

Effectiveness of international regulation of pollution controls: the case of the governance of ship emissions

Interim Report

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Interim Report

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This January 2012 version of the report corrects errata that appeared in the initial December 2011 version.

Executive Summary

ES1. This interim report of a continuing study examines the effectiveness of international regulations on ships' sulphur emissions, based on observation of ship inspections in the UK and Sweden and on interviews with regulators, inspectors and industry stakeholders.

ES2. There is currently a 'culture of compliance' in the industry, with the proportion of ship detentions as a percentage of Paris MoU inspections falling from 9% in 2001 to just 3% in 2010. But in this highly competitive industry, operator compliance depends crucially on the perception that one's competitors are also compliant – the 'level playing field'.

ES3. Only fragmentary lab-test evidence of compliance levels is available. On the one hand, some commercial laboratories have made available summaries of the test results from large numbers of samples sent to them for commercial purposes. These results are mainly valuable as an indicator of the proportions of off-spec fuel being supplied as bunkers, rather than as an indicator of regulatory avoidance, since ship operators practising regulatory avoidance are unlikely to send samples for testing. On the other hand, some authorities (such as the Swedish Maritime Administration and the Dutch Water Police) are collecting quasi random fuel samples for testing, but the numbers of such samples are small and some of the sampling may be intelligence-led. In the first quarter of 2011, 3.8% of samples, collected in Western Europe and the Baltic and sent to one large commercial lab testing agency, proved to have non-compliant sulphur levels. Most of these samples were only marginally off-spec, and there were considerable local differences, with only 1.5% of Rotterdam samples being off-spec. Test results on 149 samples collected by the Swedish Maritime Administration (partly quasi randomly and partly during Port-State inspections) showed only 4% were non-compliant (allowing for a margin of error of +/- 0.05%). Overall, the available test evidence is insufficient to estimate compliance levels across the ECAs as a whole.

ES4. If regulatory avoidance is occurring, it may be linked to the very great cost savings to be made from operating with low-cost, high-sulphur fuel at a time when shipping industry profits and freight rates are low. The imminent arrival of the new North American Emission Control Area (in August 2012) will ensure a continuing very large price differential between compliant and non-compliant fuel in the medium term. The considerable financial incentives associated with using non-compliant fuel suggest the need for particularly robust enforcement measures.

ES5. Enforcement practice varies across different Paris MoU States. UK Port-State control (PSC) makes documentary checks, particularly on the Bunker Fuel Delivery Note (BFDN) and the Oil Record Book (recording the changeover from non-compliant to compliant fuel). In addition to document checks, Sweden takes around 200 fuel samples per year for subsequent lab analysis. These samples have been taken since 1998 as part of the monitoring system for Sweden's environmentally differentiated fairway dues, and are taken partly on a random basis and partly as a part of PSC inspections. Although they do not form part of this UK-Swedish comparative study, the Dutch and German authorities have a different procedure, using on-board sampling-and-testing kits. The Swedish test results are not available until after the vessel has left port and the penalties of non-compliance are limited (no State prosecutions to date, but the flag-State is informed of the non-compliance and eligibility is forfeited for discounted fairway dues), but the crew's observation of the sample-taking is itself believed to exercise some deterrent effect.

ES6. Neither the BFDN nor the Oil Record Book are documents that were originally designed to have a statutory function. The BFDN in particular is not always in English, does not always state the sulphur level on the note itself (as opposed to the printed annexed documents), does not carry the Registration Number of the bunkerer, is frequently hand-written, and (as a carbon copy) it is sometimes unreadable.

ES7. Inadvertent non-compliance may occur particularly among vessels with single service tanks. Such vessels may have undergone a changeover from high-sulphur to low-sulphur heavy fuel oil prior to entering the ECA, but a small residue of high-sulphur within the service tank may remain and be sufficient to mingle with the low-sulphur (with a typical sulphur level only just below the 1% cap) and thus render the vessel non-compliant. Single service tank vessels undergoing changeover procedures which entail the partial emptying of the service tank prior to bunkering with low sulphur fuel may be at risk of engine breakdown if the emptying is taken too far or if bunkering is delayed. Although specialist advice is available on changeover procedures, changeovers have been observed to differ substantially between different chief engineers operating the same vessel at different times.

ES8. Not all bunkering operations (and associated MARPOL samplings) proceed as they should, particularly in the bunkering of smaller vessels in smaller ports. Not all vessels are equipped with the special flange to enable the crew to take a continuous 'drip' sample and sub-contractors operating delivery trucks may arrive at the ship with the samples already bottled and signed.

ES9. An important incentive for ship operators to comply with IMO regulations lies in the publication ('naming and shaming') on the Paris MoU's THETIS database (and subsequently on industry databases such as EQUASIS) of a vessel's inspection record. However, vessels that are non-compliant with respect to the EU directive on the burning of 0.1% sulphur fuel in port are not 'named and shamed' on THETIS or EQUASIS, because the 0.1% port sulphur cap is not an IMO regulation, and incentives towards compliance are consequently reduced.

ES10. It is not currently possible to enforce ECA sulphur regulations on vessels transiting the ECAs through the territorial waters of EU countries, bound for non-EU ports where PSC may be less effective.

ES11. A list of seven recommendations appears below.

Introduction

1. This project is funded by the UK's Economic & Social Research Council (grant reference: RES-062-23-2644) and has the support of the UK's Maritime & Coastguard Agency. We also gratefully acknowledge the help of the Swedish Sjöfartsverket (Swedish Maritime Administration) and the Swedish Transportstyrelsen (Swedish Transport Agency). The project began 1/9/2010 and finishes 31/12/2012. This is an interim report.
2. The project draws on observation of ship inspections in selected UK and Swedish ports, and interviews with inspectors, regulators and shipping industry stakeholders, with the objects of both assessing the effectiveness of current enforcement of controls on ships' SOx emissions in the North Sea and Baltic Emission Control Areas (ECAs), and of offering suggestions to regulators on the enforcement of possible future regulations on carbon emissions.
3. Fieldwork and interviewing are still continuing. To date (17/11/11), 36 interviews have been completed and 16 ship inspections have been observed. In addition, some background statistical data have been collected, namely records of Falmouth bunker deliveries and records of the test results from Swedish fuel samples.

Summary of the Relevant Regulations

1. Annex VI of IMO's MARPOL convention is concerned with regulations for the prevention of air pollution; Regulation 13 is concerned with NOx emissions, while Regulation 14 is concerned with SOx and particulate matter. The initial Annex VI regulations on SOx entered into force 19/5/05 and revised regulations on 1/7/10. Mandatory measures to reduce greenhouse gas emissions (GHGs) will come into force 1/1/13, requiring all ships to have a Ship Energy Efficiency Management Plan (SEEMP) and all newly built ships to comply with the Energy Efficiency Design Index (EEDI). The signatories to Annex VI have merchant fleets totalling 85% of the world's tonnage. The regulations apply to all ships over 400 gross tonnage. All except the smallest ships must carry a current International Air Pollution Certificate, certified by class. Emission Control Areas (ECAs) were set up in the Baltic (2006) and the North Sea/English Channel (2007), a third ECA will come into force in North America in 2013. Initially, the sulphur limit on fuel in the ECAs was set at 1.5%, reducing to 1.00 on 1/7/10 and further reducing to 0.1% on 1/1/15. At time of writing (26/10/11), the UK has not yet issued an update to Merchant Shipping Notice 1819, reducing the sulphur limit from 1.5% to 1.0%. The world-wide sulphur cap was initially set at 4.5%, reducing to 3.5% on 1/1/12. A further world-wide reduction to 0.5% is projected for 1/1/2020, subject to a review respecting fuel availability to be completed by 2018 – if the review is unfavourable, then the 0.5% limit will be postponed to 1/1/2025.
2. In addition to these global regulations, the EU has introduced, from January 2010, an additional requirement for all ships at berth (and at anchor within port limits) to burn fuel with 0.1% sulphur. Additionally, there is an EU ban on sales of distillate fuel with sulphur content greater than 0.1%. An earlier (1999) EU Directive had set a cap on fuel burned on

inland waterways. In Sweden, since 1998, the fairway dues (levied on all berthing ships to cover the costs of ice-breaking and navigation lights) have been differentiated according to whether vessels attest to continuous burning of low-sulphur fuel and/or whether the vessels have NOx-efficient engines. In addition, all the major Swedish ports operate differentiated port charges for vessels attesting to continuous burning of low-sulphur fuel. The fairway dues are substantial: the maximum charge per port call for an oil tanker is SEK 77,000 (£7,200), plus a charge of 70 ore (i.e. 5p) per gross tonne for using fuel with a sulphur content greater than 0.5% (i.e. half that permitted under the ECA regulations)¹. The Swedish port charges vary from port to port, but are smaller than the fairway dues. In Gothenburg, Sweden's largest port, there is no extra charge for vessels using less than 0.2% sulphur, for vessels using 0.2 – 0.5% sulphur the charge is 10 ore (ie 0.7 pence) per gross tonne, for vessels over 0.5% sulphur the charge is 20 ore. In the view of one Swedish port official: 'My gut feeling is that it has only a marginal effect – our fees haven't been so high that they are proportional to the cost of switching to a better fuel'.

The Culture of Compliance

1. Port State Control (PSC), that is the equal enforcement of international shipping regulations by the port State regardless of a ship's flag, was introduced (in 1982) because some ship owners were effectively evading international regulations by 'flagging out' to commercial registries, some of which lacked the capacity and/or political will to enforce international regulations. This regulatory avoidance was hazardous to life and to the environment, but was stimulated by the potential cost savings to be made from such avoidance in a highly competitive industry. For example, the Organisation for Economic Cooperation and Development (1996) estimated that a bulk carrier carrying two fewer crew than the statutory requirement would save \$37,000 pa². Port State Control seeks to penalise regulatory avoidance by targeted policing and by 'naming and shaming'. In respect of targeting, ships deemed to be a greater risk of non-compliance for whatever reason (for example, age, flag, previous inspection record) can expect to be inspected more frequently – thus, an elderly coaster inspected in 2011 had been previously inspected by PSC 35 times 1992-2010. And, in respect of naming and shaming, a vessel's inspection record is published on the Paris MoU website (and re-published on industry websites such as EQUASIS), which influences commercial decisions by charterers, insurers and others, and which in turn influence the freight rates that a vessel can command in the market place. As a result, most ship operators are incentivised to proactively comply with ship regulations. Thus, the following message, which posted on the wall in the Master's office, from the CEO of a Far Eastern shipping company: "2011 Yearly Aims:
 1. Detention zero by PSC inspection
 2. Save costs. Cut down 5% against the 2010 year's budget for repairs (including dry-dock repair) and stores
 3. Reduce the personnel injury on board by half against 2010 year
 4. High risk zero and observation less than 5 items by Oil Major Inspection [i.e. the SIRE inspections operated by the industry on oil tankers]".

2. Further incentives to compliance should be noted. The differentiated Swedish fairway dues (and to a lesser extent, the differentiated Swedish port charges) offer financial incentives for vessels using Swedish ports to operate continuously with low sulphur fuel. Additionally, some operators have found PR value in having a 'green profile': the car carrier operator, *Wallenius Wilhelmsen*, has been operating continuously on low sulphur fuel since 1995 – a decision displayed prominently on its website³. And Swedish ferry companies dispose of all their toilet waste ashore, although there is no statutory requirement of them to do so. For the same reason, some charterers may require operators to run vessels continuously on low sulphur fuel. Thus, the ocean-going tugs that tow oil rigs all operate continuously on low-sulphur marine gas oil because they are required to do so by the oil companies under the terms of their charters.
3. While it is difficult to estimate the relative importance of these different influences – frequent PSC policing, PSC naming-and-shaming, green profile PR, demands from charterers – it seems clear that this has led to an overall improvement in compliance levels over time. Ship detentions in the Paris MoU (covering UK, European and Canadian ports) fell from 1,699 vessels in 2001 (comprising 9% of all ship inspections) to 790 in 2010 (comprising 3% of all ship inspections)⁴. There is now said to be a 'culture of compliance' in the industry.
4. Levels of compliance with the sulphur regulations ought to be estimable from published results of tests on fuel samples, but the evidence is too fragmentary and rather contradictory. The Dutch authorities have been taking small numbers of fuel samples for testing since 1999. Alarm bells rang in the shipping press in 2011 when Meindert Vink of the Netherlands Shipping Inspectorate presented findings from 135 fuel samples taken in the port of Rotterdam in 2010⁵. These showed that in the first six months of 2010 (when an ECA sulphur limit of 1.5% was in force), the non-compliance level was 7% (from 72 samples), whereas in the second six months of 2010 (when an ECA sulphur limit of 1.0% was in force) the non-compliance level had risen to 46% (from 63 samples). However, this alarm may have been misplaced. While, in theory, these 135 samples are meant to be randomly drawn (from 34,000 ocean-going vessel arrivals and 108,000 inland vessel arrivals per annum), it is in fact unclear how far the sampling is intelligence-led, arising out of complaints from harbour authorities and others. It might be thought that more credence would attach to the report published by the technical manager of one of the major test laboratories, Lintec Testing Services Ltd, based on tests of the very much larger number of samples taken for commercial purposes. While some of these samples will have been sent for testing because of commercial disputes, the great majority are sent routinely as a matter of company policy by ship operators. The Lintec data for the first quarter of 2011 showed that 1.5% of all fuel samples taken in Rotterdam, and sent to Lintec for testing, had excess sulphur content⁶. However, most of the Lintec samples were only marginally off-spec and it must be allowed that ship operators consciously seeking to avoid complying with the low-sulphur regulations would be unlikely to send samples for commercial testing. Nevertheless, the Dutch Shipping Inspectorate figure of 46% may be less than reliable as an indicator of ship operator non-compliance: the number of samples is small; the sampling may have been partly intelligence-led; and some, at least, of the non-compliant samples may have been the result of the supply of off-spec bunkerers rather than regulatory avoidance.

5. The overall Lintec figure for samples with non-compliant sulphur levels drawn from Western Europe and the Baltic region is 3.8%. As stated previously, non-compliant fuel need not imply regulatory avoidance by the ship operator: the vessel may simply have been supplied with off-spec fuel by the bunkerer, without the operator's knowledge. The report does not state what proportion of the 3.8% non-compliant samples were only fractionally off-spec, but in a personal communication the author has indicated to us that most of the samples that were non-compliant in respect of sulphur were only marginally off-spec; this would indicate that in most cases the operators are inadvertently non-compliant, rather than engaging in regulatory avoidance. However, again it should be borne in mind that any operator consciously engaging in regulatory avoidance is unlikely to be sending fuel samples for testing.
6. If the Rotterdam samples are excluded from the Lintec testing total, then the figure is around 5% for Western Europe and the Baltic. An earlier unpublished compilation by the European Maritime Safety Agency (EMSA) of test results from commercial samples collected at a time when the ECA sulphur limit was 1.5% had reportedly also shown a 5% non-compliance level⁷. So there is no clear evidence that non-compliance (inadvertent or not) has been increasing over time.
7. The Swedish Maritime Administration has kindly made available the results of tests on samples that they conduct as part of the enforcement of their environmentally differentiated fairway dues. Tests on samples taken from 149 vessels in 2010 (the same year as the Rotterdam tests) and, allowing for a margin of error in sulphur content of +/- 0.05%, show that only 6 vessels (i.e. 4%) were found to have non-compliant heavy fuel oil⁸. While some of these samples are collected on a random basis, others are collected as part of PSC inspections (and are thus partly intelligence-led). The only other test evidence we have found within the public domain comes from Danish Maritime Administration sampling in 2008, where 3 samples out of 54 were found to be of non-compliant fuel⁸.
8. In some parts of the globe (notably, South America and Caribbean) low sulphur fuel may be unobtainable. Operators who have been able to provide documentary evidence to the MCA of their unsuccessful efforts to obtain compliant bunkers at their last port are allowed by the MCA to proceed to bunker at Falmouth or Portland without penalty. Additionally and more importantly, a vessel may have been supplied with off-spec fuel by the bunkerer without the knowledge of the operator. Not all vessels are fitted with the special flange on the bunker fuel access pipe which enables the crew to take a proper continuous and independent 'drip' sample. And some bunker suppliers (particularly sub-contractors operating delivery trucks) may arrive with the samples already bottled and signed. Further, in the case of the many vessels with only a single service tank (i.e. the day tank supplying the main engine, as opposed to storage tanks), the excess sulphur level may simply be the result of faulty changeover procedure – see 'Problems of Effective Enforcement' below.
9. Other (non-sampling) evidence bearing on compliance should be mentioned. Bunkering operations at Falmouth, which lies just at the western boundary of the ECA, has experienced a major boom from shipping without compliant fuel, seeking to bunker with compliant fuel

before entering the ECA. One of the two bunkering operations in Falmouth kindly made available some of their activity data: 369 vessels bunkered there in 2006; this rose to 1304 vessels in 2008⁹. It has been suggested that a laser technology, LIDAR, can be used to analyse the sulphur content in a ship's exhaust plume and the Swedish Maritime Administration has experimented with mounting LIDAR equipment on a spotter plane, but this experiment was discontinued because of technical difficulties and concerns about aircrew safety. We understand that LIDAR would only have been used as a screening device: identifying potentially non-compliant vessels which would, on berthing, have been boarded for inspectors to take fuel samples for analysis. However, LIDAR equipment was mounted at the entry to the port of Gothenburg to analyse the exhaust plumes of more than 2,000 vessels and found 5% of these to be seemingly non-compliant¹⁰.

10. From the available evidence, therefore, it appears that the majority of ships in the ECAs are operating with compliant fuel. However, a significant minority of vessels appear to be non-compliant. Ships operating continuously in the ECAs, such as ferries, coastal traders and North Sea rig supply and support vessels, are particularly likely to be compliant – such ships undergo frequent PSC inspections and many operate continuously on low-sulphur distillate fuel (MGO). Ships calling at ports where the operator is aware that fuel may be sampled by the authorities, such as Rotterdam and the Swedish ports, may also be significantly more likely to be compliant. Vessels calling at Swedish ports are also offered financial incentives towards compliance. Note however that ships transiting Swedish waters en route for non-Swedish ports such as St Petersburg (where PSC in the past has been shown to be less effective¹¹) are not subject to sample-testing and may well be more likely to be non-compliant. The shipping industry's new-found culture of compliance may be imperilled in respect of compliance with the sulphur regulations.

Fuel Price Differentials

The potential savings quoted by the OECD, and reported above, for operating with less than the statutory minimum crew are dwarfed by the savings that can be made by operating with non-compliant fuel. *Wallenius Wilhelmsen's* previously cited policy of operating continuously with low-sulphur fuel was estimated by the company to have cost an additional \$2.7 million dollars in 2009. In that year the price differential between low-sulphur and high-sulphur heavy fuel oil was around \$10 per tonne. In early 2011 the price differential suddenly increased to around \$80 per tonne, following disruption to supplies of Libyan oil which has naturally low sulphur content. The price differential between high-sulphur heavy fuel oil and distillates is around \$300 per tonne. Industry analysts are clear that, short of a world economic slump, the imminent enforcement of a North American in ECA (in August 2012) will ensure a continuing very high price differential between ECA-compliant and non-compliant fuel. It is estimated that, after August 2012, half of all container ship voyages will involve transiting an ECA. There are also concerns about future fuel availability, due to limited refinery capacity and burgeoning demand for distillate from China and India. As one expert interviewee put it: 'In the future world, distillate will be costly, its availability will be questionable, and its quality will be much more variable'.

The Concern for a Level Playing Field

The shipping industry is highly competitive and a combination of the current economic downturn and surplus capacity (due the arrival of many new-builds into the market place) has served to depress freight rates across most sectors. Unscrupulous operators ('free riders') can thus secure a considerable competitive advantage through regulatory avoidance. This is particularly the case for the use of non-compliant fuel, where the potential cost savings are very large indeed. The main concern of operators concerning enforcement practice regarding the sulphur regulations (as with all international shipping regulations) is that enforcement should be sufficiently effective to prevent unfair competition from free riders. Thus, a ship operator: 'We don't have a problem with enforcement because we fully comply. And we expect everyone else to fully comply' [emphasis as in the original]. And a shipping industry representative: 'I think of course we need enforcement, the industry wants enforcement because we don't want people cutting the corners. So all the good ship-owners want everybody else to be paying the same price. And that is almost the fundamental mantra that we follow in [the industry association]'. However, the current main concern of the industry is not with enforcement of the current sulphur regulations, but rather with the projected future tightening of the ECA regulations in 2015 entailing a sulphur limit of 0.1% (which would entail continuous operation in the ECAs on high-cost distillate fuel) – see for example the industry evidence submitted to the House of Commons Transport Select Committee Inquiry on the Implementation of IMO and EU Regulations on Sulphur Emissions by Ships in October 2011¹². Yet it is a moot point whether the present (fragmentary) evidence of non-compliance with the current regulations constitutes the 'level playing field' desired by the industry.

Problems in Effective Enforcement

1. Although the Maritime & Coastguard Agency can charge operators for follow-up visits to detained ships, port-state control is not a revenue-generating activity and the MCA's port-state inspection operations naturally face budgetary constraints. The MCA has to find budget cuts of 22% over the period 2011-2015, as part of the UK government's comprehensive spending review¹³. The MCA has not equipped its surveyors with the sampling kits used by Swedish inspectorate or with the sampling-and-testing kits used by the Dutch. Nor does the MCA have the technical capacity to detect non-compliant ships transiting UK waters but not destined for UK ports. The cost of the analysis of the samples collected by the Danish Maritime Administration was 150 Euros per sample¹⁴.
2. As previously mentioned, the Swedish maritime authorities have experimented with a laser system (LIDAR) for detecting sulphur content in ships' exhaust plumes, mounted on a spotter plane. In principle, this would have allowed both early warning of possibly non-compliant ships bound for Swedish ports, and would also identify possibly non-compliant ships transiting Swedish waters. The experiment was discontinued for technical and aircrew safety reasons. It appears that a LIDAR device mounted at port entry points (and which could be readily shifted from port to port as part of a random surveillance system) could potentially act as a screening device for identifying possibly non-compliant berthing vessels, which could then trigger collection of test samples of the fuel by PSC. However, such a system would not be effective for screening *transiting* ships from the coastline of busy shipping lanes such as the Dover Straits

and the Oresund, partly because LIDAR detects sulphur in all the airspace between the device and the vessel (so that the results would be contaminated by the exhausts from multiple other vessels), and partly because the most likely follow-up course for the authorities would be simply to notify the vessel's flag-State of a possible non-compliance, with likely limited consequences.

3. The MCA relies for detection of non-compliance on document checks, rather than on fuel sampling. Paris MoU PSC inspectors (in the UK and in Sweden alike) may ask to see the Bunker Fuel Delivery Note (BFDN) provided by the bunker supplier, which specifies the sulphur content of the fuel. And PSC inspectors may ask to see the Oil Record Book which records the point at which the vessel both began and later completed its changeover from high-sulphur to low-sulphur fuel. Neither of these documents was originally designed to have a statutory function and they are not particularly robust documents for that purpose. As one expert interviewee remarked: 'The bunker delivery note is no longer just a commercial document, it is a statutory document as well – [the new regulations have] brought whole tiers of regulatory control to an existing activity'. The BFDN is not always written in English – it is expecting rather a lot of inspectors to require them know that 'zwavel' is the Dutch for 'sulphur'. Some BFDNs for MGO supplied in the EU (which EU regulations require to be less than 0.1% sulphur) do not state the sulphur level on the note itself, but only on the printed annex to the note. The BFDN is frequently supplied by a sub-contractor, rather than a registered bunkerer and the Registration Number of the bunkerer does not appear on the delivery note. The BFDN held on the vessel is a carbon copy and is thus not always readable, particularly after storage. The BFDN is also frequently hand-written, as are the entries in the Oil Record Book. Both documents are thus open to fraud/forgery. Hard evidence of fraud is naturally hard to come by, however fuel samples taken by other maritime administrations have sometimes shown considerable discrepancies between the sulphur level recorded in the BFDN and that found on analysis. For example, the *Grande Mediterraneo* (IMO no. 9138393) inspected in Wallhamn, Sweden, on 10/11/2010 was found to have Heavy Fuel Oil in the service tank that was 1.68% sulphur, while the BFDN recorded 0.98% sulphur¹⁵. It should be noted that regulators and industry stakeholders alike were aware of the frailties of the BFDN as a statutory document; one regulator reported that discussions had taken place about the future possibility of electronic bunker record-keeping.
4. Although Masters are required to notify maritime administrations of their estimated times of arrival, this duty is normally delegated to the port authorities. However, some smaller ports are not notifying the MCA of arrivals and so inspections are not scheduled. Potentially, the European Maritime Safety Agency's (EMSA) SafeSeaNet system monitoring ships' AIS (radio) transmissions, or the Long Range Identification and Tracking – International Data Exchange (LRIT-IDA) also administered by EMSA, could help identify such un-notified port calls. Note that, while it used to be said that ship operators could avoid a PSC inspection in the UK by the expedient of berthing Friday afternoon to Sunday evening, in 2011 the MCA reached an agreement with the union about out-of-hours working.
5. Specifically in respect of the EU requirement to burn fuel with a maximum of 0.1% sulphur in port, because this is an EU (rather than an IMO) requirement, non-compliant vessels do not

have this deficiency recorded in the Paris MoU THETIS database and or (consequently) in industry databases like EQUASIS. Note however that the MCA records *detentions* due to non-compliant fuel on its own website (cf. the report of the detention of the *Pleiades Spirit* in the Port of Tyne for not burning 0.1% fuel at berth on 16/8/10). Thus, non-compliance with the EU regulations has little adverse commercial impact on the vessel's freight rates, because 'naming-and-shaming' on industry websites has not occurred. Past research on PSC has shown that the effectiveness of the Paris MoU is partly dependent on its 'smart regulation' strategy of incentivising ship operators to pro-actively comply with regulations by influencing the freight rates that vessels can command through the 'naming and shaming' of the non-compliant¹⁵. Not to name-and-shame in THETIS (a system, ironically, developed by the European agency, EMSA) those ships non-compliant with EU port fuel regulations is thus to reduce materially operators' incentives to comply. The following notes are taken from observation of a UK PSC inspection in 2010:

'[...] the surveyor gave the ship a clean bill of health on its Paris MoU inspection, but then produced a different form [from the Paris MoU form] for a UK General Inspection where he recorded the auxiliary engines and boiler as being powered with fuel with sulphur content greater than 0.1%, with the deficiency to be rectified before the next port (i.e. in this case, as soon as the ship had bunkered and performed a fuel changeover). The captain was [...] mollified by being told by the surveyor that his ship would not be listed as having this deficiency on any database, such as SIRENAC [predecessor to THETIS] or EQUASIS. The captain asked what he should do with the paper copy of the UK General Inspection. The surveyor said he could store it with the paper copy of the Paris MoU inspection, which would go in the enormous binder-folder where ship certificates are kept all-together. After a moment's deliberation, the captain said he would store it separately.'

6. Port-State inspections follow a discretionary methodology, allowing surveyors some latitude in the depth and foci of inspections and in the actions required from non-compliant vessels. The Paris MoU Port State Control Instruction 43/2010/05 lists the PSC inspection instructions for the low-sulphur regulations and states that the surveyor 'should use professional judgement to determine whether to detain the ship or to allow it to sail with deficiencies which do not pose an unreasonable threat of harm to the environment'. This discretionary element is welcomed by many operators, but it also leads to uncertainty about penalties which may serve to weaken compliance. While one surveyor might typically record non-compliant fuel as a '15' deficiency ('to be rectified by the next port') his colleague in the same office might typically record it as a '99' ('an observation to the master'). Uncertainty is not confined to the type of deficiency that may be recorded. EU member states which assert their right to prosecute vessels for contravention of air pollution regulations have not always achieved prosecutions, seemingly because of legal difficulties in conclusively establishing the burden of proof (for example, could it be proven that the test sample had not been tampered with en route to the laboratory?). The Swedish Maritime Administration's programme of sampling and testing programme has not yet led to a single prosecution by the State Prosecutor's Office¹⁶; and Denmark's testing programme detected 10 violations of the sulphur regulations in 2006 and 2007, but these resulted in only one successful prosecution¹⁷.

7. One would expect some uncertainty must also arise among operators out of differences in inspection practice between different EU states, although none of the operators or shipping industry representatives interviewed in fact voiced any concern about these differences. This project has focussed on UK-Swedish practice, where (as already stated) the main difference lies in the Swedish practice of taking samples for testing: Swedish surveyors take around 200 samples per annum (not all of them on PSIs – there is a deliberate element of randomness in the testing). These are sent away for testing and the results are never available until after the ship has departed, though the flag-State is notified of non-compliant test results and non-compliant ships also lose any preferential rates of Swedish fairway dues for which they may previously have been eligible. However, the Swedish surveyors believe that for the crew to witness the sampling procedure does itself exercise a deterrent effect. It should be noted here that the authorities in Holland and Germany have made available sampling-and-testing kits, so that test results are available during the course of an inspection and this has resulted in some vessels being detained for burning non-compliant fuel. It was reported to us that the Swedish authorities had considered the deployment of these sampling-and-testing kits but had concerns about the accuracy of the kit test results compared to laboratory testing.

8. Vessels with a single service tank (that is, the day tank that serves the main engine, as opposed to storage tanks) are particularly disadvantaged by the technical difficulties entailed in compliance. Such a vessel may take as much as a four-day changeover period to flush low-sulphur fuel (LSFO) through its service tank before sufficient high-sulphur fuel (HSFO) has been expelled to make the vessel compliant. The highly viscous HSFO leaves sticky deposits that are difficult to get rid of and, since the sulphur content of the LSFO is typically only marginally below the 1.0% limit at, say, 0.98% sulphur, only very small amounts of HSFO need to be retained in the service tank to be diluted with the LSFO in order to render the fuel non-compliant. The changeover procedure on one such inspected vessel was fieldnoted to be as follows:

‘...part-emptying the settlement tank (upstream from the service tank) for 4 days and flushing through the service tank [with LSFO]. The capacity of the settlement/service tank was 17 cubic metres and each day they emptied out 4 or 5 cubic metres. The main engines took 0.55 cubic metres of fuel per hour [i.e. 13 cubic metres every 24 hours]... because the fuel used for flushing/dilution was 1.0% sulphur itself, only a tiny amount of remaining HSFO would be required to put the vessel over the limit. Nevertheless, the vessel had been following a responsible and reasonable changeover procedure and had made best efforts to be compliant’.

9. No data are available on the percentage of the world fleet with single service tanks, but single service tank vessels are certainly very common among older vessels and embrace a wide range of ship types including tankers, car carriers and large container vessels. In 11 observed inspections in this study where the number of service tanks was known, 8 of the vessels had only single service tanks and, of these, 6 were undertaking fuel changeovers (the other two vessels operated continuously on distillate fuel). Specialist advice is available from organisations such as Lloyds FOBAS on how to calculate a correct changeover period, based on the specifications of the fuels concerned, and the capacity and throughput of the service tank. But one serving Chief Engineer interviewed reported that he had adopted a much shorter

changeover period than his predecessor on the same vessel and there are grounds for suspecting that changeover practice is quite variable on the same or similar vessels. It may therefore be doubted whether all vessels with single service tanks are in fact burning compliant fuel, despite having gone through a changeover procedure. Where the changeover procedure involves partial drainage of the service tank prior to dilution with the LSFO, then there is a particular danger of engine breakdown (and consequent collision, grounding or foundering) if the emptying is taken too far. In California (which requires ships to burn low sulphur fuel within 24 nautical miles of the State's coast), the tanker *Overseas Cleliamer* reportedly came within 15 feet of grounding on the rocks of the Marin Headlands near the Golden Gate Bridge due to engine breakdown while undertaking a fuel changeover¹⁸. Partial emptying of the service tank prior to bunkering with low sulphur also carries risk of engine breakdown if the bunkering is delayed by queuing or bad weather. Operators are aware of these problems, but many of these vessels have insufficient space in the engine compartment to retro-fit an additional service tank that would obviate the need for partial drainage. Some operators are addressing the problem by arranging for the service tank to be split during dry-docking. One dry-dock manager reported that his company had experienced a big increase in requests for this kind of retro-fitting in the last 3-4 years, with a particular peak in the last 1-2 years, and that competitor dry-docks were experiencing a similar boom in split tank retro-fitting. New-built vessels all carry extra service tanks, unless designed for continuous MGO operation. So this compliance problem will diminish over time.

Conclusions

1. This interim report will not cover issues concerning the enforcement of regulations on carbon emissions, since the regulatory framework on ships' carbon emissions remains unclear at this time. We plan to circulate for discussion some suggestions on this topic once the regulatory picture becomes clearer, provided that it is within the time-scale of this project. Because of the very limited PSC experience with inspections of vessels with scrubbers, we are unable to draw any conclusions or make any recommendations on the monitoring of ships with ships with scrubbers. However, enquiries with dry dock managers do not indicate any dry-dock work on the retro-fitting of scrubbers currently taking place, so PSC monitoring of scrubbers is unlikely to be an important issue in the short-term.
2. On the enforcement of the regulations on sulphur emissions, the evidence reported above leads us to conclude that it is clear that a minority of berthing ships in the UK and Sweden are continuing to burn non-compliant fuel. While the best estimate for non-compliance in Western Europe and the Baltic as a whole is 3.8%, this is largely a result of the supply of off spec fuel rather than conscious regulatory avoidance. No data are available on ships transiting UK and Swedish waters en route for, say St Petersburg, but it seems quite possible that rather more of these transiting vessels will be non-compliant. There is no reason to suppose compliance levels will be similar across different EU States in the ECA, and indeed it seems likely that compliance levels among berthing ships in Swedish ports may be higher than in the UK, and that the non-compliance figure of 4% drawn from the Swedish authorities' fuel-testing programme (although based on only a very small percentage of port

calls) is reasonably accurate. Possible reasons for the relatively low Swedish non-compliance figure include:

- The long-standing (since 1998) financial incentives to continuously burn low sulphur offered by the environmentally differentiated Swedish fairway dues (the differentiated Swedish port charges appear of only marginal effect in comparison).
- The wish by local operators and charterers to demonstrate a green profile
- The high proportion of berthing ships in Sweden operating continuously in the Baltic and/or North Sea ECAs
- The deterrent effect of the long-standing Swedish fuel sampling programme, despite the limited penalties exercised against non-compliant vessels.

It is impossible to estimate the relative importance of these different factors.

3. The estimate of 3.8% overall non-compliance appears to be an indication of largely inadvertent non-compliance as a result of the receipt of marginally off-spec fuel, rather than largely the result of conscious regulatory avoidance. However, evidence is available which does indicate some conscious regulatory avoidance, witness the Swedish test results from the *Grande Mediterraneo* and the UK detention of the *Pleiades Spirit* above. There is a danger that the 'level playing field' desired by operators may not be met and that the industry's 'culture of compliance' may break down in this regulatory area. The major factor in this possible breakdown is undoubtedly the very substantial cost savings to be made by running on non-compliant fuel. We should also note that there is probably some additional inadvertent non-compliance in respect of vessels with single service tanks operating an inadequate changeover procedure.
4. The substantial financial incentives to use non-compliant fuel (uniquely large in respect of the rewards for regulatory avoidance in the shipping industry) argue the need for particularly effective measures of enforcement in this particular domain of PSC. Although there is scope for making documents like the BFDN more suitable for statutory purposes, a reliance solely on visual checking of documents does not seem appropriate to this need for particularly effective enforcement.
5. If the EU 0.1% sulphur port fuel regulations are not to appear toothless, non-compliant vessels need to be 'named and shamed' on the EQUASIS website.

Recommendations

1. That the MCA consider piloting, as part of PSCIs, the use of both fuel sampling kits similar to those used in Sweden and fuel sampling-and-testing kits similar to those used in Germany and Holland. The sampling kits would be used in conjunction with laboratory testing. The pilot would provide information on: (a) the compatibility of the sampling-and-testing kits with 'light-touch' inspections; (b) the suitability of different enforcement options following a non-compliant lab test result (assuming that the vessel in question has already left port); and (c) up-to-date information on contemporary compliance levels in UK ports.

2. That all EU countries inform the European Commission of all vessels found to be non-compliant in respect of the 0.1% sulphur port fuel regulations, with a view to the Commission seeking to ensure that these non-compliant cases appear on EQUASIS.
3. We note the possibility that bunker deliveries be recorded electronically. In the absence of an agreement on electronic recording, we recommend that agreement should be sought at IMO on a new format for the Bunker Fuel Delivery Note. Consideration should be given to the following propositions: (a) that the BFDN should be in English; (b) that it should always state the sulphur content; (c) that the Registration Number of the bunkerer be recorded (whether or not delivery is by a sub-contractor); and (d) that the material of the BFDN be such that erasures or alterations to the note be visibly obvious.
4. That discussions be entered into with the Paris MoU staff about the feasibility of making a vessel's non-compliant fuel lab test result at the last port the occasion for a P1 inspection at the vessel's next Paris MoU port.
5. Further consideration needs to be given to the potential danger posed to ships with single service tanks changing over to compliant low sulphur fuel by means of the partial emptying of the service tank. For example, it may be inadvisable for such ships to have to queue for bunkering.
6. Given the failure of the Swedish experiment to mount LIDAR equipment on a spotter plane, we can offer no recommendations on the monitoring of compliance by transiting, non-berthing vessels. However, consideration could be given in future to mounting LIDAR on a vehicle rig for visiting ports and 'screening' incoming and berthing ships for possibly non-compliant fuel, with arrangements for follow-up sampling of those identified as possibly non-compliant.
7. There may be scope for the sharing of best inspection practice on monitoring compliance with fuel regulations. For example, on methods of checking the accuracy of the logged changeover procedure, based on the BFDNs, service tank throughput, etc.

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