplier to receive the off-specification bunkers and replace them with acceptable product, the owner/charterer can anticipate a substantial loss because any potential purchaser of the off-specification bunkers would likely purchase them as “slops”, and likely offer 20 to 25 per cent of the value of the bunkers. Many vessels’ owner/charterer encountered similar troubles over the years when left to deal with a problem on their own without any support from the supplier. Of course, any and all such losses in the price differential and other related damages would form part of the owner/charterer’s claim against the supplier, subject to the General Terms and Conditions (“GTC”) of the supplier. Suppliers’ GTC are often onerous, and many times the vessel owner is not even aware of them if the charterer is the contracting party.

6.3 Hurdles to Recovery Against the Supplier or Manufacturer

In the situation where a charterer has contracted for delivery of bunkers that are later determined to be off-specification, and the owner seeks to recover in tort against the supplier (with whom it has no contractual privity), there is likely to be an uphill battle. Tort cases brought by owners who do not have any contract with the manufacturer or supplier of off-specification bunkers are rare and only recently have begun to be attempted in any volume, so reference must be made to legal principles established in other contexts in order to predict challenges that might be faced.

In other situations, the owner or charterer may have contractual privity with the supplier, but the supplier’s GTC impose difficult-to-overcome burdens to recovery, such as short time limits to bringing any claim, disclaimers of warranties, and limitations of liability. In situations where a contract between the parties includes such provisions, the obstacles to recovery become even more daunting.

6.3.1 The Economic Loss Rule

The first hurdle an owner or charterer will face under U.S. law when it pursues a claim in tort against the supplier or manufacturer is the U.S Supreme Court’s ruling in *East River S.S. Co. v. TransAmerica DeLeval Inc.*, 476 U.S. 858 (1986). The rule of *East River* and its progeny is that in admiralty cases, a manufacturer or supplier of a product has no duty to prevent that product from injuring itself. What this means in practice is that pure economic loss arising from the supply of bad bunkers is not actionable in tort; absent physical damage to the vessel, an owner can have no tort or strict liability cause of action when off-specification bunkers are loaded onboard.

The plaintiff in *East River* had contract as well as tort claims against the defendant supplier, and the Court reasoned that where only the supplied product was injured, the plaintiff’s claims sounded in contract rather than tort. But the U.S. Court of Appeals for the Fifth Circuit has made clear that *East River* bars recovery of purely economic loss even in the absence of contractual privity.[8] Moreover, the more general rule in the U.S. that a plaintiff in admiralty must suffer physical damage to its property in order to recover any economic loss is alive and strong.[9]

Presumably, however, bad bunkers will almost always result in some type of physical damage to the vessel. Damage to engines, or even something as simple as clogged fuel filters can be sufficient to satisfy the physical damage requirement.[10]

8 *Nathaniel Shipping, Inc. v. General Electric Co.*, 920 F.2d 1256 (5th Cir. 1991).
9 *Robins Dry Dock v. Flint*, 275 U.S. 203 (1927).
10 *Oldendorff Carriers GmbH & Co. KG v. Total Petrochemicals & Ref. USA, Inc.*, 2104 U.S. Dist. LEXIS 162005.

6.2.2 General Terms & Conditions (GTC) for Sale of Bunkers

In modern commerce, no bunker sale is made without first being made subject to the supplier's GTC. These will vary widely and, in practice, are not well understood by the purchaser until after the bunkers have been discovered to be off-specification (and, in the case of third-party owners who are not privy to the contract, may not be known at all).

Whether or not those GTC can be made operative on a third party such as a vessel owner can depend in large part on the GTC themselves. Some will disclaim all liability to third parties and explicitly state that there are no intended third-party beneficiaries of the contract. Others will seemingly contemplate potential liability to third parties whether in tort or contract, but limit liability to a maximum amount. They may also limit any damages to repair or replacement of machinery and disclaim any liability for purely economic loss such as downtime and lost profits. If possible, it would therefore be prudent to attempt to obtain all contractual documents as well as the supplier's standard GTC prior to commencing action against the supplier.

Where the putative plaintiff (whether owner or charterer) was a party to the contract with the supplier, the supplier's GTC can operate to bar all recovery.

For instance, the receipt for the delivery of the bunkers will almost universally contain a small-print reference making the delivery and acceptance subject to the supplier's GTC (which will typically be found in even smaller print on the back of the receipt or, more usually these days, at a URL address). Once a representative of the purchasing party (typically, a member of the crew such as the Mate) signs the delivery receipt, those GTC become binding on the parties to the contract.

Except in regards to towage or employment contracts, U.S. maritime law typically gives force to contractual limitations of liability and time bars.[11] Even complete disclaimers of liability in tort will be given effect, so long as such a disclaimer is expressly stated.[12] Courts will examine contractual time bars and deadlines for providing notice, and will typically find them to be reasonable and enforceable as long as they do not provide for such a short period of time so as to effectively bar any action. That is, so long as the time period provided for in the GTC gives the purchasing party an opportunity to discover and investigate the alleged breach by the supplier, the limitation period will be enforceable and, if not complied with by the purchaser, will effectively bar recovery under any theory. For instance, a marine surveyor's contractual terms requiring notice of a claim within ninety days and the filing of any suit within six months has been found to be reasonable and enforceable.[13]

6.3.3 Possible Causes of Action

Once the "Economic Loss Rule" and the supplier's GTC have been overcome, a charter or third-party owner may have a tort cause of action against the supplier or manufacturer of the bunkers. Tort theories of recovery that might be considered are fraud, unjust enrichment, product liability, and negligence.

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11 See, e.g., *Bisso v. Inland Waterways Corp.*, 349 U.S. 85 (1955); *Syrett v. Reisner McEwin & Assocs.*, 24 P.3d 1070 (Wash. App.—2001); *St. Paul Fire & Marine Ins. Co. v. TGMD, Inc.*, 2013 A.M.C. 519 (E.D. Wi. 2012).

12 See *Miller Indus. V. Caterpillar Tractor Co.*, 733 F.2d 813 (11th Cir. 1984).

13 *Syrett*, 24 P.3d 1070.

6.3.3.1 Fraud

Fraud will be particularly difficult for a third-party owner to prove, because the owner—by virtue of being a stranger to the contract between the charterer and the bunker supplier—will in most cases not have been a party to the communications between the charterer and the bunker supplier. U.S. Federal Rule of Civil Procedure 9(b) has a higher pleading standard for fraud causes of action, and requires a plaintiff to allege: (1) the precise misrepresentations made by the defendant; (2) the time, place, and person responsible for the misrepresentations; (3) the content and manner in which these statements misled the plaintiff; and (4) what the defendant gained by the alleged fraud.[14] Without having been involved in the communications between the supplier and the charterer, this pleading standard will in most cases preclude any claim by a third-party owner for fraud against the bunker manufacturer or supplier. But the same pleading standards will apply to an owner or charterer who was a party to the contract, and the time bars and notice deadlines typically found in a supplier's GTC do not typically afford plentiful time to discover the facts necessary to adequately plead a claim for fraud.

6.2.3.2 Unjust enrichment

Success on a theory of unjust enrichment seems similarly unlikely to succeed. To prevail on an unjust enrichment claim, a plaintiff must show: (1) the defendant was enriched; (2) at the plaintiff's expense; and (3) equity and good conscience require restitution.[15] Notwithstanding the fact that unjust enrichment theories are more typically asserted by a supplier who has not been paid than by (1) an owner who did not purchase the bunkers but was nonetheless damaged by them or (2) a charterer who purchased and actually paid for a product that did not meet its specifications, the existence of a valid contract governing a particular subject matter ordinarily bars recovery on an unjust enrichment theory for events arising out of the same subject matter.[16] The existence of a contract between the supplier and the purchaser would therefore seem to normally preclude recovery for unjust enrichment.

6.3.3.3 Product liability

Generally, a manufacturer has a non-delegable duty to ensure its product is reasonably safe for its intended use.[17] The legal theory supporting the product liability doctrine is that fault should "rest with the party best-suited to take preventive steps and reduce the likelihood" of harm.[18] Manufacturers, wholesalers, and retailers can each be liable when bunkers are found to have been "unreasonably dangerous" to the vessel, because they are each "an integral part of the overall producing and marketing enterprise that should bear the cost of injuries resulting from defective

14 *Cosulich v. Specialty Fuels Bunkering, LLC*, 2014 U.S. Dist. LEXIS 79183, at n.9 (S.D. Ala. 2014) (citing *Am. Dental Ass'n v. Cigna Corp.*, 605 F.3d 1283, 1291 (11th Cir. 2010)).

15 *Aegean Bunkering (USA) LLC v. M/T AMAZON*, 2016 U.S. Dist. LEXIS 113623, *19 (S.D.N.Y. 2016) (citing *Kaye v. Grossman*, 202 F.3d 611, 616 (2d Cir. 2000)).

16 *Integral Control Systems Corp. v. Consolidated Edison Co. of N.Y.*, 990 F. Supp. 295, 301 (S.D.N.Y. 1998).

17 *Vaughn v. Marine Trans. Lines*, 723 F.Supp. 1126 (D. Md. 1989).

18 *Ryan Stevedoring Co. v. Pan-Atlantic S.S. Co.*, 350 U.S. 124 (1956).

products."[19]

U.S. Admiralty courts look to the Restatement (Third) of Torts ("Restatement") in analyzing maritime claims for product liability.[20] The Restatement provides that "One engaged in the business of selling or otherwise distributing products who sells or distributes a defective product is subject to liability for harm to persons or property caused by the defect."[21] Under the Restatement analysis, bunkers are defective if they "depart[] from [the] intended design even though all possible care was exercised in the preparation and marketing of the product."[22]

6.3.3.4 Negligence

To prevail on a negligence claim, a plaintiff must establish: (1) the defendant had a duty to the plaintiff to exercise due care; (2) the defendant breached that duty; (3) the plaintiff suffered damages; and (4) the damages were proximately caused by the breach.[23]

Where a bunker manufacturer or supplier is essentially a stranger to a "remote" party such as a vessel owner with whom it had no contractual or other relationship, the question of whether a duty existed will turn on the foreseeability of the harm.[24] Foreseeability of harm to a vessel's machinery when off-specification bunkers are burned would not, in the usual circumstance, seem difficult to establish. Where the plaintiff is the one who actually purchased the off-specification bunkers, foreseeability of harm becomes even more clear.

It can be expected that a manufacturer or supplier would attempt to defend itself by showing that in manufacturing or supplying bunkers, it followed industry standards. Evidence of compliance with industry standards and practices can be admissible as bearing on the standard of care in determining negligence.[25] However, compliance with such industry standards does not automatically absolve a defendant from liability.[26]

6.4 Conclusion

Owners and charters who find themselves in possession of off-specification bunkers face a number of practical and legal obstacles in order to make themselves whole. The Jones Act limitations on options for getting the off-spec bunkers off the vessel are clear. The supplier's GTC can be expected to impose further burdens on any recovery and, even if those are overcome, options for recovery in tort can be limited. Although this is a developing area of the law, the general contours of maritime liability discussed above can be expected to govern.

19 *Pan-Alaska Fisheries, Inc. v. Marine Constr. & Design Co.*, 565 F.2d 1129, 1135 (9th Cir. 1977).
20 *Oswalt v. Resolute Industries, Inc.*, 642 F.3d 856 (9th Cir. 2011).
21 Restatement (Third) of Torts: Products Liability § 1.
22 Id. at § 2.
23 *Canal Barge Co. v. Torco Oil Co.*, 220 F.3d 370 (5th Cir. 2000).
24 *In re Signal Int'l LLC*, 579 F.3d 478 (5th Cir. 2009); *Consolidated Aluminum Corp. v. C.F. Bean Corp.*, 833 F.2d 65 (5th Cir. 1987); *In re Kinsman Transit Co.*, 388 F.2d 821 (2nd Cir. 1968).
25 *Holzhauer v. Golden Gate Bridge, Highway and Transp. Dist.*, 2015 U.S. Dist. LEXIS 76539 (N.D. Ca. 2015) (quoting *Muncie Aviation Corp. v. Party Doll Fleet, Inc.*, 519 F.2d 1168 (5th Cir. 1975)).
26 *Contango Operators v. Weeks Marine*, 2015 U.S. App. LEXIS 8857 (5th Cir. 2015) (citing Restatement (Second) of Torts § 295).

Lianjun Li
Partner & Head
Transportation and Commercial Litigation Practice
Reed Smith Richards Butler

Cheryl Yu
Senior Chinese Lawyer
Transportation and Commercial Litigation Practice
Reed Smith Richards Butler

7.1 Introduction

From January 1, 2020, the limit for sulfur in fuel oil used on board ships operating outside designated emission control areas will be reduced to 0.5% m/m (mass by mass). Shipowners are required to comply with the new requirement or otherwise they will be penalized. Responses have been sluggish and there might be various disputes between vessel owners and time charterers by the time the new requirement comes into effect. As a Member State to the IMO and signatory to the MARPOL Convention, China has actively taken steps to ensure compliance with the new requirement. This article gives an overview of China's current practice on sulfur content requirement and discusses the Chinese courts' approach in dealing with potential bunker disputes.

7.2 An Overview of China's Current Practice

As a Member State to MARPOL, China has been proactive in complying with the new sulfur requirement.

On 30 November 2018, China's Ministry of Transport issued a regulation named *The Implementation Scheme of the Domestic Emission Control Areas for Atmospheric Pollution from Vessels* (*"Implementation Scheme"*) which has been effective from January 1, 2019.

The Implementation Scheme sets forth several emission control requirements for sulfur oxides (SOx) as following:

1. From January 1, 2019, the ships entering the Emission Control Areas (ECAs) shall use marine fuel oil with a sulfur content of no more than 0.5%. Large-scale river ships and river-sea ships shall use the fuel oil that meets the newly revised requirements specified in the national standards for marine fuel oils, while other river ships should use the diesel fuel that meets national standards. From January 1, 2020, ships entering the inland river control areas shall use the marine fuel oil with the sulfur content no more than 0.1%.
2. From March 1, 2020, ships entering the ECAs without any alternative measures such as sulfur oxides and particulate pollution control devices can only load and use the marine fuel oil that should be used in accordance with the ship's *Implementation Plan*.
3. From January 1, 2022, ships entering the Hainan Island territorial waters in the coastal control areas shall use marine fuel oil with a sulfur content of no more than 0.10%.
4. The feasibility of using marine fuel oil with a sulfur content of no more than 0.10% is

to be evaluated in a timely manner to determine whether ships entering the coastal control areas will be required to that 0.10% fuel from January 2025.

To comply with the new requirement, Chinese vessel owners are prepared to either use the low sulfur fuel (or cleaner fuels like LNG and nuclear energy) or install systems to remove sulfur oxides (SOx). Sinopec, a large state-owned oil supplier of China, plans to start the supply of low sulfur fuel oil this year in Eastern China ports as they believe the low sulfur fuel oil will be a mainstream option in the market.

Although it is commonplace that English law is the governing law in most charter parties, vessels consuming non-compliant fuels in China could still face regulatory and administrative liabilities. Currently, China has in place the following bunker fuel requirements:

1. Pursuant to Article 106 of China's Air Pollution Prevention and Control Law (Revised) (Atmospheric Law), vessels consuming fuels that are non-compliant with the Atmospheric Law could face a fine of not less than RMB10,000 (US$1,400) but not more than RMB100,000 (US$14,000) by the maritime administrative agency and the competent fishery department. The Atmospheric Law does not express whom to bear the fine and only points out that the vessel is to be fined.
2. The guideline, *Supervision and Management for the Ship Emission Control Area*, published by of the People's Republic of China Maritime Safety Administration (MSA) in 2016 provides that in addition to fines, enforcement officers can detain vessels for inspection or require vessels to correct violations.

By way of an illustration, in 2017, the MSA as the competent authority imposed a fine of RMB60,000 (US$8,500) on a vessel that did not meet the sulfur content requirement. Sufficiently grave violations may even lead to a detention by MSA.

7.3 Potential Bunker Disputes in China

Generally speaking, under a time charter party, it is the charterers who will bear the risk of defects in the quality of the bunker. Whereas under a voyage charter party or where the vessel is operated by the vessel owner, the risk will be borne by the owner. Although vessel owners are primarily liable for fines in case of non-compliance with the new sulfur content requirement, it is unclear whether they have a claim against time charterers based on the charter party provisions that time charterers shall bear the risk of quality defects in the bunker. Such disputes have not arisen yet, but it might be important to look at how Chinese courts generally deal with the bunker disputes.

7.3.1 Case study 1

Supplier failed to provide compliant bunkers in the case of *Fujian Guanhai Shipping Limited Company v. Shanghai Huaya Ship Fuel Company* (2014) Hu Hai Fa Shang Chu Zi No. 114. In this case, parties entered into a bunker supply contract for M/V "Guanhai 308". The defendant bunker supplier supplied about 58 tonnes bunker to the vessel, which was mixed with the remaining 20 tonnes of bunker in the tank. Subsequently, the vessel's bunker system failed and caused corrosion and wear of the vessel's parts. The plaintiff vessel owner repaired the vessel. Parties jointly submitted the bunker sample to testing and test results showed that the acid value of bunker exceeded the standard. The owner then unilaterally conducted another test and the test report concluded that defective bunker was the main cause of the damage to the vessel.

The court accepted that as the total acid value of the bunker exceeded the standard, it might cause corrosion and sedimentation of the vessel's parts and thus damage the vessel. Also, before the defective bunker was injected, the vessel had not been damaged according to the vessel log. The bunker system broke on the thirteenth day after the bunker injection. The court also rejected the supplier's argument on fuel blending as in the case of qualified bunker, even when bunkers are mixed, there should be no substantial change that could cause to the vessel's bunker system. The court thus held that the supplier breached the contract in failing to provide qualified bunker.

7.3.2 Case study 2

The bunker supplier was held not liable in *Shanghai Zhonggu Xinliang Co., Ltd. v. Shanghai Yucheng Petrochemical Co., Ltd* (2015) Hu Hai Fa Shang Chu No. 329. In this case, parties entered into a bunker supply contract and stipulated the China's national quality standard GB/T17411 - 2012 to be the bunker quality standard. In the appendix to the supply contract, they also agreed on using the requirement of ISO 8217:2005 for certain bunkers. Parties agreed that either party can send jointly retained samples to the institution approved by both parties for inspection. After the bunker's stem, the vessel owner also injected light diesel into the four vessels and then the four vessels' bunker systems failed. It transpired that the owner's light diesel oil was of poor quality. Parties submitted the bunker sample for inspection and the test results showed that the bunker sample met the requirement of ISO 8217 – 25 (the applicable standard to the allegedly defective bunker). The owner then unilaterally sent the bunker sample to another institution for inspection and test results showed that the bunker sample did not meet the national quality standards. The owner carried out another inspection with a different institution and concluded the same.

The court considered the fact that the owner added light diesel oil to the bunker supplied by the supplier and the light diesel oil was proved to be of poor quality. It was not conclusive to say that the vessels' failure was caused by use of the supplier's bunker.

Regarding the procedures in testing the bunker quality, the court was of the view that national standards are default standards to be applied only when there is no special provision in the contract. Since the parties have listed a different bunker quality standard in the appendix to the supply contract, the ISO 8217:2005 requirement should prevail. Also, it was contractually agreed that both parties shall jointly submit the bunker sample for inspection and the court accepted the first test report which was jointly conducted. In the absence of clear evidence to show that there were difficulties for re-inspection by the jointly appointed institution or the institution's impartiality was jeopardized, the owner's subsequent inspections were not in conformity with the contract. The court therefore rejected to adopt the subsequent test results and held the supplier not liable.

7.4 Conclusion

In view of the above-referenced cases, one may expect the Chinese courts to generally follow the contractually agreed terms in resolving the disputes unless in the case of ambiguity. Potential bunker disputes relating to the new sulfur requirement can be complex as to who bears the consequences of non-compliance in the absence of express contractual terms.

Therefore, parties should be very cautious in drafting the charter party terms and make express reference to the allocation of liability in case of non-compliance with the new requirement.

Daryll Ng
Managing Partner, Virtus Law
Stephenson Harwood (Singapore) Alliance

Haris Zografakis
Partner
Stephenson Harwood

Justin Gan
Senior Associate, Stephenson Harwood
Stephenson Harwood (Singapore) Alliance

8.1 Introduction

In this section, we look at two typical examples of off-specification bunker disputes which arose and subsequently handled in Singapore:

8.2 Case Study 1

Owners chartered the vessel out under an NYPE 93 Time Charterparty. clause 9(b), line 118-125, of the charter party provided as follows:

"The Charterers shall supply bunkers of a quality suitable for burning in the Vessel's engines and auxiliaries and which conform to the specification(s) as set out in Clause 47.

The Owners reserve their right to make a claim against the Charterers for any damage to the main engines or the auxiliaries caused by the use of unsuitable fuels or fuels not complying with the agreed specification(s). Additionally, if bunker fuels supplied do not conform with the mutually agreed specification(s) or otherwise prove unsuitable for burning in the Vessel's engines or auxiliaries, the Owners shall not be held responsible for any reduction in the Vessel's speed performance and/or increased bunker consumption, not for any time lost and any other consequences."

8.2.1 Sequence of events

Around 600MT of MFO380 bunkers were supplied to the vessel. The owners tested the bunkers supplied by the charterers and obtained a report on concluding that the bunkers contained non-hydrocarbons, in breach of the requirements in paragraph 5 of ISO 8217:2005 and thereby also in breach of clause 9(b) of the NYPE93 standard form read with the abovementioned rider clause.

The owners requested the charterers to de-bunker at their time and costs, but the charterers refused. At the time, the vessel had already consumed a portion of the bunkers without issue. The charterers then agreed to a joint testing with the owners which showed that the bunkers were indeed off-specification.

8.2.2 No contractual provisions to resolve bunker quality dispute

More often than not, charter parties fail to provide for how sampling or testing of bunkers should be carried out in the event of a bunker quality dispute. It is recommended that the following should be considered or provided for:

- joint testing in the event that the owners allege that the bunkers are off-specification[27];
- the party who will bear the costs of testing the bunkers; and
- the tests which are to be conducted.

Owners are recommended to include in the charter party an express right that they may, at their sole discretion, de-bunker the off-specification bunkers and for all costs of the de-bunkering to be borne by the charterers. However, this will not be exhaustive of the owner's mitigation options.

On the other hand, charterers are recommended to include in the charter party the end supplier's terms and conditions relating to the quality, quantity, risk, sampling, mode and time of delivery of the bunkers supplied on a back-to-back basis.

8.2.3 Should the owners take the commercial risk to burn off-specification bunkers?

While commercial considerations and the common law doctrine to mitigate losses may compel owners to take the risk to consume off-specification bunkers, it is not recommended to do so prior to joint testing. This is as such an action may be seen as an assumption of responsibility over the bunkers/burning and it may be difficult to seek recourse later against the charterer or supplier.

If bunkers are to be burned, it is recommended for owners to get a letter of indemnity from the charterers and clearly identify and agree who is to bear the costs of such burning, the consequences of such burning and for any replacement fuel. Consideration must be given to whether the charterer is substantive enough to pay up under such a letter of indemnity.

It is important to note that an aggrieved party is not required to act in a way which exposes it to financial or moral hazard (e.g. taking steps which might jeopardize its commercial reputation or partaking in hazardous litigation against a third party), or to incur great expense or put itself to great inconvenience in stemming the loss.

8.3 Case Study 2

Along the same contractual chain, issues between suppliers and charterers often translate to dispute between charterers and owners (and vice versa) as parties attempts to pass around potential losses. When multiple parties conduct their own testing and get different results, how should the matter be resolved?

In this case, the sellers purchased bunkers from the physical suppliers on their general terms and conditions, for supply to the charterers. The terms entered into between the sellers and the charterers mirrored those entered into between the seller and the physical suppliers of the bunkers.

Physical suppliers' GTC, in pertinent part, was provided as follows:

Clause 5:

a. *The specifications of the Marine Fuels supplied to Buyer shall be the Seller's or Seller's suppliers' commercial grades as per normal Singapore bunker ISO 8217*

27 See the American Club's animations for bunker testing best practices at https://www.american-club.com/page/bunker-fuels.

specifications offered generally to their customers at the time and place of delivery

b. *Seller shall not be liable to delivery Marine Fuels with any characteristics or specification*

c. *Sampling by Seller or Seller's supplier shall be done throughout the Marine Fuels' delivery i.e. continuous drip sampling as per MPA SS600. The barge drip samples which will be final & binding shall be retained by Seller or Seller's supplier for thirty (30) days from the date of delivery in a safe place for verification of the quality thereof, if required.*

d. *If Buyer makes a claim or complaint within the period of the date of delivery in accordance with Section 13(b) below, based on the analysis of the barge retained samples, shall be submitted for analysis to a mutually independent laboratory. The mutually independent laboratory's analysis shall be conclusive as to the quality of the product delivered. The analysis shall be established by tests in accordance with ISO 8217 and/or any other specifications agreed to between Buyer and Seller. If the tested result favors Buyer, the Seller shall bear full cost of testing, however if the result favors the Seller, then the Buyer shall bear full cost of testing.*

Clause 13:

a. *Any claim as to the quality of the fuel delivered must be submitted by Buyer to Seller in writing within twenty-one (21) days of the date of delivery. If Buyer fails to submit a quality claim within twenty one (21) days of the date of delivery, any such claim shall be deemed to be waived and absolutely barred. Buyer shall base its quality claim solely on an analysis of the retained drip sample provided by Seller at the time of the delivery as provided for in Section 5(a) above. Buyer shall furnish Seller the results of testing of the retained sample to enable Seller to properly evaluate the claim.*

b. *The analysis shall be established by tests in accordance with ISO8217 (latest edition at the time of delivery) and/or any other specifications agreed between Buyer and Seller. For interpretation of test results the method as set out in ISO 4259 sections 9 and 10 in respect of precision and interpretation of test result shall be used. The results of the analysis shall be conclusive as to the quality of Marine Fuels delivered except in cases of manifest error. Unless otherwise agreed, the expenses of the analysis by the independent laboratory shall be borne by the party whose claim is unsupported by the test results.*

8.3.1 Sequence of events

The charterers ordered from the suppliers 1,000 metric tons of high sulfur fuel oil (HSFO) 380 centistokes (cst) residual marine gas oil (RMG) with a maximum of sulfur content of 3.5% m/m, with specifications set forth under ISO 8217:2005. The sellers ordered the same from the physical suppliers.

The bunkers were supplied to the vessel. Meantime, the sellers conducted a survey and testing on the stemmed bunkers. The results of the testing were set forth in a report showing that the bunkers were on-specification.

About a week later, the charterers obtained a report which stated that the bunkers were off-specification as it did not meet the density and viscosity requirements of ISO

8217:2005, contained excessive water, and high levels of sodium and catalytic fines. The charterers thereafter refused to consume the bunkers, claiming that the vessel's safety would be compromised.

About a week later, a joint testing attended by representatives of the owners, charterers, sellers and physical suppliers was conducted. The results revealed that the bunkers were on-specification. Thereafter, owners and charterers conducted their own testing on two different samples. The results of both tests indicated that the bunkers were off-specification. In particular, the density, kinematic viscosity, water by distillation and calcium levels of the bunkers exceeded the maximum specification.

The physical suppliers maintained that the bunkers should be burned as part of the duty of mitigation. This was relayed by the sellers to the charterers. On the other hand, the charterers refused to do so unless a letter of indemnity was provided.

The physical suppliers took the position that the joint testing results which indicated that the bunkers were on-specification were final and binding. However, the sellers took the position that an average of the joint testing results and charterers' test results should be taken, and that would indicate that the bunkers were off-specification.

In the meantime, the charterers and/or the owners de-bunkered the vessel and only recovered a portion of the costs of the bunkers.

8.3.2 Poorly drafted contractual provisions led to delay in resolving the bunker quality dispute

In this case, the poorly drafted physical supplier's GTC led to confusion and delay in resolving the bunker quality dispute between sellers and physical supplier.

Sellers argued that clause 13(c) of the physical supplier's GTC would also refer to the charterers' test and that a comparison of that test with the joint test, pursuant to ISO 3104 and ISO 12185, was required to determine whether the fuel was on-specification or not. This brought into question whether the fuel quality be determined based on an average taken from the tests, or was the sample retained used in the joint test the final and binding result.

To prevent this impasse, physical suppliers should have clearly provided in their contract that sections 9 and 10 of ISO 4259 were to only apply to the joint test and only the joint test is final and binding on all parties.

It is recommended that across chains of contracts, provisions for joint testing in the event that the owners or charterers allege that the bunkers are off-specification should be put in place, with such joint testing results as being final and binding on all parties. The test to be used in such joint testing should also be clearly specified.

8.4 Conclusion

In conclusion, the overwhelming number of bunker claims and disputes involving owners, charterers and physical suppliers have given all three parties a clear indication of what could go wrong when bunkers are in issue. Owners and charterers should act on the above lessons learnt from the pandemic off-specification bunkers issues to tackle potential problems that could arise out as of January 1, 2020.

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Our Contributors
(in alphabetical order)

Müge Anber-Kontakis joined Shipowners Claims Bureau, Inc. in 2006 and currently is Vice President, Global FD&D Manager and Counsel. She is an attorney-at-law admitted both in Istanbul and New York. As the primary editor for the Chapters 5 through 8 of the Compendium, Müge was the key source of topics designated and assigned to the legal contributors.

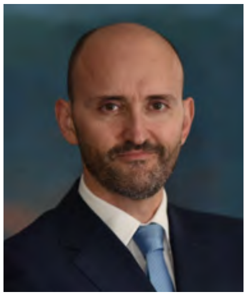
She graduated from Marmara University Law School in Istanbul in 2001. In 2004, she acquired a master's degree inf International Transportation Management from the State University of New York Maritime College, where she also attained a graduate certificate in Chartering Operations issued by Association of Shipbrokers and Agents of the U.S.A. She also holds a Master of Laws degree from Hofstra University School of Law.

Prior to her employment at the Shipowners Claims Bureau, Müge practiced maritime law at well-known maritime law firms, respectively in Istanbul and New York City, where she practiced a wide variety of maritime and admiralty cases. Müge also handles a wide variety of complex P&I cases globally involving litigation and arbitration. Additionally, she is a member of SCB's legal team, which advises on legal matters concerning SCB.

Müge represents the American Club in the Defense Insurers' Forum, along with the FD&D directors of other international defense clubs. She is also an active member of numerous professional affiliations in maritime industry. In 2018, she was appointed as the Corporate Counsel Industry Liaison Officer of the International Bar Association's Maritime & Transport Law Committee. She represented the IBA at the United Nations during meetings of the United Nations Commission on International Trade Law on Recognition of Judicial Sale of Ships.

Dr Gareth Burton is Vice President Technology at the American Bureau of Shipping. He began his career with a consulting engineering company before joining ABS in 2001. During his time with the organization, he has held various roles in engineering, business management and product development in the U.S.A., Mexico and Singapore. In his current role, he is responsible for the development and execution of the ABS research program.

Gareth holds a bachelor's degree from the University of Manchester, England and holds both master's and doctorate of engineering degrees from the University of Ulster, Belfast, Northern Ireland. In addition, he has completed the executive MBA program through Texas A&M University.



Evangelos Catsambas has 20 years of experience in shipping litigation/dispute resolution (charter party, bill of lading, shipbuilding contract and MOA disputes), maritime casualties, general commercial litigation/dispute resolution and (non-contentious) contract drafting. He has a diverse practice, working for shipowners, charterers, cargo traders, bunker traders, P&I clubs and hull & machinery insurers.

Evangelos was the 2013 and 2014 winner of the Client Choice 2014 Individual Award for Greece (Shipping & Transport). He is a recommended individual for Shipping Litigation in Greece by the Legal 500 (2017), quoted as "Incredibly bright and flexible", and also for shipping (International Firms) in Greece by Chambers Europe (2018), which says that he "impresses the market with his "knowledge of charter party disputes" and vessel performance cases." Clients highlight his "excellent legal knowledge mixed with a practicality and commerciality" (Chambers Europe 2019).

Justin Gan acts in charter party, offshore, and ship financing disputes for P&I clubs, owners, charterers, traders, and financiers. In recent years this has more often included insolvency-related matters and enforcement. Outside the marine and international trade sector, His high-value commercial disputes experience includes shareholders', aviation, and construction disputes.

Justin has helped clients manage litigation in other jurisdictions, such as the People's Republic of China, Holland, and in the U.S.A. He is experienced with international arbitrations ad hoc or institutional under a variety of rules and seats. Part of his practice is non-contentious, drafting and negotiating commercial and maritime contracts, often custom.

Justin's career began as an advocate & solicitor in Singapore, focusing on marine and international trade disputes in the leading local practice. Subsequently Justin joined an international firm in Hong Kong. He is qualified to practice as a solicitor in Hong Kong and in England & Wales. He returned to Singapore in early 2018.

Dimitri P. Georgantas practice concentrates on litigation in the areas of Admiralty and maritime insurance defense and admiralty law including maritime professional injury, collision & allision, marine environmental pollution, marine insurance & ship finance, carriage of goods and maritime liens.

Mr. Georgantas has tried jury as well as numerous bench cases involving maritime personal injury, major collision and casualty cases, cargo and commercial matters and has also represented clients in arbitration proceedings. Additionally, he has handled numerous transaction matters involving the sale and purchase of vessels and barges.

Mr. Georgantas is admitted to practice before the United States Fifth Circuit Court of Appeals, the United States District Court for the Southern District of Texas, and the Supreme Court of Texas. He is a member of the Maritime Law Association of the United States. Mr. Georgantas received his Juris Doctor from California Western School of Law in 1981. Raised in Athens, Mr. Georgantas is fluent in modern Greek.

Alex Huo is a Technology Manager at American Bureau of Shipping having joined the company in 1996. In 1996 he joined ABS. and since then has worked in engineering and technology functions in Singapore, Shanghai and Houston. He is currently leading the efforts associated with air emission compliance. In particular, Alex is focused on the development of industry guidance on SOx emission compliance, contributing to the development of statutory requirements and completing the technical evaluation of compliance options.

Prior to joining the American Bureau of Shipping, began his career in the engineering departments of various shipyards located in both China and Singapore. Alex holds a bachelor's of engineering degree in Marine Machinery from Dalian University of Technology, China.

Lianjun Li, M.Sc., LLM, FCIArb has been a partner since 2004 and is a leading lawyer in the shipping team in Hong Kong. He qualified as a solicitor in Hong Kong, England and Wales in 2002. He has extensive experience in international trade and commodity disputes, documentary credit issues, shipping disputes (charter party problems, ship purchase and sale disputes, bill of lading and cargo claims, P&I matters, ship casualties), ship finance and sale and purchase, international commercial and shipping arbitration and in practical and legal aspects of doing business, negotiation and litigation in China.

Marc Matthews practices in the areas of admiralty and tort litigation with a special emphasis in defending vessel owners and operators from claims arising under the Jones Act, the Longshore and Harbor Workers' Compensation Act, and the Outer Continental Shelf Lands Act, as well as from claims arising from vessel collisions and cargo damage. He has extensive experience in the arrest and seizure of vessels in the federal courts, both from the standpoint of arresting vessels and from the standpoint of obtaining the release of arrested vessels.

In addition to his maritime practice, Mr. Matthews has substantial experience in handling commercial contract disputes (in both land-based and maritime contexts) and insurance subrogation. He is also a trained mediator and is available to act as a third-party neutral mediator to assist litigants in resolving their disputes prior to trial.

Dr William Moore is the Senior Vice President and Global Loss Prevention Director at Shipowners Claims Bureau, Inc. and is the senior editor of *Bunkering - A Compendium*. In that capacity, he brings 22 years of experience to the development and implementation of the Club's loss prevention initiatives to assist American Club Members in the reduction of maritime risks. He formerly worked at the American Bureau of Shipping in New York City and Gard Services in Bergen, Norway. He acquired his doctorate degree in Naval Architecture & Offshore Engineering at the University of California at Berkeley and is also a graduate in Ocean Systems Management at the Massachusetts Institute of Technology.

Dr. Moore is the former chairman of the IMO's Joint Maritime Safety Committee & Marine Environmental Protection Committee's working group on the Human Element. He is also a Member of the American Bureau of Shipping.

Daryll Ng is the managing partner at Virtus Law and also heads the Stephenson Harwood (Singapore) Alliance dispute resolution practice in Singapore. He specializes in marine and commercial dispute resolution. Qualified to practice both in Singapore and the UK, Daryll has appeared at all levels of the Singapore Court and has acted in numerous arbitrations and mediations.

Daryll founded Virtus Law LLP in 2013 together with Arthur Loke, after 15 years of local and international practice. With the Stephenson Harwood (Singapore) Alliance, he offers Singapore law expertise in all aspects of commercial litigation and arbitration including insolvency, shipping and international trade.

Daryll has been named in Asia Business Law Journal's A-list of Singapore's Top 100 Lawyers, recognized as a market-leading lawyer for Shipping, Maritime & Aviation by Asialaw Leading Lawyers 2018 and listed as a Recommended Lawyer for Shipping by The Legal 500 Asia Pacific 2019.

John Poulson, CEng, CMarEng is the Director and Chief Surveyor for Atlantic Marine Associates. He joined "The Bank Line" of Glasgow and London from school at age 16 in 1975. His studies and subsequent career at sea in the Merchant Navy took him from Cadet, Junior Engineer and through the ranks to become Chief Engineer of ocean-going ships at the age of 28. John brings forty plus years' experience in marine engineering, surveying, consulting, claims, loss prevention and provision of expert opinion.

In 1989, moving ashore, he joined the Salvage Association, later becoming Regional Manager of BMT Salvage Ltd. for the Americas in April 2001. He opened the New York office of the Noble Denton Group of Companies in July 2007 as President, heading up their "Marine Casualty Investigation Division" for the Americas. In 2012, John became Executive Vice President and Principal Surveyor of Atlantic Marine Associates, which provides marine surveying, consulting and expert witness services from their offices in the U.S. and London.

Of late, John has handled numerous cases involving the issue of contaminated fuel supplied to vessels and the consequential losses to shipowners, P&I clubs, hull & machinery underwriters and bunker suppliers.

Ganesh Vaideeswaran is the Chief Operations Officer of VISWA Lab. Hehas been involved in the identifying and solving of marine fuel related issues for nearly 15 years. Along with the VISWA team, Ganesh has been involved in developing algorithms such as PFIN (Problem Fuel Identification Number) and programs such as POMP (Peace of Mind Package) to improve the identification of fuels with problem potential.

Dr Ram Vis, also known as the "Bunker Guru", has a PhD in Metallurgical Engineering, a master's degree in Internal Combustion Engineering and a bachelor's degree in Marine Engineering.

As a Marine Engineer sailing on ships and during his work at the American Bureau of Shipping, experienced firsthand the problems caused by poor quality fuels on ships. This led him to pursue his lifelong vision of VISWA Lab, ensuring and enabling the highest quality energy solutions for the marine industry.

Dr. Vis is on the Roster of Experts of the IMO. He is a consultant to the Department of Transportation's Maritime Administration and is a member of CIMAC heavy fuels and ASTM D2 Committees. Dr. Vis's vision has led to VISWA Group being what it is now. VISWA Group consists of VISWA Lab, VISWA Scrubbers, VEEMS and VTIC.

Cheryl Yu is a Senior Registered Foreign Lawyer (PRC) with the Law Society of Hong Kong. She has wide experience in dealing with disputes in relation to charter party, cargo claims, bills of lading and sale contracts, newbuilding contracts and ship finance, marine insurance and in "wet" shipping, including salvage, collisions, total loss and wreck removal. She has considerable experience in reviewing standard forms of and amendments to charter parties, ship management agreements, FOBAS agreements and the like.

Haris Zografakis started his career in the City of London in 1994. Dispute resolution represents the largest part of his practice and he has acted in over 300 arbitrations, High Court, Court of Appeal and Supreme Court and multi-jurisdictional cases ranging from modest demurrage claims to mine off-take, shipbuilding and oil and gas disputes worth hundreds of millions. His reported Court cases include the Johnny K, *Trafigura v Kookmin Bank*, the Sabrewing, the Northgate, the Port Russel, *U&M v Konkola Copper Mines*, *CH Offshore v PDVSA Petroleo* and *Petrosaudi Oil Services v Novo Banco et al*. While he has been described as a "solid and tenacious litigator" (Chambers UK 2007), he is also involved in non-contentious work, structuring transactions and drafting standard terms.

This diverse practice has allowed him a unique insight into all aspects of shipping and international trade that is uncommon amongst the shipping legal profession. He has served on the editorial board of Shipping and Transport Law Journal, is member of the Council of the London Shipping Law Centre, has published and lectured extensively worldwide including for BIMCO.

Haris heads the Stephenson Harwood's commodities practice, which was recognized as a First Tier team by The Legal 500 UK 2015. The same directory described him as "leading a true team, perfectly organized, providing excellent legal and commercial advice". He has also recently been inducted to the 2018 Legal 500 Hall of fame as a result of his continued recognition by the directory.

AMERICAN STEAMSHIP OWNERS MUTUAL
PROTECTION & INDEMNITY ASSOCIATION, INC.

SHIPOWNERS CLAIMS BUREAU, INC., MANAGER
One Battery Park Plaza, 31st Floor
New York, New York 10004 U.S.A
TEL +1 212 847 4500
FAX +1 212 847 4599
WEB www.american-club.com
EMAIL claims@american-club.com

2100 West Loop South, Suite 1525
Houston, TX 77027 U.S.A
TEL +1 346 223 9900
EMAIL claims@american-club.com

SHIPOWNERS CLAIMS BUREAU (UK) LTD.
78-79 Leadenhall Street
London EC3V 3DH, United Kingdom
TEL +44 20 7709 1390
EMAIL claims@scb-uk.com

SHIPOWNERS CLAIMS BUREAU (HELLAS), INC.
Filellinon 1-3, 3rd Floor
Piraeus 185 36 Greece
TEL +30 210 429 4990 1 2 3
FAX +30 210 429 4187 8
EMAIL claims@scb-hellas.com

SCB MANAGEMENT CONSULTING SERVICES, LTD.
The Workstation, 28th Floor
43 Lyndhurst Terrace, Central
Hong Kong SAR
People's Republic of China
TEL +852 3523 0582
EMAIL hkinfo@scbmcs.com

SCB MANAGEMENT CONSULTING (SHANGHAI) CO., LTD.
Room 1803 – Hongyi Plaza
288 Jiujiang Road
Shanghai 200001 People's Republic of China
TEL +86 21 3366 5000
FAX +86 21 3366 6100
EMAIL claims@scbmcs.com