

BUNKERS

An analysis of the practical,
technical and legal issues

Christopher Fisher
Jonathan Lux

BUNKERS

DEDICATION

For Josie, Ruth, Danielle and Adam
who considered us well and truly bonkers
to consider embarking upon another
edition of *Bunkers*.

Chris Fisher/Jonathan Lux

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An analysis of the Practical,
Technical and Legal Issues

By

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Third Edition

Foreword by
Lord Donaldson of Lymington

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Foreword

The past decade has seen a great many changes in international shipping and bunkering, but globalization, the explosion of the Chinese economy and a sea-change in attitude towards the environment suggests that the next decade will see even more pronounced changes. Ten years after the second edition of *Bunkers*, this third edition, completely revised, updated and expanded, could hardly be more timely.

The European Union and International Maritime Organization are leading the way with new legislation on emission controls and double hull tankers, and concern for the environment has become a major consideration for everyone. With tighter restrictions on emissions and the eradication of single-hulled tankers and barges, we can look forward to a cleaner atmosphere and cleaner seas.

The bunker industry is also cleaning up its act in many other areas. New, tighter fuel specifications will help reduce the number of deliveries of poor quality bunker fuel and help eliminate cheating. New codes of practice promise to transform the process of fuel delivery. And increased awareness of the inherent dangers of shipping and bunkering will greatly improve the safety and security of crew members and their ships around the world.

Bunkers are the lifeblood of international shipping and *Bunkers* gets right to the heart of the industry. The book is a highly-accessible and comprehensive training tool for readers at any level of expertise, knowledge and experience of bunkering.

Understanding all the difficulties of handling and using marine fuel is vital for a safe and well-run ship, and every marine engineer and student of marine engineering will find the practical and technical content helpful and informative.

Technical and operations staff will find useful procedures and practical advice to improve on board handling and treatment and avoid costly engine damage.

Fuel purchasers, charterers and shipowners will find the book helps them make better purchasing decisions and deal more effectively with problems when things go wrong. Bunker suppliers should find the sections on fuel production, specifications, sampling, testing and claim handling particularly helpful. And the P&I Associations, law firms and arbitrators will find concise information to assist with bunker claims and disputes.

I am very pleased to welcome the publication of such a valuable guide to the bunker industry and congratulate its authors upon providing a unique reference which, if used as it should be, will promote understanding, raise awareness, increase safety levels and help protect the environment.

June 2004

The Rt. Hon. The Lord Donaldson of Lynton

Preface

In 1985, Chris Fisher and Stephen Hodge compiled *Fisher and Hodge on Bunkers*. This was the first book dedicated to the practical aspects of fuels for merchant vessels. It was revised and updated in 1994 and published as *Bunkers: An Analysis of the Practical, Technical and Legal Issues*. Chris was joined by a new co-author, Jonathan Lux, who contributed the legal section.

Those who found the last editions useful will find many new sections and updates of the earlier works, reflecting changes in all aspects of the bunker and marine industries. Additionally, the authors have been pleased to receive feedback from readers who have asked for more depth in some sections and we hope these have been sufficiently covered. A new feature is the Frequently Asked Questions (FAQs) heading up most chapters. The reader will find brief answers to these questions and be guided to the relevant text that deals with the particular subject in more detail.

The contents have been selected on the basis that they will be of value to a wide audience, including marine engineering students, seagoing engineers, technical ship managers, members of the legal profession, insurers, charterers of ships, fuel suppliers and those involved with surveying, inspection and testing of marine fuels.

The authors

Both authors have been involved with providing technical and legal services to the shipping and oil industry and have taken part in many bunker conferences and training courses over the last 20 years. They are keen to see more mediation in bunker disputes as an alternative to costly and lengthy court and arbitration hearings and now offer their services in this area of dispute resolution.

Chris Fisher

After studies at Poplar Marine College, Chris went on to sail on tankers and, having served as Chief Engineer for a number of years, he came ashore into the position of Marine Superintendent with Texaco Overseas Tankship in 1981. During this period he became particularly interested in the changes of the quality of marine fuels, brought about by more intense refinery techniques, and became involved with related technical issues in the maintenance and repair of the Texaco fleet.

In 1984, he moved into consultancy, providing expert services to shipowners, and insurers, mainly in the field of liquid cargo losses and contaminations. He teamed up with Stephen Hodge, a chemist, and they wrote *Fisher & Hodge on Bunkers*. This was the first technical book devoted to the subject.

In 1987, Chris joined Det Norske Veritas Petroleum Services (DNVPS), which had pio-

neered routine marine fuel quality testing and at that time tested some 20,000 samples a year. In 1990, Chris moved with his family to The Netherlands, where he set up a new fuel testing laboratory in Rotterdam for DNVPS. The business of fuel testing grew rapidly in this period and by 1996 DNVPS was contracted to test around 50,000 samples a year. In 1994, he joined up with Jonathan Lux and they produced *Bunkers*.

Following his interest in laboratories and all aspects of liquid cargo loss control, he joined the Inspectorate group of companies in 1995, as Director of their Northern European companies in The Netherlands, Belgium and Germany. He quickly established a new dimension to Inspectorate – Bunker Claims – which focussed on providing laboratory and technical services to those involved with bunker disputes. Between 1995 and 2003, he attended many arbitrations and court hearings as a technical expert.

During 2003, Chris decided to end his period in the inspection business and he and his family returned to England where he established his own company, Bunker Claims International Ltd, once again providing expert opinion in court and arbitration hearings on bunker matters. He also visits ships to investigate engine damages and bunker problems. Chris enjoys teaching and spends as much time as he can giving lectures and attending training course workshops.

Jonathan Lux

Jonathan joined Ince & Co in 1975, qualified as a solicitor in England and Wales in 1977, and in Hong Kong in 1986. Jonathan became a partner in 1983. He specialises in maritime law, insurance matters and international trade and has been involved in many landmark cases in these fields. He acts for the major P&I Clubs, their shipowner or charterer members, cargo interests, cargo sellers and buyers as well as the major insurers covering the divergent risks in issue. Jonathan has been a pioneer in the introduction of ADR (principally mediation) into his fields of practice. He is an accredited mediator (CEDR, The Academy of Experts and ADR Net) and leads the firm's ADR Group which will assume increasing importance in the light of the radical reforms to the Courts' Civil Procedure Rules. Jonathan is a Member of Mediation Panel of Mediationsstelle für Wirtschaftskonflikte.

With the increasing number of disputes involving bunkers, Jonathan has become a leading expert advising bunker suppliers, shipowners and charterers. He has been a Council Member of the International Bunker Industry Association and former co-ordinator of its working group on dispute resolution. He has drafted a number of the conditions which have now become standard clauses in the supply contracts and charterparty terms.

Jonathan is co-author of *The Law of Tug, Tow and Pilotage*, *The Law and Practice of Marine Insurance and Average* and *Bunkers*. He is editor of *Classification Societies* and author of various other publications in the fields of maritime law, insurance and international trade. He

is a frequent lecturer on these subjects both in the UK and on the international circuit.

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Jonathan Lux would particularly like to thank the following for their invaluable help in preparing this third edition of *Bunkers*. The blame for any errors or omissions must lie at Jonathan's door. Particular thanks are due to Dharshini Bandara of Ince & Co's Hamburg office, together with Colin de la Rue, Michael Volikas, Ms Claire Hillier and Joe Zhou of Ince & Co's London office. Ivar Tonnesen of Gearbulk was his usual helpful self when it came to identifying suppliers' terms and conditions of sale and Bob Thornton of Trans-Tec Services was also most helpful in this regard. Jonathan would also like to thank Keith W. Heard of Burke & Parsons in New York and San Francisco lawyer Mia Perachiotti-Germack for their very considerable assistance from the other side of the Atlantic. It's also appropriate to record thanks to BIMCO who unhesitatingly gave their permission to print the text of their Standard Bunker Contract.

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Chapter One

A Brief History of Marine Propulsion

Although the story of marine engineering only began some 150 years ago, the need to develop mechanical power to take the seafarer out of the control of the wind and tides was apparent even to the Romans. It is alleged that they considered the use of the paddle-wheel, but elected to use oars as they considered them to be more efficient. Manpower was obviously not a problem.

Hero of Alexandria has been credited with the earliest demonstrations of the use of pressurised steam with his eolipile of 130 B.C., but nobody really took his concept seriously with respect to developing useful work until the seventeenth century. Thomas Savery, in 1698, patented a double-chambered steam operated device for extracting water from mine sumps. This engine was used for many years and the 'pulsometer' pump, still used today, operates on a similar principle.

Thomas Newcomen realised the importance of the vacuum principle, and developed the piston concept, which separated the pump and steam ends of the machine.

In these early days, the development of the steam engine was mainly centred on pumping devices for mine work.

Although James Watt is sometimes credited with the invention of the steam engine, this is a misconception. Watt began studying the well-established atmospheric machine of Newcomen in the mid-eighteenth century, by which time Newcomen's pumps were being used throughout industry. Watt, without doubt, was a major contributor to the development of more efficient and higher-powered steam engines. He realised that separate condensing of the steam, outside the operating cylinder, and the use of steam to exert a force on a piston, would reduce fuel consumption and help to create more useful work.

Although the steam engine was used extensively in the industrial world at the turn of the eighteenth century, the machinery was crude, heavy, large, slow and not particularly suited for marine propulsion.

To catalogue the successful, and not so successful, attempts of designers to produce a marine propulsion engine is not in the scope of this book, but a brief account of the development of steam and diesel engines, combined with some thoughts for future means of vessel propulsion, does have a bearing on the subject of bunkers.

Many tests were conducted using steam-powered vessels in France and the United States between 1785 and 1810. These trials were mainly on barges or canal boats with perhaps the most famous being the *Charlotte Dundas*, a tugboat built at Grangemouth Dockyard in 1801. The propulsion machinery was a horizontal, direct-acting, condensing engine. Although a technical success, the vessel was not commercially accepted, as the wash created by the tug would have eroded the Clyde Canal banks, so requiring extensive maintenance. It is interesting to note that the vessel developed twelve horsepower (h.p.) using a

stern paddlewheel with an operational speed of some three knots.

One of the first steamships to have made a sea passage was the vessel *Phoenix* which was built at Hoboken for trade on the Delaware River. She made a 'coast hugging' voyage from Hoboken to the Delaware River and steamship river passages and canal transits very quickly led to the development of cross-Channel ferry services. In 1820, a service between London and Paris was provided by the ship *Aaron Manby* which was fitted with an engine designed by Henry Bell delivering a service speed of some eight knots. Inevitably, the idea of steam propulsion was adopted for longer sea voyages and the American *Savannah*, a sailing vessel with an auxiliary engine and detachable paddlewheels, crossed the Atlantic in 1859, but only used the engine for about eight hours. In 1825, *Enterprise*, a vessel of some 470 tons, made a passage from London to Calcutta. Again, this was a sail vessel fitted with an auxiliary engine which was reported to have been used for over 60% of the voyage.

The first bunker problem was beginning to manifest itself at this time. Designers of vessels had to create space to stow cargo, passengers and sufficient coal for the voyage. In April 1838, the vessel *Sirius* crossed the Atlantic with coal stowed both below and on the main deck. This voyage was a race against Brunel's masterpiece the *Great Western*. In fact, *Sirius* ran out of coal on her voyage across the Atlantic to New York and the crew resorted to burning furniture, cabin doors and even a mast in order to beat Brunel's ship.

The *Great Western* completed the voyage in a shorter time and had fuel to spare on arrival, having crossed the Atlantic at a speed of some nine knots. Brunel then turned his genius to the construction of the first large iron ship *S.S. Great Britain*, the keel being laid at Patterson's shipbuilding yard at Bristol in 1838.

John Stevens and John Ericsson are considered to be responsible for the development, but not the invention, of the screw propeller and it was Ericsson who convinced Brunel that he should stop the construction of *S.S. Great Britain* until he had redesigned the propulsion system, taking away the paddlewheel and installing, in its place, a propeller. In addition to the four engines developing 1,500 h.p., this vessel was fitted with masts and sails. The sails were obviously a form of insurance against machinery failure, but the records show *S.S. Great Britain* only once used her sails to complete a voyage. This was not due to a fuel related problem; the propeller became damaged by her foremast when it was taken over the side in heavy weather. The *S.S. Great Britain* is now berthed in Bristol and enthusiasts work continuously on preservation. Certainly worth a visit and a donation to help the cause.

The arrival of compounded steam engines in the early 1860s paved the way for improved fuel consumption. Before this period, with low boiler pressures of 20 pounds per square inch (p.s.i), fuel consumption was in the order of four pounds per horsepower hour (lb/h.p.hour). Obviously this meant the shipowner, when undertaking voyages had to

consider both his fuel costs and the problem of trading to ports which could not supply sufficient bunkers.

Development of the marine steam engine was of interest not only to the merchant fleets, but also the Admiralty. In the early days, however, fighting ships tended to use the engines if the vessel was becalmed, whereas the merchantmen used sails if the engines failed. With the development of the triple expansion engine, boiler design also improved and steam pressures began to increase, resulting in lower fuel consumption. The introduction of the Scotch boiler, with the addition of forced draft, provided steam pressures of up to 150 p.s.i. The combination of triple expansion engines with Scotch boilers continued through the turn of the century and became extremely popular. In the period between 1820 and 1900, the fuel consumption had been reduced from around 10 lb/h.p. hour to about 1.5 lb/h.p. hour.

The next major change in ship propulsion was the introduction of the steam turbine. Although engineers such as De Laval, Curtis and Rateau experimented with patented turbine blading systems, it was Parsons who made the greatest contribution to development of the marine steam turbine. In 1894, he began construction work on the first turbine steamer *Turbinia*.

At the Spithead review, *Turbinia* showed off her speed of 34.5 knots and captured the imagination of the world. Not only was the vessel turbine driven, but also, a single water tube boiler supplied steam.

For those interested in steam engines, marine and industrial, the London Science Museum has a good collection and we recommend a visit.

Cunard put their faith in Parsons and his turbines and began construction of the *Mauretania* and *Lusitania* which were to develop 7,300 h.p. to challenge the Germans who had begun to take control of the transatlantic passenger trade with vessels (such as *Deutschland*), which were powered by vast reciprocating engines delivering 32,000 shaft horsepower. The *Mauretania* used steam at 16 bar (210 p.s.i.), developed in 25 coal-fired boilers. She achieved a speed of 27 knots and took the Atlantic Blue Riband, holding it for 22 years until 1929. Her coal consumption amounted to 900 to 1,000 tons per day, which was hand-fed into the boilers. The engine room was crewed by 366 men. It could be said that the *Mauretania* sealed the fate of the large steam reciprocating engines for the propulsion of the transatlantic passenger ship, although the *Titanic* was built with reciprocating engines operating on high steam pressure using low-pressure steam turbines in order to reduce fuel consumption.

The steam turbine, although very popular with the large passenger liner owners, never really gained supremacy over the reciprocating engines for smaller cargo vessels. In order to provide the propeller shaft speeds on turbine vessels, it was also necessary to install a reduction gear, but the development of gearing is beyond the scope of this book.

The development of the internal combustion engine began in the late eighteenth century

but progress was slow over the next hundred years. In 1892, Rudolph Diesel registered a patent for a compression ignition reciprocating engine. This early patent used coal dust as fuel and was not really a success.

The petroleum industry started in the mid-nineteenth century when crude oil was discovered in Pennsylvania in 1859. The first use of crude oil was to make lamp oil or kerosene but it was clear that other fuels could be made from this new energy source. Rudolph Diesel was quick to grasp this and by 1895 had built a prototype engine working on liquid fuel. Today we still call such engines Diesels and the fuel they consume Diesel.

Oil for use in ships' boilers and diesel engines was not a commercial proposition until the turn of the nineteenth century, due to its high cost compared with coal and the lack of bunkering ports around the world. In 1870, the merchant vessel *Constantine* had its boilers converted from coal to oil firing. The vessel traded in the Caspian Sea using fuel refined from the large Russian stocks of crude oil. In 1885, the ship *Himalaya* was bought by the Marahu Petroleum and Oil Product Co, for experiments on the use of burning shale oil. The fuel was carried in drums on deck but the vessel's classification society was not entirely happy with the experiment and the project was abandoned.

The pioneering days of the compression ignition engine, as a means of ship propulsion, progressed along the lines of redesigning steam reciprocating engines into diesel engines. The steam auxiliary plant remained, as did the boilers. In 1912, Burmeister and Wain equipped a vessel powered by two four-stroke engines developing 2,500 brake horse power on twin screws with a speed of 11 knots. The auxiliaries were electrically driven and a boiler was installed as an emergency unit. It is suggested that this vessel, *Selandia* probably paved the way for the modern motor vessel.

By 1921, around 21% of the total merchant gross tonnage used fuel oil for boilers. At this time motor ships were being operated on diesel oil. With a small cost differential between the boiler fuel oil and diesel engine fuel, the incentive to burn heavy fuels in diesel engines was not apparent.

In the 1930s, fuel economy became important when oil-burning, steam turbine vessels were consuming some 1 lb of fuel/indicated horsepower hour whereas the diesel-driven vessels were achieving 0.35 lb/i.h.p. hour. It was not only fuel prices, but also the reduction in space needed for coal, boilers and their associated large crew complements, which aided the popularity of the diesel engine at sea. The earlier diesel engines needed compressed air to atomise the fuel in the cylinders, however the air compressors were unreliable and caused many problems. The introduction of the airless injection engine, in around 1928, was a major step forward in increasing engine reliability.

As the steam turbine building programme advanced and the diesel engine gained popularity, vessels powered by steam reciprocating engines began to be taken out of service.

Marine diesel design developed along many different paths, with engine builders offering not only two-stroke and four-stroke engines but single and double-acting. Further designs

included crosshead and trunk types and opposed piston arrangements.

The early diesel engine designers and builders focused their attention on large, slow speed, direct driven engines with speeds of 90 to 160 revolutions per minute. By the 1920s, however, both medium and high-speed engines began to appear.

Medium speed engines, 400 - 700 r.p.m., were coupled through fluid or electro-magnetic slip couplings into a reverse reduction gearbox, driving a single propeller shaft. High-speed diesel engines were used to generate power to drive shaft motors. These arrangements allowed more flexibility in maintenance, as individual engines could be shut down for repair whilst the vessel proceeded on the voyage.

The gas turbine propulsion method was adopted mainly by the British Royal Navy, which was more interested in speed than fuel consumption although, in 1948, initially as an experiment, a Shell tanker *Auris* was re-engined with a gas turbine plant serving the main propulsion motor. The 12,000 ton *Auris* was superseded by the more popular 65,000 ton ships and she was taken out of service in 1960. The fuel consumption of a well-designed gas turbine plant should be similar to that of a steam turbine system. It would be fair to say that any problems experienced by gas turbine vessels were usually with auxiliary equipment rather than the main turbines.

Throughout the period 1920 to 1960, steam reciprocating engines were phased out and steam turbines took over, merchant vessels becoming predominantly fitted with either diesel or steam turbine plants.

By the 1950s successful experiments had been conducted demonstrating that marine diesel engines could operate on heavy fuels and J. Lamb had presented to the Institute of Marine Engineers, his well respected paper *The burning of boiler fuels in marine diesel engines*.

A.G. Arnold also presented a paper *The burning of oil in two and four stroke cycle diesel engines and the development of fuel injection equipment* (Inst. Mar. Engineers Transactions Volume 65 - 1953). Slowly, more and more marine diesel engines, capable of burning heavy fuels, were installed in merchant vessels. At the same time, the oil companies developed better lubricants specifically designed for engines operating on these fuels, and advances in fuel treatment systems were made to improve the quality of the fuel delivered to marine engines.

Steam turbine plants developing 32,000 shaft h.p. became very popular in the 1970s for the propulsion of 250,000 tonne tankers. These vessels had service speeds of 15 to 17 knots with fuel consumption of up to 150 tonnes a day. Vessels other than tankers were generally fitted out with diesel engines and the slow speed diesel engine tended to dominate the scene up until the 1973 Middle East War. Prior to this time, bunker prices were low and shipowners gave little attention to fuel consumption, looking towards reduced crew costs for any savings.

The Middle East War resulted in an almost threefold rise in the cost of fuel oil, just when

new building order books for tankers were full. The effects of this price rise on the shipping world were severe, causing owners to review their new building plans and develop energy conservation programmes on existing ships.

Large steam turbine vessels were slowed down to 'economical' speeds of nine to ten knots and shipowners began to look at energy-saving ideas, such as improved hull performance gained by application of superior self-polishing paints and hull cleaning programmes. Some propellers were modified to be more effective at lower speeds, resulting in an array of nozzles and shrouds appearing around propellers. Some shipowners removed the steam turbines and replaced them with slow or medium speed diesel engines in order to cut fuel costs. Indeed, vast amounts of money were spent under the heading of 'energy conservation' on many vessels, which were laid up or scrapped soon after, due to over tonnage.

The combined effects of higher priced crude oil and increasing demands for gasoline, aviation fuels and lubricants, forced the refiners to implement improved refining techniques that they had been developing over many years. These new techniques were to achieve a greater conversion of crude to high demand products. Unfortunately these techniques were to have a major impact on the quality of marine fuels. Ships' staff had become familiar with handling and treating heavy residual fuels from simple refining processes but the new breed of fuels were more complex and needed special care.

Diesel engine builders were quick to respond to the poor fuel quality problem and new efficiency requirements, but the slow speed engines with long stroke, lower propeller speeds and improved thermal efficiency still tended to be most popular. Leading builders of these engine types were MAN B&W and Sulzer. Constant improvements and modifications to slow speed engines took place in the first half of the 1980s. All the attention given to efficiency resulted in a reduction of the specific fuel consumption of up to 12% between 1970 and 1985.

A high percentage of the heat released by fuel used in a diesel engine is lost in friction, the cooling circuits and with the exhaust gases. Engine designers, therefore, began introducing complex heat recovery systems. Since the price of bunker fuel fluctuates with the rise and fall of crude oil prices, the economics of high initial costs and pay back periods for these systems also became complex.

The medium speed engine builders also responded to the need for improved efficiency by designing engines to burn lower quality fuels. New medium speed engine vessels were claimed to have some advantages over the slow speed crosshead layout, the engine room construction being cheaper and the machinery space smaller, leaving a greater cargo carrying capacity. By increasing the bore to stroke ratio, lengthening the stroke and increasing the injection pressures, designers claimed better fuel consumptions than low speed engines of similar power. As both slow and medium speed designers claimed that low-grade fuel could be burned in their engines, and modern maintenance and surveillance

techniques brought the reliability of the two types closer together, the choices open to the shipowner were many.

The increase in density, viscosity and level of contaminants in marine fuels gave rise to improvements in the design of purifiers. Shipowners also experimented with fuel additives to reduce fouling in combustion spaces and to improve general fuel handling.

By the late 1970s, the quality of marine fuel had become a matter of serious concern to ship operators. Handling problems and engine damages were reported, followed by complaints and claims directed towards the fuel suppliers. These problems were drawn to the attention of the classification societies and Det Norske Veritas, the Norwegian Classification Society, responded by introducing the first fuel quality testing programme in 1981. During the 1980s, major fuel suppliers, engine builders, the British Standards Institution and the International Standards Organization developed the first marine fuel standards.

By 1990, very few steam propulsion ships remained in service and new buildings were being fitted out with medium or slow speed diesel engines.

According to a study by MAN B&W, in 2001 there were some 89,100 merchant ships with a gross registered tonnage above 100. About 26% were fishing vessels, 26% general cargo, 11% tankers, 7% bulk/combined carriers and the remainder a mix of craft including tugs and passenger vessels. About 67% of the total number of these ships were being powered by four-stroke diesel engines and 26% by two-stroke, mainly slowspeed engines. The remainder were unknown, either two stroke or four stroke. Turbines were thought to be less than one percent.

At the time of writing this book, new problems and challenges face the shipowner. The new generation of ships will not only have to maintain a high degree of fuel efficiency but also comply with new environmental legislation.

Marine fuel will always represent a very small percentage of total world energy consumption but legislation on control of exhaust gas emissions, already enforced on land, will be extended to ships. Refinery technology will continue to advance and refiners may decide to utilize total conversion processes, which will not yield any residual fuels. It may be many years before this practice becomes widespread but the problems of reducing total emissions from ships will be the next major challenge.

Alternative energy sources such as liquid fuel from gas, bio fuels, nuclear, wind, hydrogen and solar, will no doubt have their place in ships of the future but it is probably safe to say that, during the next 20 years, ships' engineers will continue to experience the problems of operating high powered diesel engines on low grade residual fuels at sea and distillate fuels when in port or near to land.

Most of the above served as the introduction chapter to our last book, published in 1994. Since then, the ISO Standard 8217 has been revised, an ISO technical report on bunker-

ing procedures has been published, a number of strange substances have been discovered in marine fuels and, as predicted, the drive to force ships to use more environmentally friendly fuels has been geared up.

Many of the ships trading in 1994 are still in operation. These and new ships are still facing the problems associated with the consumption of low-grade bunker fuel. Many ship-owners have also found that they cannot rely on the quality of distillate fuels such as gasoil and marine diesel, because they too have been used as dumping grounds for waste materials.

Some ports have gained in notoriety as bunkering stations where the buyer must take extreme care to reduce the risk of being cheated on quantity and quality.

The issues of where and how to take a representative samples have not been entirely resolved and continue to be a major stumbling block in claim and dispute resolution.

A new dimension in dispute resolution has been added by the introduction of mediation and this is finding its place alongside arbitration and litigation.

The bunker world has, like most industries, been dragged into e-commerce and it is likely that this will introduce new areas for lawyers to ply their trade.

Bunker conferences, seminars and training sessions continue to provide the organisers with profitable business, with the locations for these becoming more exotic each year.

There is still much to talk and complain about in the bunker industry and this always stimulates excellent discussions at such gatherings. A delegate at one of the International Bunker Conferences, who had attended many previously, was heard to say 'When I went to my first bunker conference I came away very confused on so many issues'. Asked how it was for him now, he replied 'Oh, I am still confused but on a much higher level'.

The authors of this book hope that they may be able to take away some of the confusion by presenting their thoughts and ideas on the complex, frustrating but essential world of 'Bunkers'.