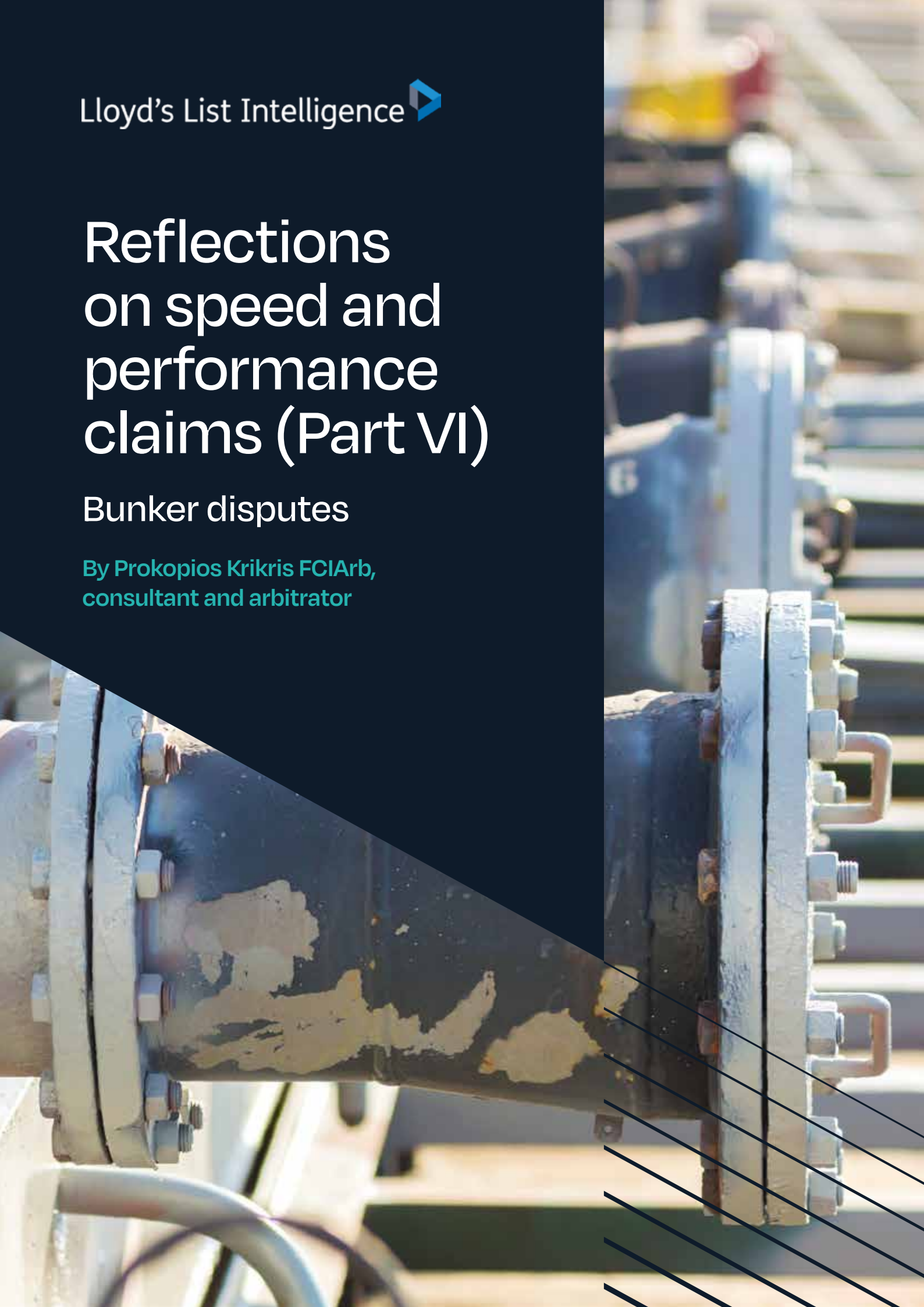



# Reflections on speed and performance claims (Part VI)

Bunker disputes

By Prokopios Krikris FCI Arb,  
consultant and arbitrator





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The series "Reflections on Speed and Performance Claims" presents the reasoning applied by arbitrators in their decisions and sets out various observations based on the parties' arguments submitted in several cases.

# Reflections on speed and performance claims (Part VI)

## Bunker disputes

By Prokopios Krikris FCI Arb, consultant and arbitrator

### Introduction

Speed and performance disputes under time charterparties have long been a recurring feature of maritime arbitration. While such disputes traditionally focus on compliance with speed and bunker consumption warranties, they often involve a wider range of related issues, including bunker quantity and quality disputes, fouling, weather routing, emissions, engine performance and the quantification of any resulting losses.

This article, forming part of the continuing series “Reflections on speed and performance claims”,<sup>1</sup> examines several issues that commonly arise alongside allegations of underperformance. In doing so, it explores the origins and development of such disputes through the lens of both London and New York arbitration awards, as well as relevant engineering and naval architectural literature. The analysis demonstrates that many of the issues currently debated in practice are long-standing rather than novel.

Particular attention is given to bunker quantities and surveys, bunker quality, fouling, weather-related resistance and the different methodologies used to evaluate time loss and bunker overconsumption. The discussion also considers the interaction between legal and technical issues, including the use of weather-routing reports, back-calculation exercises for bunker discrepancies, engine data and expert performance analysis. Given the limited number of reported cases currently addressing emissions-related disputes, that topic will be examined separately in a future article.

### Charterparty terms

Several provisions deal with bunker-related issues and their connection with speed and performance claims. These commonly include bunker quantities and surveys, bunker quality, fouling and maintenance, emissions and off-hire or deviation issues linked to bunkering during the voyage.

Quantity disputes usually concern bunkers remaining on board at redelivery, replenishment requirements and the evidential value of bunker surveys. Quality disputes generally involve compliance with fuel specifications, alleged engine damage, and questions of causation, which can often be difficult to establish.

### Bunker quantity issues

Bunker quantity disputes may affect the assessment of losses arising from underperformance, whether advanced as damages or off-hire claims. Such disputes can arise in different situations. Excessive fuel consumption may lead to bunker shortages on redelivery or require the vessel to deviate to an intermediate bunkering port to complete the voyage. Low bunker reserves may also require an earlier switch to different fuel before entering an emission control area. In such cases, additional claims for damages or off hire may arise.

<sup>1</sup> Published on [www.i-law.com](http://www.i-law.com).

## Insufficient bunkers on board

Related issues arise where insufficient bunkers result in deviation or slow steaming during the voyage. Disputes may concern the time loss, expenses and bunkers associated with deviation to an intermediate bunkering port, slow steaming due to low bunker reserves or the need to switch earlier to another type of fuel because of insufficient VLSFO reserves. Such disputes are not uncommon in practice and are highly fact sensitive. In these cases, weather-routing reports, deck and engine logs, and bunker surveys before and after the incident may become important evidential material.

These disputes may also raise issues concerning seaworthiness and the parties' respective obligations under the charterparty. As the learned authors of *Carver on Charterparties* said, the obligation of seaworthiness "includes commencing a voyage with insufficient fuel, or with the wrong quality of fuel".<sup>2</sup> Moreover, "what is required in order for a ship to be seaworthy is relative",<sup>3</sup> so this is fact sensitive.

Furthermore, according to the authors of *Time Charters*, the description "with hull, machinery and equipment in a thoroughly efficient state" is "an undertaking that the ship is in good order and condition. It is implicitly an undertaking that the ship is seaworthy".<sup>4</sup> Typically, under the NYPE form charterparty, it "imposes only an obligation to exercise reasonable diligence to maintain the ship, other forms of maintenance clause may be worded so that the obligation is absolute, subject to any applicable exceptions".<sup>5</sup>

The bunkering requirements will depend on the agreed terms. Under clause 2 of the NYPE, charterers remain responsible for supplying the vessel with bunkers, but the owners are required to cooperate by providing the necessary information to calculate the appropriate quantities. Where the charterers "rely upon such information, and it turns out to be wrong, they are not responsible for the consequent losses".<sup>6</sup> Equally, although the charterers pay for and supply bunkers, owners remain responsible for ensuring that the vessel has enough fuel to make her seaworthy.<sup>7</sup> Lastly, the choice of the bunkering port is for the charterer to make, but the owner would be entitled to object if the vessel has insufficient fuel to reach it.<sup>8</sup>

In practice, particular difficulties may arise during long sea voyages, especially where bunkering is carried out in stages and overall fuel consumption may be affected by changing or unpredictable conditions. Thus, it is required that the fuel quantity be "sufficient to get the vessel to the next bunkering port in all reasonably foreseeable circumstances"<sup>9</sup> including an appropriate allowance for adverse weather, currents and unpumpable fuel.

However, there is:

"no obligation cast upon the shipowner to have more than a reasonable and ordinary supply of fuel on board, having regard to the character of the voyage and the character of the weather that was to be expected. Account must be taken inter alia of the distance to be covered to destination or the next intended bunkering port, the distance expected to be covered each day, having regard to the weather likely to be encountered at that particular season of the year, the state of cleanliness of the vessel's bottom, and the condition of the engines and/or boilers; the anticipated daily consumption of fuel at the expected speed of the vessel. With these factors in mind, the required quantity of bunkers can be calculated but, to the sum so produced, must be added a reasonable margin to cover emergencies according to what prudent owners usually do in the particular trade."<sup>10</sup>

## Reported cases reflecting these issues

In *The Marina di Cassano*,<sup>11</sup> on appeal from an arbitration award, the court upheld the arbitrators' finding that the vessel sailed with insufficient bunkers, amounting to a breach of clause 1 of the charter. The owners were therefore held liable for the additional costs incurred when the vessel deviated to the Azores to replenish bunkers after the master realised during the voyage that the remaining fuel was insufficient to complete the passage.

In *London Arbitration 2/85*,<sup>12</sup> during the voyage, the master raised concerns that the vessel's bunker reserves were becoming insufficient and that a deviation to replenish bunkers would be necessary. At the time, the

<sup>2</sup> *Carver on Charterparties* (3rd Edition, Sweet & Maxwell, 2024), para 3-082.

<sup>3</sup> *Ibid*, para 3-076.

<sup>4</sup> A Baker et al, *Time Charters* (8th Edition, Informa Law from Routledge, 2025), para 3.41.

<sup>5</sup> *Ibid* at para 11.10.

<sup>6</sup> *Ibid* at para 12.4.

<sup>7</sup> *Carver on Charterparties*, para 7-059.

<sup>8</sup> *Ibid*, para 7-063.

<sup>9</sup> *E B Aaby's Rederi A/S v Union of India (The Evje) (No 2)* [1976] 2 Lloyd's Rep 714, page 718 col 2.

<sup>10</sup> R Cornah et al, *Lowndes & Rudolf: The Law of General Average and The York-Antwerp Rules* (15th Edition, Sweet & Maxwell, 2018) at para 9.04.

<sup>11</sup> *Italmare SpA v Stellar Chartering & Brokerage Inc (The Marina di Cassano)* [1984] 2 Lloyd's Rep 577.

<sup>12</sup> (1985) 137 LMLN, *Lloyd's Maritime Law Newsletter*, 31 January 1985.

vessel was encountering adverse weather conditions, and the owners argued that, if the vessel continued at full speed as ordered by the charterers, she would not have sufficient fuel to reach the next bunkering port. The charterers nevertheless instructed the master to proceed directly to the discharge port and warned that the vessel would be placed off hire if she deviated to bunker.

### New York arbitrations

Apart from English cases, New York arbitration awards have similarly considered speed and performance warranties “in connection with the owners’ obligations undertaking under clause 1 [of the NYPE form] to maintain the vessel in an efficient condition throughout the charter service.”<sup>13</sup>

In a previous arbitration<sup>14</sup> the vessel had an unscheduled call for taking bunkers as the master has miscalculated the quantities required to be supplied given the vessel’s speed and consumption settings.

The owners said that this prolonged stay at port had caused bottom fouling which affected performance during the voyage, and that this was the responsibility of the charterer. The master calculated properly the bunkers necessary to perform the voyage, based on past experience, but the bottom fouling rendered his calculations inaccurate. In any case, the owner contended that the charterer was responsible for bunkering in the first instance; the master’s role with respect to his involvement was carried out as agent for the charterer.

The charterer argued that any error in the calculation of bunkers of fuel required by the vessel to complete a contemplated voyage rendered the vessel unseaworthy, and it was this responsibility which rested solely with the owner. Although the charterparty required the charterer to provide and pay for all bunkers, it did not shift the responsibility of ensuring the vessel had sufficient bunkers to complete its intended voyage. Here, the master was notified of the next voyage and it was upon his calculation of the required bunker quantity that charterer relied. Whether the vessel’s

bottom was fouled or whether the miscalculation was for other reasons, the owner was not relieved of its duty to maintain the vessel in a seaworthy condition.

The panel held:

“The Master was requested to compute his bunker requirements for a voyage from Singapore to Port Hedland and thence directly to Antwerp. He did so and was accordingly supplied with the quantity required. It subsequently turned out that the requested amount was insufficient and accordingly the vessel was required to make an interim bunkering call at Cape Town.”

The panel recognised that there are any number of possibilities which may have caused the master’s bunker computation to go awry, but none of them would lead them to find charterer liable for the Cape Town call. The master may have been negligent in computing the bunker quantity required for the voyage; the bunker computation may have been made immensely more complex by the variables of a slow steaming situation; the bottom fouling brought about by an extended Indian port stay could have been a far greater factor than the master imagined; or other engine room difficulties could have contributed to the extraordinary consumption experienced by the vessel after it sailed from Singapore. In fact, the problem may have been a combination of all of the above factors and perhaps others.

The panel did not accept that the master was acting as the charterer’s agent or on its behalf when calculating the quantity of bunkers required for the vessel to proceed directly to Antwerp.

As the panel held:

“... while it was the charterer’s responsibility to supply and pay for bunkers it remained the vessel’s obligation to assure itself that sufficient bunkers are on board to perform the intended voyage. The evidence conclusively established that the Charter furnished that quantity of bunkers requested by the Master. If the Master miscalculated the speed and consumption because of bottom fouling or slow steaming, then it is his error for which the owner must assume responsibility. It cannot be imputed to the Charterer.”

<sup>13</sup> *Time Charters* at para 3A.54.

<sup>14</sup> SMA 1351.

Similarly, another panel<sup>15</sup> held that the owner was responsible for time and expense incurred in an interim bunkering call which was necessary to render vessel seaworthy to complete a contemplated voyage.

Another panel<sup>16</sup> held that sailing from port with insufficient fuel to reach the vessel's destination and thereby causing a diversion for bunkering was held to constitute gross negligence on the owner's part.

Moreover, a panel<sup>17</sup> held that the fact that the owners ordered the vessel to deviate to Las Palmas for bunkers was in direct contravention to clause 8, the deviation was not necessary for the completion of the voyage but rather arranged by the owners in anticipation of possible bunker problems after the redelivery of the vessel from the charterers.

Whereas in another case, the panel held that although bunkering was the charterers' obligation under charterparty, where deviation for bunkers was result of the vessel's overconsumption during periods of breakdowns and delays due to slow steaming, the time and cost of such deviation was for the owner's account.<sup>18</sup>

As these disputes concerned bunker consumption and bunker reserves, bunker surveys were closely scrutinised and assessed on a case-by-case basis when evaluating the issues in dispute.

## Bunker surveys

Most charterparties require the parties to arrange a joint bunker survey upon delivery and redelivery to determine the quantities remaining on board. This is important

<sup>15</sup> SMA 1351.

<sup>16</sup> SMA 1471.

<sup>17</sup> SMA 3453.

<sup>18</sup> SMA 1109.

because charterers pay for the bunkers on delivery and are generally required to redeliver the vessel with approximately the same quantities. The agreed figures are then reflected in the final hire statement, showing any balance due between the parties.

Although charterparties commonly provide for the measurement and verification of bunkers through a "joint survey", the scope and effect of such provisions depend on the wording of the clause. In practice, surveys are usually carried out by an independent surveyor jointly appointed by the parties, or the owners can decide whether to be represented by the master and chief engineer. The reference to "a joint survey" reflects that the parties "can make separate surveys, but it is common that they agree to have a joint survey by an independent surveyor".<sup>19</sup>

Before the surveyor conducts the bunker survey, various checks are normally undertaken including verification of the vessel's trim and draft, tank calibration tables, sounding arrangements, fuel density and temperature, logbook records and the accuracy of the gauging equipment.

In this context, bunker quantities are commonly measured by either sounding or ullaging methods. Sounding measures the depth of liquid in the tank by lowering a weighted tape to the bottom, while ullaging measures the empty space above the liquid surface. In both cases, the readings are checked against tank calibration tables, taking into account the vessel's trim and heel, in order to determine the quantity of bunkers on board.<sup>20</sup>

Issues have also been reported concerning alterations to airpipe heights following shipyard delivery, as well as the use of fabricated tubes or pipes inserted within sounding pipes – the "magic pipes" – which can influence the result of the bunker survey. In one case, it was held that "Secret

<sup>19</sup> E Plomaritou E and A Papadopoulos, *Shipbroking and Chartering Practice* (8th Edition, Informa Law from Routledge, 2018) at page 364.

<sup>20</sup> Captain A Brink, *On-Off Hire Condition & Bunker Surveys* (1st Edition, 2013), pages 48 to 50.

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structural modifications in the vessel's tank made its ullage readings unreliable".<sup>21</sup>

Despite these procedures, disputes concerning bunker quantities continue to arise in both practice and arbitration. As reflected in several London and New York awards, tribunals have considered not only the bunker survey results but also the vessel's warranted fuel consumption and actual performance during the voyage to reconcile evidential differences in the bunker surveys. In many cases bunker survey findings and performance evidence were assessed together as part of the overall factual analysis. The following is a summary of some of the disputed issues:

- (1) The masters' estimate of expected bunkers on delivery was wrong.<sup>22</sup>
- (2) The survey results may not be conclusive even if signed.<sup>23</sup>
- (3) The agreed surveyor never attended to conduct the survey.<sup>24</sup>
- (4) The surveyor disembarked without agreeing on the survey findings.
- (5) The surveyor's figures should be preferred absent proof of being wrong.<sup>25</sup>
- (6) The master concealed the bunkers during the survey.<sup>26</sup>
- (7) The master suddenly declared more bunkers on board, and he was constantly reporting under-consumption, thus raising doubts.<sup>27</sup>
- (8) The master maintained undeclared bunker margins, thereby raising doubts as to the accuracy of the reported quantities.<sup>28</sup>
- (9) The owners failed to provide a satisfactory explanation as to why different bunker figures were provided for owners and charterers on redelivery.<sup>29</sup>

(10) A unilateral bunker survey was used to amend the bunker quantities.

(11) The charterers insisted that the parties conduct multiple bunker surveys.

(12) The multiple surveys produced differing results, which raised doubts regarding the surveyors' competence and the proper conduct of the surveys.

(13) One or both parties unreasonably withheld consent to the appointment of a proposed surveyor.

(14) The parties disputed the applied method for measuring the bunkers remaining on board.

## The back calculation

As explained previously,<sup>30</sup> cases such as these can turn upon hard contemporaneous evidence and probable explanations submitted by the parties. It can therefore become a matter of whether the master's or the surveyor's figures are true. To decide this, the parties can adopt the method of "back calculation".

This approach tests each party's theory by working backwards to determine whether it produces a reasonable result, with unrealistic outcomes generally being disregarded. In *London Arbitration 1/99*<sup>31</sup> the methodology was easily applied, and assisted the tribunal in resolving the dispute. However, back calculations are not always precise and may present challenges, making each case highly fact specific.

Another challenge in working backwards can be incorrect vessel's logs and possible inconsistencies with bunker surveys performed before. For instance, in *The Pantanassa*<sup>32</sup> the judge found that the master:

"... was under a considerable error as to the amount of fuel on board. Certain calculations have been put before me designed to estimate what the error was at the time that the vessel left San Pedro. Those estimates depend upon calculations based on the abstract of the engineer's log which puts down a uniform consumption per day, irrespective of the distance travelled, and irrespective of whether the

<sup>21</sup> SMA 2508.

<sup>22</sup> *Ejplioa Shipping Corporation Ltd v Canadian Transport Co Ltd (The Pantanassa)* [1958] 2 Lloyd's Rep 449.

<sup>23</sup> *London Arbitration 1/99*, (1999) 503 LMLN, *Lloyd's Maritime Law Newsletter*, 18 February 1999.

<sup>24</sup> *London Arbitration 6/10*, (2010) 794 LMLN 3, *Lloyd's Maritime Law Newsletter*, 30 April 2010.

<sup>25</sup> *London Arbitration 5/18*, (2018) 996 LMLN 3, *Lloyd's Maritime Law Newsletter*, 2 February 2018.

<sup>26</sup> *London Arbitration 7/15*, (2015) 925 LMLN 4, *Lloyd's Maritime Law Newsletter*, 15 May 2015.

<sup>27</sup> *London Arbitration 20/19*, (2019) 1038 LMLN 5, *Lloyd's Maritime Law Newsletter*, 12 September 2019.

<sup>28</sup> *London Arbitration 5/21*, (2021) 1075 LMLN 4, *Lloyd's Maritime Law Newsletter*, 12 February 2021.

<sup>29</sup> *London Arbitration 1/06*, (2006) 682 LMLN 3, *Lloyd's Maritime Law Newsletter*, 11 January 2006.

<sup>30</sup> P Krikris, "Redelivery bunker quantities remain a topic of heated debate", *Maritime Risk International*, October 2021, page 14.

<sup>31</sup> (1999) 503 LMLN, *Lloyd's Maritime Law Newsletter*, 18 February 1999.

<sup>32</sup> *Ejplioa Shipping Corporation Ltd v Canadian Transport Co Ltd (The Pantanassa)* [1958] 2 Lloyd's Rep 449, page 454 col 2.

vessel was using its engines or not, of 24.12 tons a day, a log as to which Mr Roche, if he made no concession, at any rate referred to as 'cooked', and it obviously was, with the result that I do not think any calculations based upon it really assist me in knowing what the error was ...”

Turning to *London Arbitration 1/99*,<sup>33</sup> one of the issues before the tribunal was whether the joint survey findings were conclusive. Clause 61 stated: “On-hire and off-hire survey of bunkers to be ascertained according to Master’s statement in conjunction with charterers nominated surveyors”.

The surveyors conducted a joint survey and found 368.625 mt of fuel oil and 58.057 mt of marine diesel oil (MDO) on board. The latter figure was later revised to 59.6 mt to reflect consumption during manoeuvring while entering the port.

Approximately 14 days later, upon sailing from the port, the master reported quantities on board of 377.8 mt of fuel oil and 27.5 mts of MDO. The owners sought to explain the discrepancy by referring to the conditions at the time of the survey, namely that the vessel was at anchorage during the inspection. At that time, the vessel was lighter and therefore subject to greater rolling than when fully laden.

The charterers argued that the joint survey was binding and that the original figures had been accepted without qualification.

The tribunal considered the consumption figures based on delivery and redelivery surveys and that the vessel burned only 89 mt during the time charter service of 26.35 days. Applying the charterparty speed 13 knots for the distance 1,350 nm, the vessel would have taken 4.33 days in good weather for that voyage, at a consumption of about 24 mt daily. On that basis, the vessel would be expected to consume around 104 mt fuel oil but she burned only 20.5 mt daily. The tribunal noted that “it would have been surprised if, when laden, the vessel burned around 3.5 mt less per day than as per her description, which would have been the case if reliance was to be placed on the survey reports”.

Furthermore, the tribunal found the owners’ explanation for the discrepancy to be credible and agreed to vary the delivery surveyors’ findings.

A similar decision was reached in another arbitration<sup>34</sup> under SMA Rules. The charterparty provided for a joint off-hire survey by a sole surveyor, and the master and chief engineer represented the owners. In assessing the quantity of fuel oil on board at redelivery, the panel considered the fuel consumption reported during the voyage together with the consumption figures stated in the charterparty. Taking into account the vessel’s speed, the distances sailed during each leg of the charterparty and the consumption figures reported by the master, the arbitrators rejected the suggestion that the vessel consumed 21.6 tons of fuel oil per day, which would be the calculation to fit in with the delivery and redelivery certificates and the bunkers supplied.

The panel considered it illogical for an owner to describe the vessel in the charterparty as capable of maintaining 13 knots on a consumption of 27 tons of fuel oil per day if, in reality, the vessel could achieve the same speed on only 21.6 tons per day. Accordingly, the arbitrators concluded that the quantity of fuel oil stated in the redelivery certificate was incorrect.

Some panels have rejected the master’s reported figures in favour of the surveyors’ calculations, while others have adjusted the owners’ calculated figures:

- (1) The amount of bunkers on board the vessel as determined by an independent surveyor during the on-hire survey was applied, not amounts determined by the master while the vessel was underway.<sup>35</sup>
- (2) Delivery bunkers were properly measured by a joint on-hire survey at the loadport, rather than by the master’s estimate at the point of delivery under the charter.<sup>36</sup>
- (3) There was no discrepancy as to the amount of bunkers on board at the time of delivery and according to the ship’s records the consumption in steaming was in accordance with the terms of the charterparty. The vessel, however, did use an abnormal amount of bunkers in port which made up the difference between the bunkers consumed in steaming and the bunkers on board on redelivery. After carefully considering port logs, vessels logs, engineers reports etc, including the fact that the vessel used bunkers in order to operate the evaporator for drinking water, boiler water etc, it was the unanimous opinion of the panel of arbitrators that the total bunker consumption charged by the vessel against the charterer be reduced by 50 tons.<sup>37</sup>

<sup>33</sup> (1999) 503 LMLN, *Lloyd’s Maritime Law Newsletter*, 18 February 1999.

<sup>34</sup> SMA 3774.

<sup>35</sup> SMA 2991.

<sup>36</sup> SMA 1900.

<sup>37</sup> SMA 629.

(4) Given that the off-hire survey, including bunker quantity survey, was taken prior to the actual re-delivery of the vessel, one had to calculate (based on charterparty consumption warranties), what quantity of MDO would reasonably be consumed during the voyage. Both parties advanced convoluted, esoteric calculations in support of their respective positions. The arbitrator preferred the charterer's scenario.<sup>38</sup>

(5) Where the time charter specified that delivery bunkers would be "determined by the master-declared figures per abstract logs", the owner was bound by the master's lower figures, even if it was subsequently proven that the figures were wrong. The panel noted that the obligation was mutual and that charterer would be bound by the master's statement, even if incorrect.<sup>39</sup>

(6) Where the charter provides that an independent surveyor would be engaged to determine the amount of bunkers on board the vessel at delivery, the surveyor's figures would be binding upon the parties unless a protest was made.<sup>40</sup>

(7) The owners and the charterers disputed the quantity of bunkers on board based on different estimates by the vessel's chief engineer and the charterer's surveyor. The panel held that the charterer's refusal to accept the chief engineer's offer to apply additional heat to bunkers and to resound tanks was not reasonable.

Therefore, the chief engineer's estimate was held to be more reliable.<sup>41</sup>

(8) Where surveys were inadequate the amount consumed while the vessel was out of charterer's service was estimated on the basis of the vessel's warranted speed and consumption characteristics.<sup>42</sup>

It should also be noted that modern technology may reduce some of the challenges traditionally associated with calculating daily bunker consumption. Accordingly, while these earlier decisions continue to provide useful insight into the issues commonly arising in bunker disputes, future decisions may adopt different approaches in light of technological developments in measuring and reporting bunker consumption.

Moreover, bunker disputes are not confined to issues of quantity alone. Questions relating to bunker quality may also adversely affect the vessel's performance, lead to engine-related problems and, in some cases, give rise to off-hire disputes and costs for de-bunkering.

## Bunker quality issues

It says in *Carver on Charterparties* that "if the insufficiency or quality of the fuel provided causes delay, the charterer is not entitled to put the vessel off hire and the owner would

<sup>38</sup> SMA 3908.

<sup>39</sup> SMA 3685.

<sup>40</sup> SMA 2992.

<sup>41</sup> SMA 3817.

<sup>42</sup> SMA 2164.

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equally be protected against a speed and consumption claim if the underperformance was caused by the poor quality of the bunkers supplied by the charterer”.<sup>43</sup>

Elsewhere it has been found that increased consumption may result from low-quality fuel.<sup>44</sup> On such occasions “it seems clear enough that the shipowner must demonstrate that the quality as well as the quantity of fuel was satisfactory”.<sup>45</sup>

In this context, it is often found in charterparties that the performance warranty clause contains provisions addressing the quality of bunkers. Additional terms may provide that owners can bring a claim against charterers for damage to engines caused by fuels that do not comply with the agreed specifications or that prove unsuitable for burning in the vessel’s engines. With the inclusion of these terms owners will not be held responsible for any reduction in the vessel’s performance or any increase in bunker consumption resulting from the use of such fuels. Still there are complex factual issues to be addressed in every case, and causation can be difficult to establish.

Moreover, additional provisions addressing notification requirements and time limits can cause a bunker quality claim to become time-barred if not raised within the contractual period, complicating further the issue of off-spec bunkers.

More generally, it seems that “fuel quality remains an extremely prominent and complex topic”.<sup>46</sup> Fuel will usually be analysed to “ensure the product supplied meets the required specification. The measurement of fuel characteristics is not an exact science and there are factors which influence a particular test result”.<sup>47</sup>

In practice, fuel quality claims also require resolution of back-to-back disputes (if the position permits) with the bunker traders. In one case it was noted that the buyer had failed to follow the sampling procedures required under the charterparty, thereby undermining its claim against the seller for alleged engine damage.<sup>48</sup>

At the same time, bunker quality issues are closely connected with operational difficulties. Where initial testing indicates that a fuel is off specification, laboratories frequently provide operational guidance regarding its use. In some cases, engine manufacturers may recommend that certain fuel should not be burned at all because of the risk of damage to the main engine, fuel oil system or cylinder combustion components.

For instance, in a service letter<sup>49</sup> from engine manufacturers, it was noted that: “It is always important to read and act on the fuel suppliers’ recommendations, manuals and best practice sheets to ensure safe and efficient use of the fuels”. Further: “It is important to ensure that the fuel characteristics and the ship’s technical capabilities match each other, for example, the fuel system and engine”.

Moreover, inadequate record keeping relating to a vessel’s fuel consumption and bunker inventories may significantly affect the owners’ position in a dispute. In one arbitration, the panel<sup>50</sup> criticised the vessel’s record keeping:

“It has been said that numerical precision is the very soul of science. I wish that the officers of the NORILSK had heard of this adage, as it might have greatly reduced the claims or even eliminated them. The record keeping with respect to vessel’s fuel consumption and bunker inventories is appallingly poor; however, since errors are not limited to the bunker records but are also carried over into ETA messages, I do not consider them to be intentional but rather the result of sloppy housekeeping.”

<sup>43</sup> *Carver on Charterparties*, para 7-061.

<sup>44</sup> *E B Aaby’s Rederi A/S v Union of India (The Evje) (No 2)* [1976] 2 Lloyd’s Rep 714, page 718; affirmed [1978] 1 Lloyd’s Rep 351.

<sup>45</sup> R Cornah et al, *Lowndes & Rudolf: The Law of General Average and The York-Antwerp Rules* (15th Edition, Sweet & Maxwell, 2018) para 9.05.

<sup>46</sup> A Ghosh, UK P&I Club, “Fuel quality questions answered”, July 2020, *Maritime Risk International*, page 14.

<sup>47</sup> CIMAC Guideline, “The Interpretation of Marine Fuel Analysis Test Results”, 2016, page 3.

<sup>48</sup> SMA 4134.

<sup>49</sup> MAN Energy Solutions, service letter SL 2019-670/DOJA.

<sup>50</sup> SMA 3341.

## Engine damage and causation

Questions of engine damage and causation are particularly fact sensitive, and the outcome of such disputes will largely depend on the quality of the evidence presented. As noted in a published article cited in *The Arbitrator*<sup>51</sup> owners advancing bunker quality claims against the charterers must generally establish both that the fuel supplied was off specification, and that the fuel caused the alleged engine damage. In practice, the owners often face difficulties in proving this second element of causation.

Accordingly, owners will usually instruct surveyors and technical experts to investigate the circumstances leading to an incident, assess the nature and extent of the damage, and provide opinions on the likely cause of the failure.

These issues can be seen in an arbitration<sup>52</sup> where the owner contended that all delays and associated costs incurred during the performance of the charter could be traced directly to bad fuel and the charterer's breach of the bunker provision of the charter.

One of the threshold issues for determination was: "Was Bad Fuel Responsible For The Vessel's Engine Breakdowns?".

The owner contended that the ongoing serious problems and breakdowns that occurred in both main engines could be traced directly to the intermediate fuel that the charterer purchased for the vessel. Primarily, the owner alleged that the IFO 80 fuel failed to meet critical charterparty specifications, notably for density and viscosity, which caused it to combust unevenly and incompletely. This in turn led to misfiring, blow-by in the cylinders, excessive vibration and wear on critical engine parts such as pistons, cylinder liners and piston rings. The owner supported its contentions with respect to poor combustion with considerable expert testimony surrounding a formula known as the calculated carbon aromaticity index ("CCAI"). Although the charterer contended that the results showed the fuel was of good quality, the owner pointed out that each sample was deficient in four or five particulars of the charter specification. Therefore, the owner argued that the charterer must be responsible for all of the breakdown delays the vessel suffered, for which the charterer placed the vessel off hire.

The charterer contended that the fuel it supplied was of good quality, noting that the vessel performed well under a previous charter using fuel purchased from the same supplier with the same specification as the fuel supplied under the subject charter. The charterer maintained that the supplier found was the only company that could supply such fuel to the vessel in Miami. The charterer pointed out that the vessel's engineers never complained about the quality of the fuel until the voyage in question. The charterer argued that the reason the ship was beset by chronic engine problems was not because of the fuel, but because of poor or negligent maintenance practices by the crew. Moreover, the charterer argued that the charterparty did not contain any reference to the CCAI, nor was the CCAI a part of the bunker specification.

The panel noted that there was clearly a pattern of engine problems with the vessel from the very beginning of the charter. The engineers were stymied by the rapid rate of failure of cylinder liners, pistons and piston rings, among other things, and believed the problem was due to the wrong type of liners and piston rings sent to the ship by the owner. A surveyor representing the hull underwriter who attended the vessel attributed part of the problem to crew negligence. However, there was also no doubt that the analysed samples of fuel that the charterer purchased did not meet all of the charterparty fuel specifications.

Further confusing matters, a survey report issued by a claims bureau did not criticise the fuel. To the contrary it stated that, according to the chief engineer, earlier fuel samples were found to be compliant. A representative from the owner's technical department also participated in that survey. He believed that a new type of recommended piston ring was to blame for the problems and that the damage to a piston on the port engine was due to a stuck valve. Moreover, while he and the surveyor both agreed that fuel samples should be analysed, his report also suggested that the crew pay particular attention to the performance of the fuel and lubricating oil centrifuges, and to maintaining the proper fuel and lubricating oil temperatures.

Therefore, the panel had found no clear pattern from the evidence and testimony presented that would support the owner's broad contention that bad fuel was the root cause of all the vessel's engine problems.

<sup>51</sup> *The Arbitrator*, published by the Society of Maritime Arbitrators, Volume 50, Number 1, January 2020, at page 4, giving credit to Paul Collier, Senior Associate, Clyde & Co, London.

<sup>52</sup> SMA 3740.



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## Will “off spec” bunkers cause underperformance?

The answer will depend on the particular facts and evidence of each case. The following observations are drawn from a number of published arbitration awards.

In general, owners bear the burden of proving that a vessel's performance is affected by the supply of unsuitable bunkers. Conversely, if the bunkers supplied contribute to speed deficiency, the owner is not responsible for the loss.<sup>53</sup>

For example, one panel held that there was absolutely no evidence to support any contention that deficient bunkers may have been the cause of the vessel's speed deficiency.<sup>54</sup>

Another panel<sup>55</sup> held that for the owner to succeed in its claim it bore the burden of demonstrating by the weight of the credible evidence that the bunkers were defective and that these bunkers were the proximate cause of the engine damage. Also the owner had to show that it did not wrongly contribute to events which caused or increased the damage.

Moreover, as another panel held, factors such as heavy weather as recorded in ship's logs, cleaning operations and charterer's supply of bunkers with lower API than that contracted for, all of which caused reduction of speed and lost efficiency, did not amount to a breach of ship's speed warranty.<sup>56</sup>

A further panel held that the owners bore the burden of demonstrating, by a preponderance of credible evidence, that the bunkers supplied by the time charterer were defective and that those bunkers were the proximate cause of the engine damage. As stated at the outset, it was the owner's burden to establish that the bunkers were faulty, and that the use of those bunkers caused the engine damage. The owner had not come anywhere close to satisfying that burden. The engine logs also noted repeated scavenge fires and scavenge alarms on at least four occasions, before the vessel began consuming the bunkers. Clearly this was an arbitration which should never have been pursued, and therefore, the panel dismissed the owner's claims.<sup>57</sup>

Similarly, in in another dispute,<sup>58</sup> the panel held that the owner could not defeat the time charterer's performance claim by arguing that inferior quality bunkers had been delivered to the vessel while operating under a prior charter; if a bunker quality problem caused the vessel's alleged underperformance/overconsumption, that was an issue for the owner to raise with the vessel's prior charterers.

Another panel<sup>59</sup> also found that that since the logbook review indicated that the insufficient engine performance existed throughout the review period, they presumed that the inherent problems the chief engineer referred to could include the deplorable dirty state of the engine room with numerous leaks, dirty filters, absent fuel treatment, defective injectors, an improper valve management program without the necessary proper tools in working order, and improper use of fuel separators. The fuel supplied was within the contracted specifications and thus did not breach the charter nor cause the engine room problems and performance difficulties.

## London arbitrations

There are few reported London arbitration cases dealing with off-spec bunkers and underperformance. In *London Arbitration 6/21*,<sup>60</sup> the vessel performed a time charter trip from Brazil to Egypt. During her voyage, there was an engine breakdown and the vessel deviated to a Senegal port for repairs. The tribunal concluded that the engine breakdown was caused by a negligent failure to adjust the cylinder oil feed rate, resulting in over-lubrication. The vessel then proceeded to the discharge port and was redelivered to the owners. Among other issues, the charterers made a claim for underperformance based on a report issued by a specialist vessel performance consultant. They also claimed for replacement bunkers at the discharge port.

Dealing with the performance dispute, the charterers calculated 50.84 hours' time loss, 64.01 mt IFO overconsumption and 0.7 mt MDO overconsumption. The owners' case was that the fuel supplied by the charterers did not meet the agreed specifications, which made it impossible for the vessel to perform within the agreed

<sup>53</sup> SMA 1074.

<sup>54</sup> SMA 1570.

<sup>55</sup> SMA 3528.

<sup>56</sup> SMA 1074.

<sup>57</sup> SMA 3528.

<sup>58</sup> SMA 3341.

<sup>59</sup> SMA 3606.

<sup>60</sup> (2021) 1076 LMLN 4, *Lloyd's Maritime Law Newsletter*, 25 February 2021.

charterparty terms. In the tribunal's view the difference in specification was not significant or relevant, and could not have been the reason for poor performance.

As discussed in a previous part of this series:<sup>61</sup>

“Therefore, the ‘small’ variations cannot justify an appreciable speed reduction or increased fuel consumption. In a claim for general average contribution by owners resulting from the towage of the ship as it ran out of bunkers on its voyage, the owners asserted (to justify the fact that she ran out of bunkers) that the vessel was overloaded at the beginning of the voyage, and consumed more bunkers as a result. In *E B Aaby's Rederei AS v The Union of India (The Evje) (No 2)* [1976] 2 Lloyd's Rep 714, Donaldson J said:

‘It is a fact that the vessel was *marginally* overloaded both when leaving Portland and, applying winter marks, when she entered the winter load line zone at about 143 deg West. In fact, this did not make the vessel any the less suited to the carriage of the cargo, but I feel constrained to hold that in law it rendered her unseaworthy. It was, of course, a patent defect. However, the degree of overloading was *so small that it cannot have appreciably reduced the vessel's speed or increased her fuel consumption.*’ (Author's emphasis.)

This reasoning aligns with the approach adopted by the tribunal in *London Arbitration 6/21*, which held that the variation in fuel specification was neither significant nor relevant and, therefore, could not have accounted for the vessel's underperformance. The tribunal also ignored the trivial currents.”

## Quantification methodologies

Further to the observations made in a previous part of this series<sup>62</sup> concerning alternative methods for analysing performance, the discussion below demonstrates that a variety of methodologies have been used to quantify time loss and bunker overconsumption during a voyage. These concepts are not recent developments. Different approaches existed prior to *The Didymi*<sup>63</sup> and have continued to feature in both industry practice and arbitration awards where tribunals have been required to consider and assess such methodologies as part of the evidence in determining the issues before them.

For example, in *London Arbitration 12/14*,<sup>64</sup> the tribunal had to assess competing methodologies applied by two different weather routing companies. Their results markedly differ. Likewise, in a presentation delivered in London in 2014, dealing with excess bunker consumption, it was stated that:

“the simple method is to work out how much time was lost on the voyage and multiply this by the permitted daily bunker consumption to ascertain the wasted bunkers. There are more sophisticated ways of assessing the performance of an engine against the known weather in loaded condition, but a great deal of technical information would be needed before the exercise could be undertaken, without incorporating large assumptions.”<sup>65</sup>

More recently, in *London Arbitration 1/26*,<sup>66</sup> the tribunal accepted an alternative methodology based on established principles of naval architecture and marine engineering, as well as common sense.

These approaches inevitably involve a degree of assumption. As a result, lawyers and other legal professionals have frequently argued either that a particular methodology should be rejected altogether or that the approach adopted is overly simplified. This proposition, however, requires consideration of the scientific principles underlying naval architecture,

<sup>61</sup> P Krikris, “Reflections on speed and performance claims (Part III): Establishing liability”, 22 July 2025.

<sup>62</sup> P Krikris, “Reflections on speed and performance claims (Part IV): Hull fouling in practice”, 7 October 2025, at pages 18 to 24.

<sup>63</sup> *Didymi Corporation v Atlantic Lines and Navigation Co Inc (The Didymi)* [1987] 2 Lloyd's Rep 166.

<sup>64</sup> (2014) 900 LMLN 3, *Lloyd's Maritime Law Newsletter*, 30 May 2014.

<sup>65</sup> London Shipping Law Centre, “Speed and Consumption issues”, 2014, at page 11.

<sup>66</sup> (2026) 1202 LMLN 2, *Lloyd's Maritime Law Newsletter*, 9 January 2026.

including the role of physics and mathematics in assessing vessel performance, and the standard burden of proof.

This degree of assumption includes the approach adopted in *The Didymi*,<sup>67</sup> which appears to have been grounded largely in common sense and a relatively simplified methodology, yet has nevertheless stood the test of time. Naval architecture itself has long been described as a “mixture of art and science”, developed through the continued application of scientific and engineering principles. Physics and mathematics remain central to that process, and even established scientific laws are founded upon accepted assumptions.

Indeed, even the most established scientific principles incorporate a degree of assumption. Newton's laws of motion and gravity, for example, remain fundamental to modern science notwithstanding the assumptions underlying their application. They continue to be widely accepted, as rejecting them outright would risk undermining centuries of scientific study and academic recognition.

The objective, therefore, when alternative methods are to be applied in specific circumstances, is not to eliminate assumptions entirely, but rather to apply common sense while avoiding excessive speculation. This approach can be seen in *London Arbitration 4/26*,<sup>68</sup> where the tribunal rejected an alternative methodology not because it lacked perfection, but because of significant deficiencies in its application.

Turning back to the presentation delivered in London in 2014, the late Captain Paines discussed two different methodologies after first referring to the English law cases

*The Didymi*<sup>69</sup> and *The Gas Enterprise*,<sup>70</sup> which continue to be relied upon by many weather-routing companies, albeit with differing applications. Captain Paines observed that “there are a number of ways in which a vessel's ‘Good Weather’ consumption can be assessed” and that, to his knowledge, no legal precedent prescribed a single method for carrying out the calculation. As a result, different accepted approaches continue to exist in practice.

In his experience, the most widely accepted methods were the “Ratio Method” and the “Good Weather All the Way” method. Captain Paines illustrated the different approaches by way of example. The vessel's good weather consumption was calculated at 653.52 mt, whereas the logs showed actual consumption of 670.50 mt, resulting in an overconsumption of 2.59 per cent during the good weather period.

Following the approach commonly associated with *The Didymi*, this percentage variation is then applied across the voyage. Applying the warranted speed of 12.5 knots over a voyage distance of 11,464.2 nm produced an overall warranted consumption of 1,188.77 mt. Applying the 2.59 per cent variation resulted in a calculated overconsumption of 30.79 mt.

By contrast, the “Good Weather All the Way” method produced a materially different result. Applying the relevant formula to the same voyage data resulted in an overconsumption figure of 83.68 mt. Similarly, under the alternative approach referred to earlier – namely calculating the time lost during the voyage and multiplying it by the permitted daily bunker consumption – the overconsumption figure would be 51.45 mt.

<sup>67</sup> *Didymi Corporation v Atlantic Lines and Navigation Co Inc (The Didymi)* [1987] 2 Lloyd's Rep 166.

<sup>68</sup> (2026) 1205 LMLN 2, *Lloyd's Maritime Law Newsletter*, 13 February 2026.

<sup>69</sup> *Didymi Corporation v Atlantic Lines and Navigation Co Inc (The Didymi)* [1987] 2 Lloyd's Rep 166.

<sup>70</sup> *Exmar NV v BP Shipping Ltd (The Gas Enterprise)* [1993] 2 Lloyd's Rep 352.

The existence of these differing approaches long predates *The Didymi*. Prior to that decision the late Donald Davies, himself then an arbitrator, had observed that “regarding compensation for bunkers it may be worth examining some London arbitrations on this important question”, particularly because the high cost of bunkers could lead to materially different results depending on the methodology adopted.<sup>71</sup>

Mr Davies referred to an earlier arbitration award in which the tribunal recognised that there were different ways to calculate bunker overconsumption. One method involved applying the actual excess consumption to the period of lost time in order to assess the charterers’ true loss. Another approach involved comparing the vessel’s actual consumption with the theoretical consumption that would have occurred had the vessel performed at the warranted speed and consumption throughout the voyage.

The tribunal, however, recognised that this latter approach would only be appropriate if the additional fuel required to achieve the warranted speed would not itself place the vessel in breach of the bunker warranty. As the arbitrator was unable, on the evidence, to determine the extent to which the bunker warranty would have been exceeded in order to reach the described speed, the tribunal adopted the former method of calculation.

This again appears consistent with the observations made during the presentation in 2014 that another possible approach is to calculate the time lost and apply the average daily bunker consumption to that period. This seems to be what the arbitrator did for the LSDO overconsumption in *London Arbitration 15/23*.<sup>72</sup>

In an article for *P&I International*, Stephen Kirkpatrick, then of Richards Butler,<sup>73</sup> recognised from its experience that different methodologies exist, saying that in an arbitration case some interesting points arose with divergent views between consultants from London and Rotterdam in the approach of assessing performance. There, one method produced larger estimates of the time lost and the bunkers consumed.

Suppose, for example, that the distance is 900 miles under a charterparty warranted speed of 10 knots, and the weather factor due to adverse weather is 1 knot. The

first method finds:  $900 / 5 \text{ knots} - 900 / 9 \text{ knots} = 80 \text{ hours' time loss}$ . The second method finds:  $900 / 6 \text{ knots} - 900 / 10 \text{ knots} = 60 \text{ hours' time loss}$ .

On the facts of that case, it was considered that the overall speed of 5 knots should be adjusted by the weather factor, thereby producing the more appropriate result.

Earlier editions of the textbook *Maritime Law*<sup>74</sup> also referred to two different methods, with the author stating: “How should speed and consumption claims be calculated? There are two alternative methods used by arbitrators in London”. The author then referred to *The Didymi*<sup>75</sup> before discussing two alternative approaches.

Under method (a), the time taken to perform the voyage based on good weather speed is compared with the time taken under the minimum warranted speed, producing a time loss of 34.248 hours. The calculation then compares the total consumption if good weather had prevailed with the maximum consumption permitted under the charterparty, including the “abouts” allowance, resulting in an excess consumption figure of 11.969 mt.

Method (b) by contrast, adopts an “all weather” approach by applying weather and current corrections to the vessel’s overall speed. It compares the actual time en route with the time the vessel would have taken based on the weather- and current-corrected speed, producing a time loss of 39.6 hours. In terms of consumption, it compares the bunkers that would have been consumed under the corrected speed with the actual reported consumption, assuming the reported figures represent the departure and arrival bunkers remaining on board (ROB).

Although these calculations do not relate to the same voyage, they nevertheless appear broadly consistent with the observations previously made by Mr Davies.

Ultimately, while different methods may be used to assess time loss and bunker overconsumption, the choice between them remains a matter for the tribunal or decision maker on the evidence of the particular case.

<sup>71</sup> Donald Davies, “Assessment of Damages for Inadequate Vessel Performance under Time Charters”, 14 J MAR L & COM 595 (1983).

<sup>72</sup> (2023) 1145 LMLN 2, *Lloyd’s Maritime Law Newsletter*, 27 October 2023.

<sup>73</sup> Stephen Kirkpatrick, Richards Butler, “Speed, bonny boat”, *P&I International* (now *Maritime Risk International*), August 2000.

<sup>74</sup> C Hill, *Maritime Law* (LLP, 1998), pages 183 to 185.

<sup>75</sup> *Didymi Corporation v Atlantic Lines and Navigation Co Inc (The Didymi)* [1987] 2 Lloyd’s Rep 166.

## Weather routing reports

While reference is often made to a single “good weather method”, in practice a number of different methodologies are applied both in arbitration proceedings and by weather routing companies.

Where the parties rely on weather-routing reports or specialist reports in support of, or defence of, a performance claim, the tribunal will assess such evidence and give it the weight considered appropriate in the circumstances. The tribunal is not required to accept the conclusions or methodology of a weather routing report as a de facto standard.

Moreover, after rejecting the weather routing reports, some reported arbitration awards suggest that tribunals have undertaken their own recalculation of the alleged loss. For example, in *London Arbitration 23/21*<sup>76</sup> and *London Arbitration 15/23*,<sup>77</sup> the tribunal carried out its own analysis of consumable bunkers and departed from the conclusions advanced by the weather-routing company. This appears consistent with the approach adopted in several SMA arbitrations. Perhaps the difference lies in the scope under section 30 of SMA Rules, which states: “The Panel shall grant any remedy or relief which it deems just and equitable”.

In addition, weather routing reports can also be incomplete. In practice, third-party experts or specialists dealing with speed and performance disputes are also likely to request additional technical information rather than rely solely on weather-routing reports. Such reports are often incomplete by their nature, particularly in relation to important engine parameters, and further technical data may therefore be required for a proper assessment.

Lastly, where a tribunal considers bunker survey findings relevant to the dispute, greater weight may be given to analyses that take those findings into account when assessing competing evaluations. Conversely, where the bunker survey results themselves are disputed, their evidential value will depend on the resolution of those underlying factual issues, adding a further layer of complexity to the dispute.

## Weather added resistance

A moving vessel experiences resisting forces that must be overcome by a thrust. Literature on basic ship theory suggests that “as the wave system becomes more severe, the power needed to drive the ship through it at a given speed increases”.<sup>78</sup> The change can be attributable to increased resistance caused by the hull and appendages, while changes in propulsive efficiency play a role. Accordingly, a detailed analysis of the engine parameters could provide further insight into these factors, particularly in circumstances where a typical weather routing report lacks sufficient detail or clarity to determine the underlying cause, especially when such analysis is considered alongside the prevailing weather parameters, including currents.

Furthermore, when the weather is heavy, causing violent motions of the vessel, the captain may decide to reduce speed. This is called “a voluntary speed reduction” and it “might be expected to be made in merchant ships [... because] the speed reduction lessens as the predominant wave direction changes from directly ahead to the beam”.<sup>79</sup> The authors of *Basic Ship Theory*<sup>80</sup> note that under Beaufort Force 5 there will be a trivial speed reduction from quartering and following winds.

Similarly: “rough water, most powerful and erratic of all the factors that oppose the propulsive force, is the most difficult to analyse. The action of rough water cannot be predicted in a deterministic way”.<sup>81</sup> The author of *Introduction to Naval Architecture*<sup>82</sup> further notes that:

“the manner in which the ship’s resistance is increased in rough water and, for the moment, to avoid the complexities of controlling her motion. Actually, sea waves have two effects in increasing resistance. The first is a function simply of their size and the force of moving water that acts against the ship’s forward motion. The second effect is the motion they induce in the ship, either pitching, rolling, or heaving, that adds to the wetted area as well as the localized increased water volume to be displaced. In the design process, both of these effects are considered in the light of consequent functional limitations.”

<sup>78</sup> K J Rawson and E C Tupper, *Basic Ship Theory* (5th Edition, Volume 2, Butterworth-Heinemann, 2001), pages 495 to 496.

<sup>79</sup> *Ibid.*

<sup>80</sup> *Ibid.*

<sup>81</sup> T Gillmer and B Johnson, *Introduction to Naval Architecture* (E & F N Spon Ltd, 1982), pages 218 to 219.

<sup>82</sup> *Ibid.*

<sup>76</sup> (2021) 1094 LMLN 1, *Lloyd’s Maritime Law Newsletter*, 5 November 2021.

<sup>77</sup> (2023) 1145 LMLN 2, *Lloyd’s Maritime Law Newsletter*, 27 October 2023.

Consistent with these observations, a panel<sup>83</sup> noted that “Even ‘moderate’ head winds can impede a vessel’s progress”, and another panel<sup>84</sup> said that “This voyage was predominantly one of bad weather of Beaufort Force 5 to 8 with head or beam winds hampering the vessel’s speed”.<sup>85</sup>

However, another panel noted that:

“The generally accepted criteria for a moderate weather day is one in which the conditions do not exceed Beaufort Force 4. FFM [the charterer] asserts the shipowner cannot arbitrarily exclude all the wind conditions of Beaufort Force 5 from the moderate weather category without taking into account wind direction and other pertinent considerations. There is some logic to FFM’s argument, but the crux of the matter is that the speed warranty has been traditionally measured by Beaufort Wind Force numbers without regard to wind direction, sea swell, hull form, deck cargo, etc. Our decision here reflects the generally accepted standard even though Clause 6 does not expressly enumerate a criteria.”

In *London Arbitration 12/14*<sup>86</sup> the tribunal noted that “the general direction of the swell was either on, or forward of, the vessel’s port beam, that was to say, a negative influence on her passage through the water”. Likely, the tribunal reached this conclusion on the assumption that where a vessel encounters beam seas and the wave encounter period approaches the vessel’s natural rolling frequency, significant rolling and associated performance difficulties may arise. In such cases “it may be necessary to change the ship’s heading and alter the period of encounter of the waves”<sup>87</sup> but the summary is insufficient to explain the analysis on this point further.<sup>88</sup>

Thus, the vicissitudes of wind, current and helmsman may help the vessel or hurt her. Based on the above observations, whether, and to what extent, the prevailing weather conditions have affected the vessel’s performance is a matter of degree.

<sup>83</sup> SMA 1262.

<sup>84</sup> SMA 2592.

<sup>85</sup> SMA 2991.

<sup>86</sup> (2014) 900 LMLN 3, *Lloyd’s Maritime Law Newsletter*, 30 May 2014.

<sup>87</sup> P A Russell and E A Stokoe, *Ship Construction for Marine Engineers* (Reeds, 7th Edition), page 276.

<sup>88</sup> Perhaps this point, together with the effect, if any, of the length of the swell on the vessel’s performance, will be analysed further in another part of the series.

## Fouling

The concept of slow steaming as a means of conserving fuel in periods of elevated bunker prices is well established and has been the subject of reported arbitration decisions. Slow steaming commonly arises during periods of financial crisis, when charter hire rates decline substantially while bunker prices increase, rendering higher fuel consumption economically unsustainable. The adoption of slow steaming, however, may give rise to legal consequences.

This is further illustrated by the following panel decision:

“Where owners prudently ordered vessel to proceed to discharge port at half speed to conserve fuel, causing 15-day delay, but where owners failed in their charter obligation to fully bunker vessel at loading port, charterers were awarded 4 1/2 day reduction in charter hire, plus price differential between loading port price of fuel for the 680.9 tons which owners failed to bunker, and average cost of same incurred during voyage when vessel finally did get bunker replenishment.”<sup>89</sup>

The effects of hull fouling on vessel performance were examined in the previous part of this series.<sup>90</sup> Additional observations identified in the relevant literature include the following (without being exhaustive):

(1) Fouling can cause both economic and environmental issues, also giving rise to other disputes related to emissions (see for instance *London Arbitration 4/26*<sup>91</sup>).

(2) Fouling can result in increased fuel consumption: “hard-shelled fouling can cause a considerable rise in ship frictional resistance, and hence a ship’s fuel consumption. Hard-shelled barnacles can also deteriorate the paint and cause other problems such as corrosion. It should be noted that the impact of fouling on ship performance is greatly dependent on the type and coverage of fouling”.<sup>92</sup>

(3) In addition to generalised hull fouling, a ship has a number of specific locations where fouling can be particularly harmful. Fouling on the propeller can

<sup>89</sup> SMA 1223.

<sup>90</sup> P Krikris, “Reflections on speed and performance claims (Part IV): Hull fouling in practice”, 7 October 2025.

<sup>91</sup> (2026) 1205 LMLN 2, *Lloyd’s Maritime Law Newsletter*, 13 February 2026.

<sup>92</sup> Y K Demirel et al, “Predicting the effect of biofouling on ship resistance using CFD”, *Applied Ocean Research* 62 (2017), pages 100 to 118.

account for as much as 50 per cent of the increased energy demand associated with a light to moderately fouled hull.<sup>93</sup>

Observed performance changes that lower a ship's ability to perform its mission or operate efficiently may be indications of the need for hull cleaning. When such deterioration occurs, conduct an underwater hull inspection to verify that fouling is the probable cause. Typical performance changes which may indicate a need for cleaning include the following:<sup>94</sup>

- (a) A reduction of one knot in speed with shaft revolutions per minute (r/min) set for standard speed.
- (b) An increase in excess of 5 per cent in fuel required to maintain a specified shaft r/min (such as for standard speed), with propulsion and auxiliary machinery at optimum efficiency.
- (c) An increase in shaft r/min in excess of 5 per cent to maintain a given speed.<sup>95</sup>

(4) There are other performance parameters that may indicate excessive fouling. For steam-propelled ships, an increase in main turbine first stage shell pressure needed to maintain a given shaft r/min can generally be attributed largely to hull or propeller fouling assuming a constant main condenser vacuum and main steam supply pressure and temperature. For ships equipped with main shaft torsion meters, an increase in torque at given shaft r/min may also indicate the need for cleaning. There are, however, other explanations for deterioration in any performance parameter and it is therefore imperative that an underwater hull inspection be conducted before initiating any cleaning.<sup>96</sup>

(5) Overcoming hull friction takes up a very high percentage of the energy generated by the ship's engines. Keeping a ship's hull clean of even a small degree of accumulated fouling (slime) and ensuring the coating is in good condition and smooth can save about 20 per cent in fuel consumed. Marine fouling has always been a liability for any ship owner or operator since man first took to the sea in ships. The build-up of microorganisms, beginning with light slime and continuing all the way through to heavy barnacles and other hard fouling, adds drag and weight to the

hull, which results in increases in fuel consumption which can be as much as 40 per cent according to the US Navy.<sup>97</sup>

(6) In a test example, the deteriorated coating and light slime affected the required shaft power up to 11 per cent and 21 per cent with heavy slime.<sup>98</sup>

(7) The resistance exerted by water on a ship will be considerably increased if the hull is badly fouled by marine growth. It is found that marine growth will adhere to the ship if the speed is less than about 4 knots. Once attached, however, the growth will continue and will be difficult to remove despite the speed. The type of fouling depends upon the nature of the plant and animal life in the water. It is essential to reduce fouling, since the increase in resistance in severe cases may be in the order of 30 per cent to 40 per cent. This is reflected in an increase in fuel consumption to maintain the same speed, or a reduction in speed for the same power.<sup>99</sup>

## Analysis of the impact of fouling

The examples below illustrate the application of different methodologies but are not intended to constitute an exhaustive analysis.

### Example 1

In *London Arbitration 23/21*<sup>100</sup> and *London Arbitration 15/23*<sup>101</sup> the tribunals recalculated the loss attributable to fouling without the benefit of expert evidence. It appears that both tribunals adopted a broadly similar methodology in assessing the loss caused by fouling. The below serves to analyse only *London Arbitration 15/23*.

The available data was as follows.

#### (a) *Charterers' WRC*<sup>102</sup> report

The voyage distance was 1,860 nm and the vessel completed in 171.5 hours, with average speed 10.85 knots and consumed 206.03 IFO at an average rate of

<sup>97</sup> Hydrex, *Journal of Ship Hull Performance*, volume 1, Issue 1, 2011.

<sup>98</sup> Schultz M (2007), "Effects of coating roughness and biofouling on ship resistance and powering", *Biofouling*, 23(5), pages 331 to 341.

<sup>99</sup> P A Russell and E A Stokoe, *Ship Construction for Marine Engineers* (Reeds, 7th Edition), page 302.

<sup>100</sup> (2021) 1094 LMLN 1, *Lloyd's Maritime Law Newsletter*, 5 November 2021.

<sup>101</sup> (2023) 1145 LMLN 2, *Lloyd's Maritime Law Newsletter*, 27 October 2023.

<sup>102</sup> Weather routing company.

<sup>93</sup> Naval Ships' Technical Manual (NSTM), Chapter 081, "Waterborne underwater hull cleaning of navy ships".

<sup>94</sup> NSTM, Chapter 081, Waterborne underwater hull cleaning of navy ships, 081-2.1.6.1.

<sup>95</sup> Ibid.

<sup>96</sup> Ibid.

28.83 mt and 0.75 mt DO at an average rate 0.10 mt daily. During good weather, the average speed was 11.38 knots, and by deducting 0.34 knots as good weather factor, the speed was 11.04 knots. By their calculations, the time loss was 25.4 hours.

The good weather consumption was 28.8 mt IFO and 0.10 mt DO, and there was calculated 21.24 mts IFO overconsumption and 0.04 mts MDO overconsumption.

*(b) Owners' WRC report*

The voyage distance was 1,860.7 miles with overall speed 10.85 knots. The current corrected speed (positive current) was 10.7 knots. The daily bunker consumption was 28.83 mt and 0.10 mt DO. There were no good weather conditions on the voyage. A day was removed from the assessment due to adverse currents during some intervals.

The arbitrator used the cube rule parameters to make a finding that “an increase in speed from 11.2 knots to 13 knots would result in a corresponding increase in fuel consumption of about 5 mt daily”.

The arbitrator also made a finding by considering the slip figures, noting that:

“Making an appropriate allowance for slip, the engine speed at 80.5 rpm would be 14.5 knots. With a relatively clean hull and propeller, the vessel could easily have achieved its warranted speed of about 13.5 knots at 84.3 rpm. Indeed, it was quite possible that the minimum warranted speed of 13

knots could have been achieved at 80.5 rpm if slip could have been reduced to around 5 to 8 per cent.”

The arbitrator then concluded:

“Having found that maximum performance speed achievable in benchmark conditions was 11.2 knots, over 1,864 miles, the voyage would have been prolonged by approximately 23 hours. At an engine setting of 80.5 rpm, the vessel had a ‘good weather’ daily consumption rate of 28.8 tonnes. At 11.2 knots, the vessel would therefore have consumed a total of 199.72 mt on the voyage. By reference to the charterparty allowance of 181.32, the vessel over consumed 18.4 mt of IFO. As the voyage was prolonged by approximately one day, the vessel would also have over consumed 0.1 mt DO.”

First, the arbitrator carried out an analysis of the slip in order to determine a speed of 11.2 knots. The approach followed was to exclude the effects of weather and currents, so that the remaining deficiency could be attributed to fouling. This methodology is rooted in principles of naval architecture relating to ship resistance and propulsion. It is not a new approach.

The same observation also applies to the percentage-based approach. For example, the arbitrator calculated the time loss at 23.04 hours. Applying the percentage-based approach to the same facts produces a time loss of approximately 23.5 hours, demonstrating that the results are, in practical terms, very close.

The advertisement features the i-law logo in the top left corner. The main title is "Maritime Risk International" in large, bold, white font. Below the title, it states "Authoritative coverage of the legal, technical and insurance issues facing the shipping industry — expert insight on the challenges that matter." At the bottom, it says "Discover the powerful clarity of i-law today". On the right side, there are two smaller images: the top one is a cover for "Maritime Risk International Technology" with the subtitle "Changing marine practice" and a sunset background; the bottom one is a cover for "Powering Shipping" with a ship's hull and propeller.

## Example 2

Another method applied in a case (which was ultimately settled) involved calculating frictional resistance through empirical models relating to fouling, although this approach requires a diver's report to be available.

In that case, a fouling assessment was carried out reflecting the percentage analysis of fouling in each area, together with the corresponding NSTM<sup>103</sup> rating.

When accurate fouling information is available, a frictional drag coefficient (or changes to this) can be calculated using the length of the vessel and the degree of roughness. The next step is then to separate the effect of the weather, either through slip analysis, by applying the weather factor from the WRC report, or by using empirical models to determine the weather factor.

For example, assume that the frictional drag coefficient is calculated at 30 per cent, which includes the power increase attributable both to fouling and weather. If a weather factor of 10 per cent is applied the calculation becomes:

$$1.3 / 1.1 = 18.1 \text{ per cent.}$$

Accordingly, if the total consumption was 400 mt, the additional consumption attributable to fouling would be calculated as follows:

$$400 \times 18.1 \text{ per cent} = 72.4 \text{ mt extra consumption attributed to fouling.}$$

## Example 3

During this voyage, the vessel's average speed was 9.5 knots, representing a reduction of approximately 2.5 knots. The WRC presented a performance report showing a time loss of approximately 80 hours and approximately 53 mt of VLSFO overconsumption. In addition, an underwater inspection conducted en route revealed heavy fouling, while the slip during good weather was reported to be close to 25 per cent, with the engine RPM and bunker consumption remaining constantly at the same level.

As explained above, the "effect" of the weather on the vessel's performance is a matter of degree. In this case, during good weather the performance speed was close to 9.5 knots, as compared to the minimum warranted speed of close to 12 knots. During other periods, the vessel encountered combined sea waves and swell waves, with

a significant wave height close to 3 metres; however, due to positive currents, the overall speed remained close to 10.3 knots. At the same time, there was some reduction in the slip, while bunker consumption and RPM remained more or less constant.

Accordingly, the "all weather" analysis showed less loss than the good weather analysis.

An alternative method was then applied by calculating the increase in frictional resistance and its effect on speed. In doing so, the resistance formula from naval architecture and fluid mechanics was applied in order to calculate frictional resistance:  $R_f = \frac{1}{2} \rho S C_f V^2$ , where:

$R_f$  = Frictional resistance

$\rho$  = Water density

$S$  = Wetted surface area

$C_f$  = Coefficient of friction as influenced by hull roughness

$V$  = Vessel speed

The coefficient of friction was calculated in accordance with the ITTC (International Towing Tank Conference) formula ( $C_f = 0.075 / (\log_{10} R_n - 2)^2$ ), while Reynold's number ( $R_n$ ), being a coefficient which is calculated using the vessel's speed, length, and the kinematic viscosity of water ( $R_n = LV / \nu$ ), giving  $C_f = 0.0016$ , which in turn showed  $R_f$  to be 234.61 N.

Thereafter, the increase in the coefficient of friction was calculated under an empirical relation, having regard to barnacle lengths of 3 mm and 5 mm. A barnacle length of 3 mm produced a 72 per cent increase in the resistance coefficient, while 5 mm produced a 101 per cent increase. Consequently, the approximate resistance increased to 205.24 N for 3 mm and 251.38 N for 5 mm.

The effect on speed was then calculated using a formula based on the resistance-speed-power relationship, which concluded that:

- Speed reduction under 3 mm = 10.06 knots.
- Speed reduction under 5 mm = 9.72 knots.

This calculated speed reduction is slightly above the "good weather speed" so it was quite optimistic.

While this appears to be a sophisticated approach involving several formulas derived from applied naval architecture, a much simpler alternative is the percentage-based approach. Applying that methodology to the facts of this case produced a calculated time loss of 78 hours and an IFO overconsumption of 59 mt.

<sup>103</sup> Naval Ships' Technical Manual.

## Alternative methodologies

*London Arbitration 23/21*<sup>104</sup> and *London Arbitration 15/23*<sup>105</sup> reflect an analysis based on slip, whereas *London Arbitration 1/26*<sup>106</sup> is silent as to the calculations applied; however, the expert ruled out weather as a contributing factor and concluded that the remaining deficiency was attributable to fouling. The expert found there was a 1-knot deficiency and applied the resulting loss to the voyage in question.

Similarly, in *London Arbitration 4/26*,<sup>107</sup> the arbitrator analysed the percentage-based approach and endorsed it as a reliable method. In *London Arbitration 12/14*,<sup>108</sup> when testing two competing methodologies, the arbitrator applied a percentage analysis and accepted the methodology that produced results similar to the arbitrator's own approach. Finally, in *London Arbitration 12/24*,<sup>109</sup> the arbitrator considered two different results derived respectively from a good weather method and an all-weather method.

It appears that where fouling was established as the cause of underperformance, some tribunals accepted adjustments for adverse currents, with the remaining deficiency being attributed to fouling where the other weather conditions remained favourable. Since the reduction in speed may be expressed in terms of added resistance, once the effects of current and weather are reasonably calculated and excluded, the remaining deficiency is attributed to fouling.

## Performance curves for fuel consumption and efficiency

In the textbook *Motor Engineering Knowledge for Marine Engineers*<sup>110</sup> the authors note:

“SFOC is the fuel consumption per unit of energy at the cylinder or output shaft. The current general practice is for the manufacturers to quote a consumption figure measured at the cylinder and expressed in g/kWh. The initial design considerations for main engines powering merchant ships will be for optimised thermal efficiency (and

<sup>104</sup> (2021) 1094 LMLN 1, *Lloyd's Maritime Law Newsletter*, 5 November 2021.

<sup>105</sup> (2023) 1145 LMLN 2, *Lloyd's Maritime Law Newsletter*, 27 October 2023.

<sup>106</sup> (2026) 1202 LMLN 2, *Lloyd's Maritime Law Newsletter*, 9 January 2026.

<sup>107</sup> (2026) 1205 LMLN 2, *Lloyd's Maritime Law Newsletter*, 13 February 2026.

<sup>108</sup> (2014) 900 LMLN 3, *Lloyd's Maritime Law Newsletter*, 30 May 2014.

<sup>109</sup> (2024) 1169 LMLN 2, *Lloyd's Maritime Law Newsletter*, 27 September 2024.

<sup>110</sup> P A Russell et al, *Motor Engineering Knowledge for Marine Engineers* (5th Edition, Reeds, 2018), pages 4 to 5.

minimum specific fuel consumption) to occur at the power conditions required to maintain the chosen service speed of the vessel ... The design of internal combustion (IC) engines driving electrical generators is arranged so that the peak thermal efficiency is at approximately 70% maximum load because this is the engine unit's average load during normal ship operation.”

There is a method of calculating changes in fuel consumption in a very similar way to the admiralty coefficient formula. The fuel coefficient =  $\Delta^2 / 3 V^3$  / Daily Fuel Consumption, where  $\Delta$  = displacement.<sup>111</sup>

In estimating the voyage requirements, the authors of the above textbook note that changes in the vessel's speed have the effect of increasing voyage time. This further explains why fouling or engine issues may cause “voyage prolongation”, which remains a key factor in determining time loss.

A further analysis of this follows in another textbook:<sup>112</sup>

$$\text{Voyage Fuel Consumption} = \text{Daily Fuel Consumption} \times \text{Voyage Distance} / 24 \times \text{Ship Speed.}$$

If the displacement and fuel coefficient remain constant between the different speeds of  $V_1$  and  $V_2$ , the formula giving the changes in the consumption is:  $\text{Cons}_1 / \text{Cons}_2 = (V_1 / V_2)^3$ , where  $\text{Cons}_1$  refers to the consumption applied under speed  $V_1$  and  $\text{Cons}_2$  refers to the consumption under speed  $V_2$ .

In giving an example, if the vessel consumes 20 mt fuel per day by sailing at a speed of 13 knots, what will the consumption be if the vessel is sailing at a speed of 11 knots?

$$\text{New consumption} = 20 \times (11/13)^3 = 12.11 \text{ mt.}$$

The total fuel consumption can be found by multiplying the daily consumption with the number of days to complete the voyage:

$$\text{Number of days} = \text{Distance} / \text{Speed} \text{ or } \text{Time} = D/V, \text{ which explains the formula: } V = \text{Distance}/\text{Time.}$$

$$\text{Daily consumption} = V^3.$$

$$\text{Total voyage consumption} = V^3 \times D/V.$$

$$\text{Voy Cons 1} / \text{Voy Cons 2} = (V_1/V_2)^2 \times (D_1/D_2).$$

<sup>111</sup> C Patterson and J Ridley, *Ship Stability, Powering and Resistance (Reeds Marine Engineering and Technology Series)* (2nd Edition), page 482.

<sup>112</sup> R Pemberton and E A Stoke, *Naval Architecture for Marine Engineers* (Reeds 2018), pages 150 to 152. This formula was also applied in C Patterson and J Ridley, *Ship Stability, Powering and Resistance (Reeds Marine Engineering and Technology Series)* (2nd Edition), page 482.

Thus, if the consumption for the voyage is 125 mt under speed 16 knots, what will the consumption be under a speed of 15 knots, while displacement remains constant?

New consumption =  $125 \times (15/16)^3 = 110$  mt, thus saving 15 mt fuel.

A general expression for voyage consumption is:  $\text{New voy cons/Old Voy Cons} = (\text{New Displacement/Old Displacement})^{2/3} \times (\text{New speed/old speed})^2 \times \text{New Dist/Old dist}$ .

As the authors of *Naval Architecture for Marine Engineers* say,<sup>113</sup> “the above calculations are based on the assumption that the speed lies between V1 and V2. If the speed is reduced to V3 however, the specific consumption may be increased by x per cent. In this case, the daily consumption and voyage consumption are also increased by x per cent”.

Therefore, assuming that during representative periods the vessel's speed is reduced by x per cent, the time taken to complete the voyage will likewise be prolonged by x per cent, given that  $V = \text{Distance/Time}$ .<sup>114</sup> The calculation of the bunkers allocated to this period will be determined either based on advancing a claim as off hire (extra bunkers consumed under clause 15) or as damages, and the quantification will depend on this.

## Applied methodologies in arbitration

Different methodologies have been tested before tribunals, whether through weather-routing reports or through expert evidence applying alternative analytical approaches. This is well documented both in literature and in numerous arbitration awards in London and New York.

For example in *London Arbitration 23/21*<sup>115</sup> and *London Arbitration 15/23*<sup>116</sup> the tribunal carried out its own analysis of consumable bunkers and departed from the conclusions advanced by the weather-routing company. In *London Arbitration 4/25*<sup>117</sup> the tribunal referred to

the cube law,<sup>118</sup> whereas in *London Arbitration 1/26*<sup>119</sup> the charterers advanced their case through expert evidence. Expert evidence was also adduced in *London Arbitration 7/15*,<sup>120</sup> *London Arbitration 6/21*<sup>121</sup> and *London Arbitration 2/24*<sup>122</sup>, which the tribunal had to evaluate in awarding losses.

A good illustration of the different methodologies can be found in *The Myrina*<sup>123</sup> where Austin Dooley, dissenting, explained the different views:

“As to fuel consumption, Charterer claims an over-consumption of 58.596 mt IFO and 3.266 mt DO, which Owner has denied. ASTRO ENERGY applies the same principle to fuel consumption as that for speed. Namely that overconsumption on good weather days would also apply to overconsumption on bad weather days.

The warranty was for about 33.0 long tons (lt) per day IFO and about 1.8 lt per day DO. Arbitration panels have applied a value from 3 per cent to 5 per cent for the word ‘about’ applied to fuel consumption (SMA Award 2592 FFM MATARENGI and ASTRO ENERGY). Charterer argues that the traditional 0.5 knot allowance for the word ‘about’ applied to speed should bear some relationship to the fuel warranty if the word ‘about’ allows for a variable consumption rate. Charterer contends that it should not be reckoned as an arbitrary 5 per cent. The relationship Charterer puts forward is that since 0.5 knot is 3.57 per cent of the warranted speed, 3.57 per cent is a logical qualification of the about applied to consumption. In this case, I accept this value. Thus, the good weather consumption should have been no more than 34.178 lt IFO and 1.86 lt DO. During the periods of good weather, I found that the record shows a consumption of 313.4 mt IFO and 17.22 mt DO giving an average of 33.58 mt IFO and 1.85 mt DO. I calculated this is 33.05 lt IFO and 1.82 lt per good weather day.

The allowed voyage consumptions at the charter party speed and consumption rates, after allowing for the double ‘about’, were 1,114.90 lt IFO and 60.81 lt DO. At the good weather speed and

<sup>113</sup> Richard R Pemberton and E A Stoke, *Naval Architecture for Marine Engineers* (Reeds 2018), page 151.

<sup>114</sup> See W Embleton, *Applied Mechanics for Engineers* (Reeds Marine Engineering series), (Reeds Volume 2, 1979), page 30, and Z Pavin and V Knezevic, “Impact of hull fouling on Vessel's fuel consumption and emissions based on a simulation model”, *Athens Journal of Technology and Engineering*, Volume 10, Issue 2, June 2023, pages 135 to 146.

<sup>115</sup> (2021) 1094 LMLN 1, *Lloyd's Maritime Law Newsletter*, 5 November 2021.

<sup>116</sup> (2023) 1145 LMLN 2, *Lloyd's Maritime Law Newsletter*, 27 October 2023.

<sup>117</sup> (2025) 1177 LMLN 3, *Lloyd's Maritime Law Newsletter*, 17 January 2025.

<sup>118</sup> The speed-power relationship of a sailing ship can be approximated with the formula  $P \approx V^3$ ; see F H Berthelsen and U D Nielsen, “Prediction of ships' speed-power relationship at speed intervals below the design speed”, *Transportation Research Part D: Transport and Environment*, Volume 99, October 2021, 102996.

<sup>119</sup> (2026) 1202 LMLN 2, *Lloyd's Maritime Law Newsletter*, 9 January 2026.

<sup>120</sup> (2015) 925 LMLN 4, *Lloyd's Maritime Law Newsletter*, 15 May 2015.

<sup>121</sup> (2021) 1076 LMLN 4, *Lloyd's Maritime Law Newsletter*, 25 February 2021.

<sup>122</sup> (2024) 1151 LMLN 3, *Lloyd's Maritime Law Newsletter*, 22 January 2024.

<sup>123</sup> SMA 3846.

consumption, these were 1,134.29 lt IFO and 62.31 lt DO. Thus, I found the vessel over-consumed a net 19.39 lt IFO and 1.5 lt DO ... In other words, even though the daily consumption was slightly less than the allowed amount, due to the extension of the voyage by the time loss, the vessel over-consumed on the voyage.”

Another panel<sup>124</sup> calculated overconsumption as follows:

“Without good-weather-day consumption in the record, the panel notes that the vessel consumed 154.2 tons during the ballast and 213 tons during the laden voyages (San Nicolas/Bakar/Bar), or a total of 367.2 tons over the entire steaming time of 84.62 days. This gives an average of 4.34 tons per steaming day, or 0.14 tons in excess of the 4.2 ton warranty-plus-5%; thus, Charterers are entitled to an over-consumption claim for 11.85 tons.”

There are also reported cases where arbitrators rejected the WRC report or experts’ report and recalculated loss.

<sup>124</sup> SMA 2771.

For instance, in one arbitration, the panel<sup>125</sup> rejected the ship’s records and the analysis of the charterers’ expert for the fuel consumption claim and determined from its own calculations the excess consumption. This seems also to have applied in *London Arbitration 23/21*<sup>126</sup> and *London Arbitration 15/23*.<sup>127</sup>

Moreover, “the distance/speed theory, where the “ship’s performance is evaluated by dividing distance traveled by time required for the voyage”, has been rejected in both SMA and London Arbitration cases”.<sup>128</sup>

In a previous arbitration<sup>129</sup> the panel had to address a claim for bunker over-consumption. The charterers’ claim was on the premise of an average speed 13.6 knots and that the vessel would have consumed maximum 38 mt IFO and 3 mt of MDO per day.

The owners argued that the perceived overconsumption corresponded to those periods when the vessel

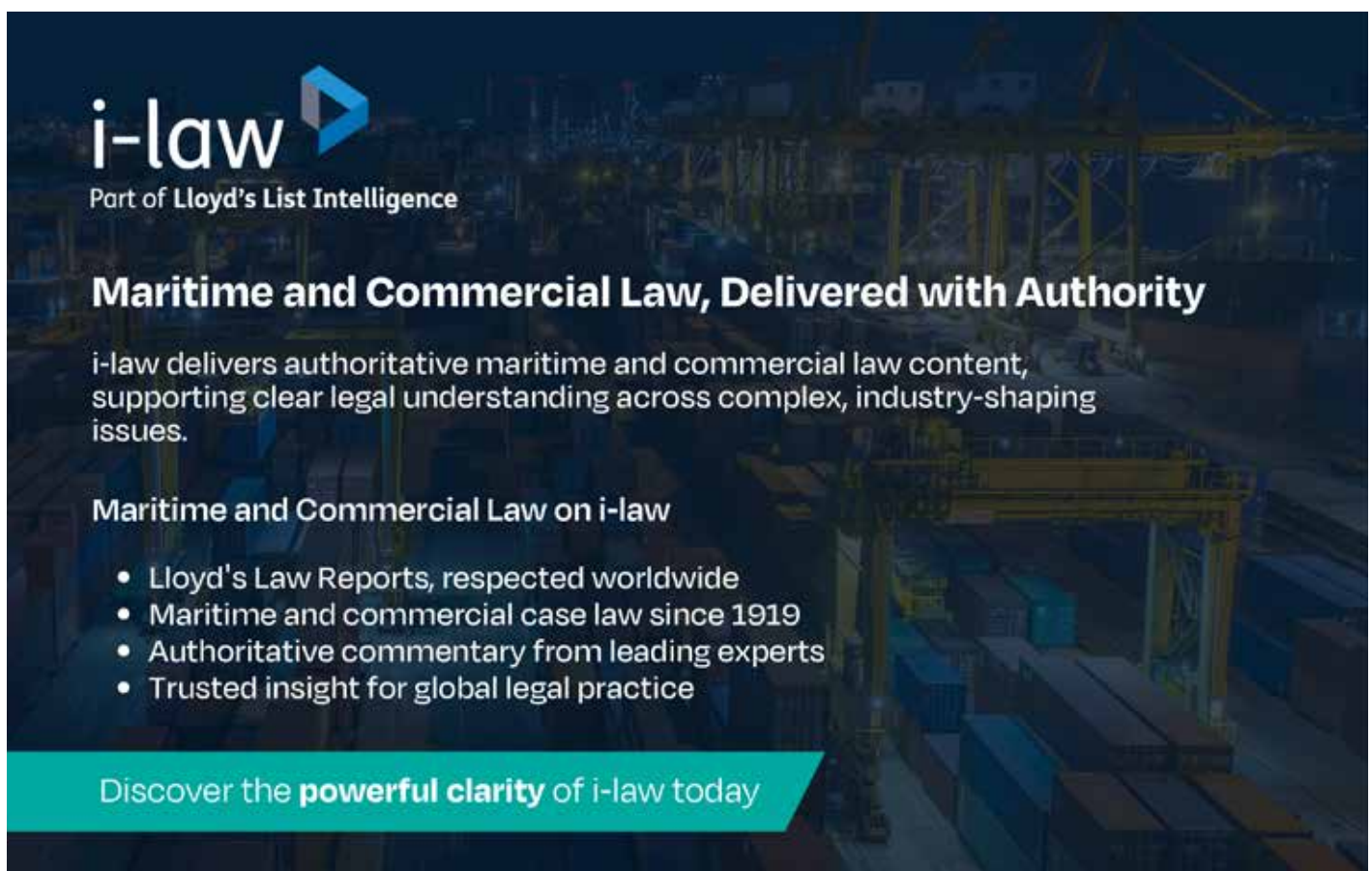
<sup>125</sup> SMA 2631.

<sup>126</sup> (2021) 1094 LMLN 1, *Lloyd’s Maritime Law Newsletter*, 5 November 2021.

<sup>127</sup> (2023) 1145 LMLN 2, *Lloyd’s Maritime Law Newsletter*, 27 October 2023.

<sup>128</sup> *Time Charters*, 8th Edition, 2025, para 3A.49.

<sup>129</sup> SMA 3341.



The advertisement features a dark blue background with a blurred image of a ship's deck. The i-law logo is in the top left, with the text 'Part of Lloyd's List Intelligence' below it. The main headline reads 'Maritime and Commercial Law, Delivered with Authority'. Below this, a paragraph states 'i-law delivers authoritative maritime and commercial law content, supporting clear legal understanding across complex, industry-shaping issues.' A sub-headline 'Maritime and Commercial Law on i-law' is followed by a bulleted list of four points: 'Lloyd's Law Reports, respected worldwide', 'Maritime and commercial case law since 1919', 'Authoritative commentary from leading experts', and 'Trusted insight for global legal practice'. A teal banner at the bottom contains the text 'Discover the powerful clarity of i-law today'.

encountered unfavourable winds and/or currents. Overconsumption must therefore be expected if the vessel was to maintain the requested speed. The panel held that:

“This might be so; however, in the context of this arbitration, this line of argument is not relevant. The vessel was requested to proceed at 15 knots, which, for days at sea, would justify a consumption of 50 M/T IFO and 3 M/T MDO. Clause 60 states that ‘this consumption indicated for good weather conditions’. Therefore, the only question to be answered is whether on the good weather days vessel’s consumption exceeded the foregoing stated quantities. The vessel’s logs establish that on six of the good weather days, the vessel overconsumed on the IFO. When averaging the good weather days’ overconsumption with bunkers savings on some of those days, the panel arrived at an overall excess consumption of 36 M/T IFO and 1 M/T MDO.”

## London arbitrations

In *London Arbitration 21/18*<sup>130</sup> one of the issues was how to calculate the overconsumption figure. The charterers claimed 46.07 mt IFO and they relied on a report from Y company. That report showed overconsumption of 91.12 mt IFO. They sought to justify this by taking the average consumption during good weather and extrapolating the difference with the allowable consumption for this period to the entire trip. So, 60.80 mt was the actual consumption and 55.948 mt was the allowable consumption. The difference of 4.852 mt was extrapolated to produce 46.07 mt.

One of the points raised by the owners was that the consumption of 29.578 mt was within the warranted daily consumption of about 29 mt, so that was enough to dispose the claim. By applying the warranted consumption of about 29 mt to the good weather period of 49.33 hours it produced an allowable consumption of 62.587 mt, being more than the actual consumption of the vessel. Also, in testing the charterers’ calculations, Y company’s figure of 55.948 mt for allowable consumption suggested a warranted consumption 27.2198 mt which was “absurdly low”.

The tribunal was puzzled with the charterers’ calculations and found the owners’ submissions and calculations to

be more convincing, showing that there was no breach of the warranty by the vessel’s consumption.

This seems to follow the same reasoning adopted by a panel<sup>131</sup> long before, holding that: “Charterers’ calculation of excess bunker consumption for extra time at sea is similarly misplaced. Moreover, the log abstracts before us confirm the vessel’s actual consumption of both IFO and MDO for all time at sea was well within the 5% allowance”, and by another panel<sup>132</sup> holding that:

“The consumption warranty, while a continuing one, is nevertheless measured over good weather days. Based on an analysis of the passage route selected by the Master, which is always at his reasonable discretion since he is ultimately responsible for the safe prosecution of the voyage, the Panel concludes that Owners were in compliance with the consumption warranty, and, thus, Charterers’ consumption claim must fail.”

In *London Arbitration 12/14*<sup>133</sup> the tribunal was again faced with two different methodologies on the bunker calculations. The tribunal noted that:

“As regards the overconsumption claim, Y Inc had concluded that the vessel overconsumed 71 mt of bunkers. X Corp had concluded that the vessel did not overconsume at all. There were two reasons for the difference. In the first place, Y Inc made no allowance for the “about” factor of (as was common ground) 5 per cent. Secondly, Y Inc calculated the bunkers allowed on the basis of a formula of ‘Daily CP Allowance x (Time en route less Time Loss)’, namely that the Y Inc time loss of 50.89 hrs (which the tribunal regarded as over-stated) was taken into account.

On both grounds, the tribunal would hold Y Inc’s calculation to be faulty and would prefer the X Corp conclusion that there was, in fact, no overconsumption.

Further, even the charterers had considered that Y Inc’s calculations did not seem to be in line with the calculations usually used for assessing consumption because Y Inc did ‘not seem to have pulled out the consumption data during the good weather periods’.”

<sup>131</sup> SMA 3473.

<sup>132</sup> SMA 1706.

<sup>133</sup> (2014) 900 LMLN 3, *Lloyd’s Maritime Law Newsletter*, 30 May 2014.

<sup>130</sup> (2018) 1013 LMLN 1, *Lloyd’s Maritime Law Newsletter*, 28 September 2018.

In *London Arbitration 15/05*<sup>134</sup> one of the issues involved the claim for excess diesel oil, 1.712 mt. The tribunal held that by applying the “about” margin, and taking into account the allowable time at sea 17.70 days and multiplying it by 0.10 mt daily, it yielded a calculation of 1.77 mt, which extinguished the charterers’ claim for alleged over-consumption.

In *London Arbitration 7/15*<sup>135</sup> the charterers complained that the owners mis-described the vessel’s consumption and misrepresented the actual consumption during the charter. The tribunal found the reports and records to be inaccurate and there was a substantial discrepancy between the vessel’s actual bunkers consumption on the laden voyage and that being warranted. The charterers relied on expert evidence, and the owners did not produce main engine trial data as required. The tribunal concluded that the quantity of bunkers on board was inaccurately declared by the master, or that bunkers were concealed during the survey. The actual consumption was much less than that represented in the charter and was not expected, having regard to the trial data with adjustments for age. The tribunal awarded damages to the charterers, adopting a broad-brush approach.

In *London Arbitration 4/26*<sup>136</sup> the charterers calculated the extra consumption due to the extra sailing time at sea due to fouling or underperformance. The award summary does not state if the arbitrator rejected or accepted this approach.

Turning to the applied calculation of the extra consumption as applied to the extra sailing time at sea, another panel<sup>137</sup> accepted a similar calculation for the extra bunkers consumed:

“On the basis of the data contained in the log abstracts furnished by the vessel, the panel has determined that the voyage steaming distance amounted to 12,036 nautical miles and was completed in 981.5 hours or 78 hours longer than the guaranteed time of 969.5 hours. Accordingly, the panel calculates that Charterer is entitled to an allowance of \$ 55,490.85 representing hire (net of commissions) and bunkers (at the actual average of IFO and MDO consumed during the voyage) for the extra steaming time of 78 hours or 3.25 days.”

## Bunker survey findings

The following examples illustrate the practical difficulties that may arise in bunker survey disputes.

On-hire bunker survey results can be relevant in addressing bunker disputes or underperformance claims. Consider a scenario where the vessel was delivered passing a particular point at sea (or delivered retroactively with the bunkers as stated in the recap being on board on delivery), and the master declares on board 800 mt of VLSFO. There is then a steaming time in ballast up to the loading port, following which a performance claim arises. Upon arrival, the master declares 700 mt, while one day later a bunker survey shows that the actual bunkers remaining on board are 730 mt.

Similarly, the off-hire bunker survey can also be relevant for the same reasons, namely where a laden voyage ends and a bunker survey shows more bunkers remaining on board. This may be relevant for different reasons, but when it comes to performance claims, it becomes a point of debate how the bunker findings should be allocated in the analysis.

Assuming that the performance report showed an overconsumption of 100 mt, while the survey finds 100 mt more bunkers on board compared to that declared in the logs, does this mean that it automatically extinguishes the overconsumption claim? The answer to this question depends on how the WRC, or an expert, has calculated the “overconsumption” of 100 mt.

However, let us now consider a situation where the vessel calls at the first discharge port and remains there for 20 days. She then sails for two to three days before arriving at the second discharge port. To avoid overpayments of hire, the charterers arrange a bunker survey upon arrival at the first discharge port. Circumstances then change and the vessel remains there for a further 20 days. During that period, there are several shifting operations in and out, as the vessel is kicked off the berth for different reasons, whether due to port issues or due to the vessel’s own issues, such as crane stoppages.

Eventually, the vessel arrives at the last port, where she again waits for 20 days, and the bunker survey performed on the 19th day is disputed.

<sup>134</sup> (2005) 670 LMLN 1, *Lloyd’s Maritime Law Newsletter*, 20 July 2000.

<sup>135</sup> (2015) 925 LMLN 4, *Lloyd’s Maritime Law Newsletter*, 15 May 2015.

<sup>136</sup> (2026) 1205 LMLN 2, *Lloyd’s Maritime Law Newsletter*, 13 February 2026.

<sup>137</sup> SMA 2814.

In this scenario, more complex issues arise. However, even if the survey results were agreed, it would still be challenging to determine how those findings should be treated in the analysis, given the prolonged periods of stay at each port and other vessel's issues within the port.

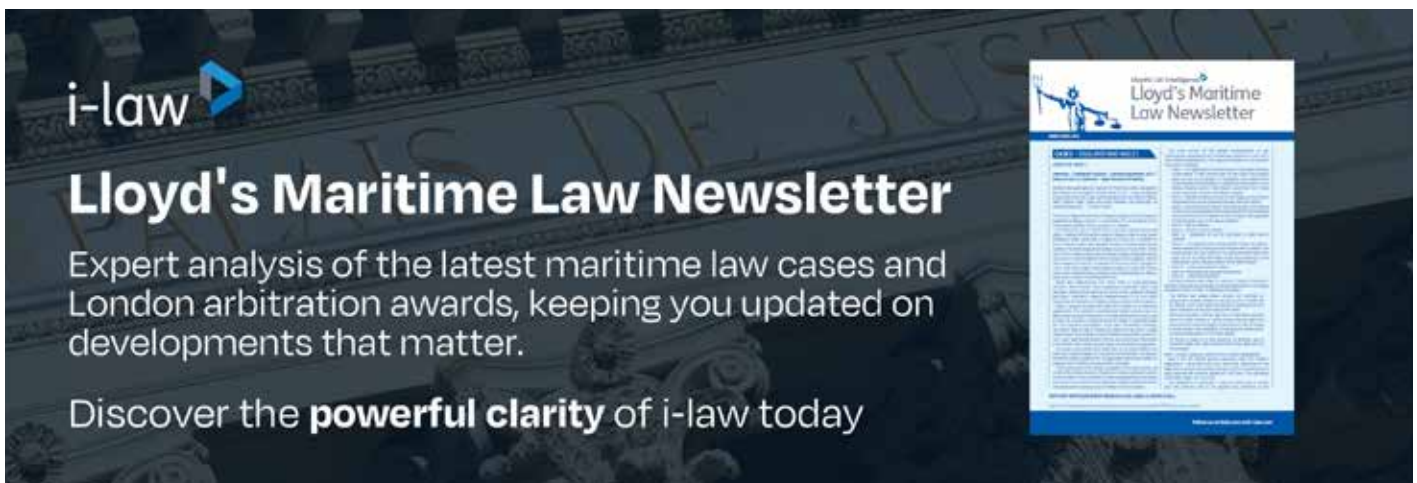
Disputed issues relating to "in-port consumption" will be examined in a separate part of this series, as these may be relevant to the application of "back-calculations". It is sufficient to note, at this stage, that numerous arbitration cases have been reported on this issue, which frequently arises in the authors' practice not only in relation to speed and performance claims, but also in claims concerning cargo heating and related matters.

## Conclusion

Speed and performance disputes frequently extend beyond the traditional issues of speed and bunker consumption warranties and often encompass a broader range of related matters, including bunker quantities, survey findings, bunker quality, fouling and other operational considerations.

The reported London and New York arbitration awards demonstrate that tribunals have adopted differing approaches depending on the wording of the charterparty, the nature of the dispute, and the evidence available in each case. The cases discussed here further illustrate the flexibility of the approach to the assessment of evidence in maritime arbitral practice.

Technical evidence has assumed increasing significance in modern performance disputes, which now commonly involve issues including fouling, emissions, fuel quality, engine efficiency, added resistance and vessel performance modelling. At the same time, the reliability of any technical analysis ultimately depends upon the quality of the underlying data, the assumptions made and the methodology applied, all of which must be assessed and tested against the other available evidence.



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