Study to assess the impact of security on the workload of all categories of ships crew members-
interaction with manning levels of ships


Final Report

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Directorate-General Mobility and Transport
We are grateful to the various stakeholders—the majority anonymous—who agreed to be interviewed in person, by phone, by completing a web survey and through email correspondence. These included representatives of national maritime agencies, professional associations, ship owners, academics, and, above all, seafarers themselves. Your time (often hours!), patience, and knowledge are greatly appreciated, and we hope that you find your viewpoints adequately reflected in this report. Particular thanks are due to the many seafarers who so graciously allowed themselves to be “ambushed” during their precious hours of shore leave with our interview questions about the details of their profession and work life, and to answer the web-based. We are also grateful to the seafarer welfare organizations and facilities that allowed us to conduct these interviews and supported our efforts, in particular the Mission to Seafarers in Portbury and Antwerp. The Seafarers International Research Centre at Cardiff University offers an exceptional platform for multidisciplinary research on the lives of seafarers, and we are especially grateful to two of their faculty, Prof. Helen Sampson, the Institute’s Director, for helping orient our efforts at an early stage of research, and Prof. Michael Bloor, for extended discussion of the issues and of his vibrant work on maritime governance and labour. Jens Bay at FORCE Technology spent considerable time orienting us to the development and capabilities of the Safe Manning simulation software capabilities, Carlos Pais Montes introduced us to the potential of AIS data, and worked with us closely in Coruna and Barcelona to prepare the data reported here, Captain Fredrik J. Van Wijnen of the Confederation of European Shipmasters Associations shared his own experience and helped make connections to others, and Captain Reuven Lanfranco gave valuable professional guidance on the findings from our web based survey.

The views and propositions expressed herein are those of the authors and the stakeholders consulted and do not necessarily represent any official view of the European Commission or any other organisation mentioned in the report.
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1. Foreword

Crew sizes have been declining on ships for many decades, due in part to technological changes and greater efficiencies, but, also because of intensification of work in a changing political, economic, and demographic maritime milieu. This reduction has given rise to long-standing concerns about under-manning and overwork, which can compromise ship safety and functioning and lead to hazardous levels of crew fatigue. There have been ongoing attempts to regulate manning levels, work hours, and rest requirements, which have had mixed success.

Against this background, beginning in the first decade of this century, new security-related tasks were added to the workload of all crews in order to comply with the implementation of the ISPS code in 2004, and of ships exposed to increasing threats of piracy, which were encouraged to adopt protection practices such as those codified in a series of broadly recommended “Best Management Practices.” Despite concerns that these new practices would add to crew workloads, there was little systematic data on the frequency at which these tasks occurred, how long they took, and their distribution among different vessels and crew members, as well as their broader impacts on overall workloads and other aspects of ship functioning. In particular, while strong but conflicting opinions were voiced on whether existing crews could reorganise in a way that handled this new situation, or whether some increase in manning levels was needed, there was little systematic inquiry into this issue.

In short, new information was needed in order to better understand and reconcile these rapidly changing and potentially conflicting regulatory demands, namely to assure that maritime vessels are not only safely operated, and kept secure in the face of new emerging threats, but that the crews assigned to perform these and other more mundane ship duties could accomplish them without compromising their required rest hours.

Against this background, DG-MOVE issued a call for proposals to assess the possible impact, including financial consequences, of security duties including the measures for self protection and the prevention of piracy and armed robbery against ships, on the workload of all categories of ships crew and the interaction of security levels with manning level of ships. Ships to be considered in particular were those subject to article 3.1 and article 3.2 of Regulation 725/2004. This report describes the findings of our research contracted in response to this call.

The tender specifications of this study gave a clear introduction to the regulatory background and needs from which it emerged.
“Regulation (EC) No 725/2004 of the European Parliament and of the Council of 31 March 2004 on enhancing ship and port facility security makes ISPS B 4.28 (manning level) mandatory, which stipulates that "in establishing the minimum safe manning of a ship, the Administration should take into account that the minimum safe manning provisions established by regulation V/14 only address the safe navigation of the ship."

The Administration has also to take into account the consequences which may result from the implementation of the Ship Security Plan and ensure that the ship is sufficiently and effectively manned. In doing so, the Administration has to verify that ships are able to implement the hours of rest and other measures to address fatigue which have been promulgated by national law, in the context of all shipboard duties assigned to the various shipboard personnel and this in accordance with the relevant IMO and ILO instruments.

Regulation 725/2004 also mentions under preamble (2) "the security of European Community shipping and of citizens using it and of the environment in the face of threats of intentional unlawful acts such as acts of terrorism, acts of piracy or similar, should be ensured at all times."

The Maritime Labour Convention 2006 provides that each Member State shall require that all ships that fly its flag have a sufficient number of seafarers employed onboard to ensure that ships are operated safely, efficiently and with due regard to security under all conditions, taking into account concerns about seafarers fatigue and the particular nature and conditions of the voyage. “

To address these needs, regulators and other maritime stakeholders require answers to the following questions regarding new security-related tasks.

1. How much work does this add to crew workloads in time and money terms—both in average terms (per vessel, per crew member) as well as for the EU –flagged fleet as a whole?
2. Which vessels, voyages, and phases of voyages, and which crew members are particularly affected?
3. Has this addition to workload required and/or resulted in an increase in crewing levels, and are these levels now adequate for meeting workloads?
4. To the extent that crewing levels have not risen in response to added security workloads, what are the reasons for this?
5. What can regulators and the maritime community do to assure that crewing levels are adequate for proper performance of workloads, including security-related tasks, and that these do not result in violations of working and resting hours?

As a first step, we identified and reviewed existing studies and literatures addressing this question, which we could draw on, rather than duplicate. This proved to be important in clarifying that only a single (and not widely known) study had directly
addressed these issues, finding that ISPS-related tasks add to workloads in a zero-sum way that undermines safety, security, and the overall functioning of ships. And, equally important, it uncovered several solid efforts (including some sponsored by the EU) that had energetically surveyed the manning levels prevailing in EU member states and the procedures by which they are determined, provided principled approaches to model and determine crew workloads and their relation to manning levels, and empirically surveyed as well as modeled how under-manning effects fatigue and safety.

This review of existing studies (elaborated in Section 4.1), helped streamline our efforts. On the one hand, they provided some “ready-made” building blocks we could draw on in assembling a portrait of how security duties due to ISPS and piracy affected workloads and interacted with manning levels or, alternatively, demonstrated that these could not be obtained with any reasonable amount of effort. For example, it would be difficult to improve upon existing surveys of crew sizes, of the prevalence of fatigue (which overlaps with “hot spots” of under-manning, where security tasks will have a disproportionate negative influence), or of the crewing levels and procedures for their determination in EU registries.

And, in a more negative sense, it was clear that certain methods of inquiry would be dead ends. For example, systematic phone or email surveys of official representatives of stakeholders such as ship owning companies would not be worth the effort: others had tried, and come away with response rates so low (and, thus, unrepresentative) so as to make generalization impossible. Similarly, while we would be able to conduct in-depth and candid interviews with individual seafarers regarding their workloads and security practices, attempting observations and interviews with a representative sample of vessels would be more difficult. To obtain samples that were both systematic and large enough to be useful would entail approaching or “ambushing” seafarers in a more formal way, and possibly give rise to the same kind of formal (and, thus, often unreliable) answers given to ITF inspectors or port state authorities.

As discussed in our reports during the period of this study, (and reflected in our recommendations), existing commercial and official datasets were of little assistance with respect to our key questions. For example, a 2011 study (Sulpice) to create a comprehensive view of seafarers' employment in Europe, clearly organised in a consistent way, found that such an approach had never been carried out before. This report commented that “It appeared that the challenge was high and despite enlarged researches in the field of data about seafarers’ employment in Europe, the result of the study can seem rather disappointing. In particular, the original project of the study, which was to present the detailed employment of officers and ratings for
each country (by ship’s type and department for Intra-EU/Extra EU traffics, and foreign flag ships, age profile and women employment) under a standardized table form, appeared to be impossible to achieve because of a lack of available data in most countries, and for some of them of no existing data at all. At least, the study, as others before, highlights the need to set up a harmonised collecting data system in Europe in the field of seafarers’ employment.”

To overcome these kinds of difficulties we utilised a variety of methods, both qualitative and quantitative, which combined the use of existing data and the creation and collection of new data, and moved between fine-grained (but not statistically representative) findings from interviews, on the one hand, and, on the other, comprehensive aggregate data and large representative samples for the EU-flagged fleet as a whole.

This tension between comprehensiveness and specificity is a necessary part of studying large complex system, such as the maritime fleet, especially when sensitive issues are at stake. Individual interviews helped us understand the realities and dynamics of security tasks and crew workloads in detailed and candid ways that were unlikely to be uncovered by a formal survey. (In some of our interviews, for example, seafarers discussed ways in which work hour records were falsified, lapses in ISPS access control, and ways in which inspections by ITF or Port State officials could be rendered less effective, etc. These are hardly things that would surface in the context of a standard survey.) On the other hand, comprehensive fleet-wide data—such as our processing and analysis of hundreds of thousands of port calls recorded by AIS transponders over 4 years, or our survey of over 300 seafarers on the nature, extent, and contexts of security duties—allowed us to locate these myriad particular “niches” within a more objective “big picture.”

Using this “best of both worlds” approach, our study was able to answer the questions we were tasked with. Referring to the 5 questions listed above, we accomplished the following.

1. Drawing on parameters obtained for the key added security-related workload of officers (and particularly the officer designated as Ship Security Officer) and ratings on all major vessel types, the typical travel patterns of their vessels, as well as the composition of crews and their salaries, we were able to model the impacts of these tasks in terms of total annual hours, which were valued on the basis of salary equivalent costs for the entire fleet of EU flagged vessel. This calculation resulted in an imputed annual cost of $40.2 million. This figure is quite modest relative total maritime vessel costs, and, even this figure overstates the actual financial consequences of ISPS and piracy-related security tasks, because most ship operators did not hire additional crew or consistently pay more to
existing crew members. At the same time, the added workloads are concentrated at peak times and on already overloaded crew members in a way that can have substantial impacts on the quality of their working lives and functioning.

2. We identified the phases of voyage, vessels, and crew members likely to be particularly exposed and vulnerable to such workload additions. And, building on this, in our recommendations section we show how existing tools and data can be used to pinpoint particular vessels whose travel patterns might be more likely to present excessive security-related workloads, and where the possibility of manning increases could be desirable.

3. Though it has not been possible to obtain access to the data that would demonstrate this systematically, we present convincing evidence that crewing levels have, on the whole, not been increased in response to the workload additions but these additions have been absorbed by existing crew to the detriment of their rest hours, ship maintenance, and, at times, ship safety and security. Our recommendation section describes the data that would allow closer monitoring of the changes in crewing levels over time, and urges efforts to make these available.

4. We provide a series of broader factors (at the scale of the ship-owner and of the maritime industry as a whole) that have acted against increases in manning levels; and,

5. We offer concrete suggestions for further advancing regulatory efforts to balance security and security tasks with other ship duties while adhering to regulations regarding rest hours, safety, and other aspects of ship functioning and crew well-being.

Our report adds to a longstanding chorus of voices calling for better accommodation of workloads associated with security tasks and improved regulation of workloads, manning levels, and rest/fatigue more generally. We believe that the findings of prior researchers, and our own extensions of these, point to ways in which this nexus and its regulation can be improved, especially if all maritime stakeholders are to realise the larger long term benefits for the system as a whole.

The structure of this report is as follows. In Section 2 we provide a high level overview of the materials and methods we utilised, which included background research, interviews, a survey, derivation of key travel parameters from transponder data, and the construction of a quantitative model; we also give an overview of the findings from this research, and the key recommendations we believe could improve the ability of the maritime community to understand and regulate the workloads added by security tasks, and do so in a way in which various facets of crew
experience (duties, overall workloads, rest hours, watch systems, travel patterns) are more tightly integrated.

Section 3 describes the background to the study, and discusses the overall decline in crewing levels over decades, the more recent addition of new workloads due to security threats, and the regulatory attempts that have been made to reflect the need for responses to these threats within existing regulation of manning, work and rest.

In Section 4.1 we review the more significant existing studies most directly relevant to the workload and manning impacts of security tasks. Section 4.2, which is a major element in our report, provides an in-depth analysis of the sources we utilised, our research methods, and our integrated approach to evaluating the impact of security tasks in the complex dynamic system that constitutes the realm of ships crews. This section includes reference to the interview highlights contained in the Annex, which illustrate the multidimensional character of this source of information.

Section 5 discusses the workloads and manning implications of ISPS and provides a review of concerns prior to and subsequent to the introduction of ISPS. It also discusses why we believe that manning levels have not been increased to a significant extent in response to expanded workloads, and the difficulties of obtaining consistent reliable information on changes in manning levels over time.

Section 6 reports on the findings of a significant web-based survey in which 335 seafarers reported on the security tasks associated with ISPS (at all security levels) and piracy measures—their nature, extent—within broader questions regarding these duties and their relation to manning levels. These responses, given by seafarers with deep experience on predominantly on EU-flagged ships and representing the various crew positions, provide one of several streams of input to the cost model, presented in Section 7. This section describes the construction, assumptions, and results of this model, which draws on the best estimates available from a variety of sources for the host of parameters needed in order to calculate the time and imputed money costs of the added security duties.

As discussed, these costs are “imputed” or potential because, in fact, they have not been literally paid for by the hiring of additional crew, nor does it seem, in most cases, by extending the number of paid hours of existing crew. Overall, new security workloads tend to be absorbed by existing crews within their existing crewing and formal work hour arrangements, and Section 8.1 discusses the forces and structures that make this the case.

Section 8.2 provides a more detailed review of the recommendations that we believe are required to address the issues raised in the report. The findings of the report as
a whole and its implications for the way forward on these issues are summarised in
the final substantive section, Section 8.3.

Finally, the report contains a full bibliography of the sources we utilised in preparing
this report, and a separate Annex volume has been prepared which includes a variety
of subsidiary materials providing further detail on the survey and interview
materials, and provides examples of the responses obtained.
2. Overview of methods, findings and recommendations

Our report evaluates the impacts and costs of security duties using a broad range of qualitative and quantitative inputs, as summarised in Figure 1. Many of the constituent “modules” in the figure constitute entire individual sections in report. This section reviews the methods and materials used (2.1), and recommendations made (2.3), and, most importantly, it synthesises and summarises the key findings from all of the various sources of data (2.2): literature reviews, interviews, survey, and cost model.

![Figure 1: Overview of research modules and data flow]

- **The impacts and costs of security duties on all categories of EU flagged vessels**
  - **Qualitative account of impacts and their systematic contexts**
    - Examination of maritime community concerns regarding workload and manning implications of ISPS (2002-present)
    - Broader literatures on maritime contexts relevant to security regulations, workloads, manning, and fatigue
    - Existing studies on impacts and costs of security duties
  - **Model of the imputed cost of security duties to EU fleet**
    - Key parameters on extent of ISPS and piracy-related security duty impacts for all vessel types, crew positions, and security levels
    - Interviews with maritime stakeholders
    - Interviews with seafarers
    - Structured survey of 335 seafarers on all categories of vessels
    - Analysis of 4 years of AIS data for all EU cargo and container vessels to analyze port stop patterns
2.1 Overview of sources and methods

Our research was based on a review and integrated analysis of several kinds of material:

- Extensive background research in the professional and academic maritime literature, as well as less formal sources (such as seafarer internet blogs and organizational newsletters) to understand existing data and studies relevant to the nature and regulation of crew workloads, and manning levels, and, specifically, how these are affected by added security requirements. This review ranged over materials directly relevant to the core focus of our research (the impacts and costs of security duties) as well as broader contextual analysis of the structures and dynamics shaping the maritime system and maritime labour to the extent these impinged on the manning/workload issues at the centre of our attention.

- Semi-structured interviews and discussions on these topics with a wide range of relevant stakeholders, including seafarers, shipping company staff, maritime security experts, governmental officials, NGO representatives, and academic maritime researchers.

- A comprehensive web-based survey answered by in excess of 300 seafarers with extensive experience on the workloads of all crew positions, and, in particular, with security-related workloads. This survey provided structured and open-ended responses to questions regarding the nature and extent of security tasks associated with ISPS (at all security levels) and with piracy measures, as well the respondents’ experiences and perceptions regarding security, workload, and manning issues more broadly.

- As the basis for creating a quantitative model of how much hours are added to the workload of EU-flagged vessels annually by ISPS and piracy-related security tasks, and, for assessing the overall annual cost equivalent of this time, we required solid estimates of all the core parameters that would be built into this model. We derived these from a wide range of sources, some in the available literature and existing datasets, but mostly these were derived specifically for this study. Thus, we used datasets and seafarer employment discussions to obtain salary levels and typical crew composition in the EU fleet needed to evaluate the daily cost of different crew categories; and we used interviews and the survey data to obtain estimates related to the nature and extent of security duties, and of the frequencies and durations of the events driving these (port visits, transits through piracy areas, and raised security levels). Since the largest workloads impact by far at the fleet level is due to tasks associated with port stops, we derived a careful estimate of the annual number and duration of port stops by EU-flagged vessels through collating and analyzing a massive dataset of recent AIS transponder data over 4 years.

- In order to create a model that provided robust estimates for the entire fleet, including all the required ship categories and EU flags, and size classes, we are using a Monte Carlo approach to shape a model that was both extensible and probabilistic. Probabilistic in that the model yields estimates not simply of expected “point” values of the time or cost estimates of these duties, but, also, the likelihood of any level of deviation from this
expected value. Given the compounded uncertainties entailed by each link in the estimation chain, a seemingly precise point estimate has far less value than the kind of probability distribution yielded by our model. Rather than stating that the annual imputed cost of all security duties is $40.2 million, our results, in essence, offer the distribution of 1000 estimates derived from 1000 runs of the model with varying values that could be assumed by each of the parameters in the model, drawn at random from the range of possible values for each. Thus, rather than assuming a single value for each of a score of parameters needed by the model, we have assumed a range and distribution of possibilities for each, so that our result represents, as well, a range that the value of interest (added hours for different crew categories and their imputed costs) could take. Thus, we offer an average value of $40.2 million for these 1000 runs, but can also say, for example, that this imputed cost also has a 10% probability of being below $22.4 million, and a 10% probability of being above $61.2.

The model is also extensible in the sense that it can be refined as estimates improve or as circumstances change. For example, when we obtained better estimates from our web-based survey (of the frequency of raised security levels, for example, or the time officers spent on ISPS duties in port approaches, stays, and departures), we were able to readily reflect these in the model.

- In some cases, despite energetic inquiries, some of the data that could enable more refined estimates or analyses of certain questions is held by commercial, NGO, or governmental bodies and is not available to researchers: for example, existing data from crewing lists, AIS transponders, or OPEX time series used by insurers and ship operators. Thus, our work attempted to optimise our understandings by combining the limited available data with data we were able to create or access independently, and, in particular, by linking robust aggregate estimates (of port stay patterns, for example) with the deep but localised qualitative data from interviews.

2.2 Key findings

The following key conclusions emerged from this multifaceted research programme. These are grouped into those relating to security duties as a whole, to the key constituents of these (the ISPS code and best practices for transit in regions where there is a threat from piracy), and to variations within these across vessel types, crew positions, security levels, etc.

2.2.1 The impacts and costs of security tasks – overview and fleet-wide assessment

- The main security duties are associated with the ISPS code duties associated with port visits (our modeling suggests about 400,000 port stops by EU-flagged vessels annually), and the piracy protection duties associated with transits through risky waters (9,000 such transits annually). While the crew tasks demanded by piracy threat can be intensive, and
these are performed in a considerably more dramatic and stressful context, they contribute a far smaller portion to the overall burden of security-related work at the fleet-wide level simply because on average the number of EU vessels “exposed” to ports is so much greater than the number exposed to piracy risks.

- The best estimate of the overall annual security-related workload of the EU fleet >500 GT (for piracy and ISPS measures, covering all crew, all vessel types, and all security levels) is 792,000 24-hour days. This translates into 83 24 hour Person-days are added to each vessel in the EU fleet in overall numeric terms, 90% of this work is done by ratings (714,000 24 hour days), and some 92% of it is due to ISPS, rather than piracy-related duties.¹

- Our estimate of the imputed annual costs of these hours (imputed because they are absorbed, rather than explicitly accounted and paid for), is $40.2 million. This relatively low cost is a consequence of the low cost of labour of ratings, who are mostly non-EU nationals. The distribution of 1000 Monte Carlo runs of this estimate, each reflecting a different random “pick” of each of a dozen or more input parameters from their respective ranges, is given in Figure 2. Half of the 1000 runs yielded estimates in the range between $29- $49 million. In addition to these direct imputed costs, we describe other financial costs of undermanning, due in part to added security duties which were reported to us by seafarers but not quantified, such as deferred maintenance, accidents and injuries due to fatigue, and increased turnover of seafarers.

¹ The estimates in this summary section (Section 2) are based on a recently completed survey that provided updated parameters for SSO hours and the frequency of level 2 and 3 security alerts. They are different in some respects from those given in Section 7, where the sources and methods of the model are described in detail. The “bottom line” of the cost model was revised upwards by about $9 million to reflect a somewhat higher estimate of the hours the SSO devotes to ISPS duties in port.
While security requirements entail a variety of tasks for both ratings and officers, which we detail in various sections, and list in Annex I, in overall terms much of this is performed by ratings, since the overwhelming portion of security-related workload is due to ISPS requirements, and a dominant portion of this is the added gangway watch required by ISPS during port stays, very often done by ratings (and sometimes crew from the engineering department).

When considered as average additions to baseline workloads of crews as a whole, the scope of security-related workloads seems moderate: just over 3 hours/week, or a 4% addition to the workload of all ratings, and even less as a weekly average over all officers. But these averages are deceptive for several reasons: this work is not spread over all ratings and officers, but a portion of them; it occurs during pivotal moments in workload schedules; and it is performed by crewmembers already overworked due to long term decline in manning levels, the increased tempo of maritime voyages, and a series of other regulatory additions to their workloads, whose burdens have not been fully offset by increased automation and technological improvements.

More specifically, while officers figure less in fleet-wide sums than do ratings, most of
this work is done by a single person, the Ship Security Officer (SSO), who with the exception of passenger ships, is almost always the Chef Officer or Captain. With this single person, the SSO, devoting 5 hours a week to security duties, in addition to their already full workload, and with these duties coinciding with their other port-related duties, these extra hours are, in fact, quite burdensome. Similarly, the additional security watches done by ratings, though distributed among 2 or 3 people, are added to their existing watch schedules and alongside other duties, and necessarily cut into “off duty” time or displace other tasks, sometimes at a cost to overall ship functioning and crew wellbeing.

- Despite the ways in which additional security duties strain schedules and workloads, there was a general consensus among national registries that no increases in minimum manning levels were required in order to accommodate the security duties stemming from the implementation of ISPS in 2004, and while ships sometimes have crews above their listed minimal levels, there is little empirical evidence of overall increases in actual crewing levels post ISPS.² Thus, these added duties were “absorbed” by existing crew

- An array of interlocked economic and political-economic dynamics of the maritime system make it structurally resistant to enabling increases in manning levels that would correspond to security-related or other marginal increases in workload. These dynamics push workload levels dangerously high, creating a workplace in which fatigue is a norm (as reported to some degree by 90% of respondents in our survey), thus undermining the maritime skill base and profession. These dynamics include the “lumpiness” of the manning position as a quanta of work capability, the fact that a marginal hour absorbed by an existing crew member saves ship-owners a substantially larger expense than the cost of that hour, and the fact that while crewing costs are a small part of the overall expenses of owning and operating a vessel, they constitute the largest and most tractable part of the operating expenses—and this is the only category over which ship-owners have a degree of direct control. More broadly, much of the EU fleet draws on a globalised pool of cheap labour; for ship owners this offers a several-fold cost advantage versus hiring EU nationals, while at the same time the wages offered are highly attractive to crew compared to the wages in their home countries. Thus, we have a system resiliently trending downward, to the limits of crew endurance, often at long term cost to the system as a whole.

- In the deeply globalised and intrinsically de-territorialised context of the maritime workplace, no single actor has emerged that is at the same time both strong and motivated enough to act effectively as guardian or coalition-broker. In such environments, there is often a “race to the bottom” as actors have incentives to relax regulations/requirements for competitive advantage, and others are forced to do likewise or risk losing much of their customer base. Because of its unique character, the

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² As discussed in the report, there are sources that would allow more rigorous examinations of this question (crewing lists and operating expenses records), but these are seldom available to researchers.
kind of governance mechanisms and institutions that partly restrain similar “races to the bottom” in other industries and in certain aspects of the maritime industry seem less capable of doing so when it comes to regulation of the manning, workload and rest hour conditions that are central to our study.

- In both ISPS and piracy-related tasks, the absorption of new tasks into an already full work load was achieved though (1) an increase in work hours (contributing, further, to the difficulties of compliance with rest hour regulations, especially in peak periods); (2) some degree of displacement of time from other tasks, especially maintenance. In the case of ISPS, this absorption of new security tasks was enabled by a stance of flexibility and some nonchalance toward strict compliance. That is, at times ISPS is able to “co-exist” with other ongoing maritime tasks, which are regarded as the main priority of crew, especially in ports, because corners are cut with respect to ISPS implementation and to proper compliance with rest hour regulations.

- While our interviews contained evidence of a more relaxed attitude to ISPS, it seems that the situation regarding piracy-related security duties is different in important ways. For one, on vessels where these are hired, some varying portion of the security duties are borne by private security guards. Also, the motivations for performance of these two kinds of security duties differ, and thus the vigour of enforcement. ISPS duties, which are mandatory, tend to be performed more as a procedural obligation, and out of fear of inspection. Piracy-related duties, on the other hand, though only recommended, tend to be taken to be real protective measures, and undertaken by crew out of real fear of attack. Seafarers do not express a vivid sense that ISPS duties are protective against real threats, whereas they see piracy-protection efforts as providing protection against a threat that is very real and concrete, and undertaken for their own protection. For this reason, ISPS tasks, at least at Security Level 1, take second place to other crew tasks, and their implementation is somewhat routine, even perfunctory, a kind of “paper compliance.” Anti-piracy measures, on the other hand, are done with far greater vigour and attention, and with an eye to actual benefit.

- Our interviews confirm what many veteran seafarers have claimed: with no redundancy in the human systems of the ship, tasks associated with security regulations are too often in zero-sum competition with crew rest hours, safety, maintenance, and, even, security itself; that is, complying with security regulations generally involves giving up something else of importance. In our survey, 90% of the deeply experienced seafarers agreed with the statement that “fatigue is a common and worrying aspect of maritime life as a whole,” and 70% considered it a problem on their own vessel.

2.2.2 Typical impacts, sources of variation, and ship and crew categories of particular concern

On the whole, the bulk of ISPS-related tasks is related to port visits: an hour or two of paperwork and coordination done in preparation to port arrival, and the equivalent of 1 to 1.5 dedicated people during time in port, mostly for added watches, but also
for inspection of cargo and provisions, etc. Thus, the total additional effort due to ISPS can be credibly modeled as two hours plus 1 to 1.5 times the number of hours in port.

Since the officers have their hands full with pressing non-security tasks, and the master (who is often the SSO) will be busy with cargo, bills of lading, etc., the paperwork components of ISPS are increasingly, done by officer cadets and signed off by an officer. The remaining tasks performed by officers are coordinating with the Port Security officer, etc. Still, our survey respondents estimate that SSO duties require an average of 21 hours a month. The watches and inspections are typically done by rating in the deck department, most likely someone a bit more senior who is familiar with the vessel, its crew, layout, etc., and sometimes by one of the more senior officers in the engineering department. While constituting 1-1.5 “person slots” in overall numerical terms, these duties do not fall to a single individual, of course, but are spread among several, especially by insertion into ongoing watches, for example shifting from a 3 person watch to a 2 person watch, or cutting into “off-duty” time.

While some companies have drafted standard and specific operating procedures for particular vessels, on the whole ISPS requirements are not spelled out in great detail, and there is considerable room for interpretation of what tasks consist of. The range of tasks associated with ISPS is evident in the responses to our survey, summarised in Annex II. But the time taken by any one of these can be quite variable. Something like “checking for stowaways” can range in its extent and thoroughness. At an extreme, tasks can be “performed” mostly on paper—for example, logging items that have been performed in a perfunctory way, if at all. With a large workload in port, few SSOs would ask that their crew members check every crate of apples brought by the same man who has been bringing them for years. Similarly, the extent of performing new demands, such as “reporting all security incidents” can be open to interpretation. If someone on shore is seen to be observing or even photographing a vessel, does this constitute a security incident or can the crew member assume that this is a hobbyist or researcher rather than someone collecting intelligence. With each report on a “security incident” entailing follow up, written statements, discussions with port security officers, etc., the onboard officer with a heavy workload might prefer to interpret this requirement in a less exacting manner.

The extent and stringency of ISPS compliance also differs from port to port. Some ports provide their own guards, while others “borrow” crew members to identify seafarers coming into the facility as a whole (in addition to a crew member assigned to guard access to the vessel itself). In some cases, the agency will provide the port access watch, relieving the crew from this duty.
Security duties not related to port visits, primarily drills and training, have lesser overall impact. New security training for shipboard personnel (both general security awareness as well as proficiency in designated security duties) are specified (2010 Manila amendments of STCW), and will begin to be enforced by Port Security Officers (PSOs) in 2014. However, these do not contribute substantially to overall workload, since they are a relatively short event (15+ hours, perhaps) to be done once in a seafarer’s career, so that most crew will be exempt by having done this training on another vessel or in another company. These trainings are conducted on land or on the ship by a SSO, guided by a model course, but not specified beyond that. Similarly, while the time required by security drills required on a regular basis needs further clarification, initial appraisals indicate that these tend to be bundled with other drills, and done during lulls in overall workloads, so their impact is less felt than those security tasks that do not offer these flexibilities.

Of course, there is vessel-to-vessel variability in the extent of security duties. For example, some SSOs may take their duties less seriously, relying more on close circuit television than constant human presence for gangway control. Crew size is also an important factor, not so much in the number of hours demanded of a crew but in the impact of these hours. In a smaller vessel, there is less “slack” in the system, and the same number of added hours would affect crew, watches, etc. more severely. At the same time, to some extent, larger vessels require more time for pre-departure security checks that must be conducted over more area.

A key variable shaping the extent of ISPS tasks is the frequency and duration of port calls. For this reason, this is mapped carefully in the report itself, and we also demonstrate how the port stop patterns of vessels can be captured and assessed, as needed, for the EU fleet as a whole, for an individual vessel, or for classes of vessels that would appear to have very heavy port visitation schedules and where a further examination of manning levels is warranted. The particular port called at is also a factor, with some port security officers being more stringent than others, or conduct their own security efforts in a way that can increase or lessen the efforts needed by the onboard crew.

Raising the security level beyond the normal Level 1 increases the extent of security duties drastically, of course. This is important for workloads on individual vessels (and our recommendations section suggests how these might be identified), but, since this occurs only rarely when considered at a fleet-level average, it does not constitute a large part of the numerical model of imputed costs overall. As detailed in section 6, 75% of the respondents in our survey experienced a Security Level 2 or 3 only twice or less annually. The Monte Carlo analysis that combines the reported distribution of times annually above Level 1 and the reported duration of these
episodes shows that fleet-wide, the average time spent above Level 1 is less than 24 hours a year. But, of course, exposure to heightened security levels is not distributed evenly across the fleet—the vessels that ply particular routes will have monthly episodes, sometimes sustained for days. As discussed in the recommendations section, we have the tools available to identify these vessels, which merit special attention for being at risk of undermanning and fatigue.

When a vessel goes to Level 2, whether because of a requirement of a flag state or a particular port, the overall load roughly doubles (i.e. requiring between 2-3 person-days for each day in port). This is to accommodate additional watches and verification of deliveries at gangways, and, at times, at the entrance to the port facility as a whole, and more stringent checks before embarking. At level 3, security tasks become the main matter at hand, and all crew are involved to some extent. Clearly these levels of security cannot be maintained for any length of time.

The extent of ISPS duties varies by vessel type, to some extent. Security is taken more seriously at container terminals than when loading bulk cargo, for example, and every container is considered suspicious, in principle. The task of checking of container seals and matching them to manifests is arduous. Much of this is done before loading, but some work remains, and the SSO can request a recheck if his suspicions are aroused. In addition, on container vessels, the presence of stevedores on board to assist in lashing requires extra vigilance against theft. Passenger ships have their own security concerns, especially regarding pass checks and baggage checks, etc., but these are almost always performed by crew members dedicated to these tasks, so the security-related workload on the core crew itself is typically less. Ro-Ro vessels also raise the security efforts required, as, essentially, large foreign objects are being brought onto the vessel, as well as their drivers, who may be able to roam and enter areas they do not belong. In most cases, the brunt of checks of the vehicles is done by port security facilities, but sometimes these are not entirely trusted, so these are done in the presence of crew members, or additional checks are performed on boarding the vessel itself. Clearly these are added demands.

For piracy, the impacts differ. Overall, the main workload is due to the hardening of the vessel in advance of the transit, extra watches during transit, and the take down of these measures after transit. We have quantified these so as to give an overall estimate based on number and duration of transits, as described in sections 6 and 7. The main source of variation regarding piracy impacts, of course, is route (many vessels will never enter waters at risk for piracy, but not many of them can avoid entering port on occasion!) There is also much variability depending on whether private security guards are taken on, and, if so, the extent to which they take on part of the crew duties, relieving crew workload, or, in some cases, adding to it by
requiring special hardening and watch procedures that are performed by crew, or even less expected workload additions, such as added efforts by the stewards department to accommodate and additional several people with irregular hours). Finally, some newer vessels have anti-piracy hardening built into them as fixed or easily installable features, lessening the preparations required. And vessels with high freeboard (9 M for example) are at lesser risk during transit.

As is evident from the foregoing, there will be an endless variety of permutations of vessel itinerary, type, and crew, shaping the extent and nature of tasks on each of the thousands of EU-flagged ships. And the same tasks could be tolerable in one setting, and intolerable in another. The following remarks by a seafarer illustrate well the kinds of difficulty involved in disentangling the impacts of security tasks from the broader and quite particular contexts of the ships location, other tasks, and schedule.³

“Coming from Australia thru Sunda straits and Gelasa straits the crew is continuously on anti piracy watches at night on bridge we have continuous lookouts. Then approaching the sunken wreck off horseburg light house at midnight we transit the straits of Singapore at 20 kts en route to Malaysia ETA 0500 Hrs. High speeds have higher stresses as overtaking in such narrow Traffic Separation scheme at closest point of approach of 2 cables at times. We get pilot on arrival then berthing stations followed by cargo ops. There are 3 Gantry cranes in operation which means besides Duty officer and Gangway ISPS watch there are 2 more seamen on deck to check for any container damage etc, Reefers plugging and un plugging etc. Ch off being busy with preparing IMDG cargo lists, reefer lists and checking stability and Ballasting / Deballasting operations. In addition in port e mandatory items like lifeboat lowering etc (though not every voyage) or checking the pilot side access doors watertightness through the underdeck passage (can maintain these only in port). Completed cargo ops around 1400 hours- Departure station, mandatory stowaway search as per ISPS, undocked and pilot off around 1530 and then transit Singapore straits to arrive eastern boarding grounds A around 1800 for pilot, berthing around 1900 hrs.

Arrival Singapore there is cargo ops again 3 or sometimes 4 cranes and to top it there is crew change, provisions, stores and bunkers. This continues till 1300 hrs the next day followed by departure stns and then transit Singapore straits manning of Bridge by master, duty off, lookout, and at night Antipiracy watches for 2 nights transiting Gelasa and Sundastratis for the next 2 nights. So which ever way you look at it NO ONE on board is spared the fatigue levels. Rest hours are violated every voyage.

³ From the Nautical Institute online fatigue reports.
Despite this inevitable variation, we can discern broad patterns, and, as we discuss in the recommendations in section 8.2.2, these can be used to identify vessels with travel patterns that put them at risk for more extensive (and/or more consequential) security duties. Understandably, the hotspots of security task impact are likely to largely overlap with the hotspots of fatigue more generally since the impacts of security tasks are dependent on the existing workloads they are added into. Some of the identified problem areas (and our interviews confirm these) are the following vessels and situations:

1. Frequent port stops. Crews have not recovered from one port stop before they begin another. And watches are disrupted, so that crew that should be ending a watch must directly begin duties associated with port approach.
2. Rapid turn-around times. These compress navigational and paperwork and cargo-handling activities.
3. Vessels transiting piracy risk areas without private security company guards.
4. Vessels calling often in ports frequently at Level 2 or higher.
5. Smaller crews. There is slack in a larger crew to absorb extra watched, but in a smaller crew port stops—and the associated ISPS tasks in particular—create large strains. Often crew watch goes to a six on/six off arrangement in order to allow an extra ISPS gangway watch alongside cargo and other activities, and “off duty” time not on watch is taken for other tasks.

2.3 Summary of recommendations

Our report ends with a series of recommendations on policies and research interventions that could help improve the maritime community’s response to the workloads that were added by security tasks, as well as address chronic under-manning and overwork more broadly. These include the following:

- One set of recommendations centers on the fact that many of the “risk factors” for under-manned ships, and, thus, those more prone to being affected by added security duties, can, to some degree, be ascertained remotely, en masse, and objectively, without recourse to port inspections that can only be applied to a small portion of the fleet, and which can be prone to manipulation. For example, the first three risk factors listed at the end of section 2.2.2, and to some extent
the 4th, can be obtained for any given vessel or class of vessels using AIS transponder data, both historically or in real time. And the fifth can also be obtained, though with greater difficulty, from crew lists and filed manning level documents. Thus, existing inspection and regulation approaches might be supplemented by an approach in which an inventory of vessels at risk for undermanning can be compiled, and queries issued by the relevant authorities on how these vessels manage such demanding schedules with their given crew. Section 8.2.3 offers an illustrative “proof of concept” for this approach, identifying the EU-flagged cargo vessels that have exhibited some defined trip-making pattern over a trial 4 year period: in this case, very frequent or moderately frequent but extended port stops. Similar approaches could apply to vessels with frequent transits through piracy areas or those calling often in ports with raised security levels.

- The trip-making patterns available from AIS could be further leveraged in the future by using existing workload simulation models, which are well suited to indicating the minimum manning level necessary to avoid violation of rest hour requirements for a given trip-making sequence. These models can also project the workloads of any crew member over time given a specified sequence of port stops with a given crew. Currently calibrated for one vessel type, the model can be adapted to other vessel types by specifying the tasks and constraints specific to them. This model clearly highlights the rest hour violations that are common and, indeed, unavoidable, under some prevailing operating schemes. In addition, existing fatigue simulators can draw on these crew schedules to indicate the build-up of insufficient rest over time and when this is likely to result in dangerous levels of fatigue for any crew member.

- More broadly, these tools and literatures we describe point to the possibility for an increasingly holistic way of measuring and regulating the various aspects of crew working conditions and ship functioning. After all, the regulation of working hours, rest hour, and manning levels are aimed at ensuring that crew are not too stressed and fatigued to adequately and comfortably perform the range of duties—including security duties—required for safe and secure shipping. Tools that bind together actual trip-making patterns, tasks performed, and possible rest hours, can help all maritime stakeholders interact in a more transparent and integrated way that combines principle on the one hand, and flexibility and attention to particular cases and needs on the other.

- Because overwork occurs in peak periods, an increase in manning to accommodate these periods may sometimes result in “excess” crew for other periods. An alternative would be to relieve crew of some task in these peak periods—especially on the approaches to ports and the stays in ports. Officers can be relieved of certain administrative tasks, which can be reduced by more
streamlined and internationally uniform paperwork requirements, or performed by shore-based company personnel, and ratings can be relieved of gangway watches and cargo-related tasks in ports that can be outsourced to hired qualified port-based staff. These suggestions have been voiced for some time, and they might be considered in light of the evidence we present here regarding the importance of port stops in contributing to security-related work loads.

- The EU could strive for the same kind of data fusion for the human element of the maritime system as is being attempted for its physical elements. The goal would be to offer consistent and harmonised data on manning levels, salaries, and crew nationalities (and, possibly, the prevailing watch system on vessels). This would help to better understand and regulate maritime labour conditions, and, when combined with the AIS and simulation tools mentioned above, allow improved guidance of the regulation of workload, manning, and fatigue. Such approaches could help raise the quality of maritime crew resource planning, and reduce workload excesses to be more in line with those that prevail in other kinds of crew-based workplaces with demanding schedules, such as air, rail, and land transport.

- We also mention briefly some interesting recent legal developments that aim to level the work conditions of EU and non-EU seafarers, which could prove fundamentally disruptive to the landscape of maritime labour, and, thus, of the context of regulatory efforts and opportunities related to workload, rest hours, and related issues.
3. **Background to this study**

3.1 **Crewing level declines and the regulation of manning, work and rest**

Manning levels have been declining over several decades, from about 45 crew members for a typical merchant ship of 15,000 DWT down to 15 crew members over the last 40 years (MTCP, 2007). This is partly as a result of technological changes (ship design, automation) that make ships’ operations less labour intensive. Even after these reductions, with crew costs constituting about half of the annual operating costs of ships (Stopford, 2009; Gekara, 2008), there is clearly an incentive to find ways to reduce personnel further. The serious shipping recession of the 1980s provided an added push to reduce personnel by automation, with traditional shipping nations of Asia and northern Europe being particularly aggressive in this substitution (NAS, 1990). In some cases reduction of crew levels was a considered and justified response to new technological possibilities, undertaken after considerable study. But in others the reduction of crew exceeded the efficiencies offered by technology, spurred by a “race to the bottom” as Flag states compete for tonnage by offering the possibility of registering ships with smaller and cheaper crews than others (including EU flagged vessels) (Macdonald, 2006). The phenomenon of Flags of Convenience emerged in the 1920’s in reaction to labour legislation enacted by Congress that led to rising seafarer labour costs, which led some US shipowners to register their ships under Panama’s flag.

There have been attempts to regulate and protect manning levels and other aspects of the working conditions of maritime workers at an international level since the globalization and liberalization of the maritime sector places their operation outside of the jurisdiction of states (Adam and Traxler, 2008). The maritime industry has long been a forerunner of globalization (Sampson & Bloor, 2007), and the laxity of its regulation was aggravated by the rise of the Flag of Convenience (FOC) system, which further loosened links between the nationality of ship owner, manager, crewing agency, officers and crew, and country whose flag the ship flies, which is responsible for its regulation (Alderton, 2002a, 2002b; Llacer, 2003; Mansell, 2009; Thanopoulou, 2000).

The two international bodies that play a key role in regulation of maritime working conditions have been the IMO and the ILO, and in particular it’s Joint Maritime Commission (JMC). MacDonald (2006) describes the evolution of uniform standards regulating various aspects of this globalised and competitive industry, including not only safety and pollution but manning levels as well, and traces the role of these two...
key UN agencies. Over 60 international labour standards adopted by the ILO since 1920 were consolidated and updated in The Maritime Labour Convention (MLC), which was adopted in 2006 (Adam and Traxler; McConnell, 2011). However, the adequacy of the MLC is the subject of dispute by organizations representing maritime workers, and there are arguments that because of its location within the UN, the IMO is heavily influenced by a membership that includes many FOC countries, which are, in turn, heavily influenced by FOC ship owners (Marcus, 2012).

Workloads and manning levels (specifically, under-manning) have received particular attention, not only from the side of labour and a concern for seafarer wellbeing, but also from other maritime stakeholders concerned with the principal consequence of under-manning, namely widespread and chronic fatigue and its clear and important role in accidents. For example, a 1998 ITF report based on a large sample (2500 respondents under 63 flags) showed fatigue—and often extreme fatigue—to be common. More recent studies confirm the prevalence and worrying effects of fatigue at sea (Smith, 2007, 2008; Allen, 2007; Lutzhoft, 2011), and have shown their direct relation to excessive working hours, the inadequacy of existing regulation and auditing, and documented great diversity in its occurrence (among types of vessel and flag of registration, for example).

Attempts to control this problem have been made through regulating manning levels, on the one hand, and rest hours on the other (Marcus, 2012). Until recently, manning levels were determined by Flag Administrations in accordance with the guidance of IMO Resolution A.890(21) and Resolution A.955(23). These were recently superseded (November 30, 2011) by IMO Resolution A.1047 (27) – Principles of Minimum Safe Manning - which states:

"The minimum safe manning of a ship should be established taking into account all relevant factors, including the following:

- size and type of ship;
- number, size and type of main propulsion units and auxiliaries;
- level of ship automation;
- construction and equipment of the ship;
- method of maintenance used;
- cargo to be carried;
- frequency of port calls, length and nature of voyages to be undertaken;
- trading area(s), waters and operations in which the ship is involved;
- extent to which training activities are conducted on board;
- degree of shoreside support provided to the ship by the company;
- applicable work hour limits and/or rest requirements; and
The provisions of the approved Ship’s Security Plan.”

The Resolution continues:

“The determination of the minimum safe manning of a ship should be based on performance of the functions at the appropriate level(s) of responsibility, as specified in the STCW Code,” which include the following: navigation, cargo handling and stowage, operation of the ship and care for persons on board, marine engineering, electrical, electronic and control engineering, radio communications, as well as maintenance and repair”.

And, Consideration should also be given to:

“the number of qualified and other personnel required to meet peak workload situations and conditions, with due regard to the number of hours of shipboard duties and rest periods assigned to seafarers; and the capability of the master and the ship’s complement to coordinate the activities necessary for the safe operation and for the security of the ship and for the protection of the marine environment”

Companies are responsible for preparing a proposal for the minimum safe manning of ships in accordance with a form specified by the Flag Administration, containing, among other details, the number and grades/capacities of the personnel required to be carried, together with a formal statement by the Administration that the named ship is considered safely manned if it carries not less than these specified number and grades/capacities of personnel.

The Resolution Annex 5 describes a Framework for Determining Minimum Safe Manning, outlining a process which “should enable companies to achieve greater depth and insight into the interdependencies and interactions of operational elements that influence the amounts of crew member workload and, ultimately, the proposed minimum safe manning level.” This process involves a breakdown into tasks comprising the relevant necessary functions, the attributes of these tasks, and the personnel qualifications, procedures, and infrastructure/technologies needed to perform them. This assessment is used to determine the capacity of individuals to perform them, given human element limitations and relevant national and international regulations.

3.2 The persistence of under-manning and fatigue as chronic phenomena

“The answer to your questions is simple: more work, less people” (former engineer, interviewed Antwerp, 2012)
While IMO Principles of Safe Manning and the ILO Seafarers’ Hours of Work and the Manning of Ships are intended as guidance, there has been a sense that they are not being adhered to in the spirit intended (Macdonald, 2006). Manning levels vary considerably by flag state, and, in fact, one can observe identical sister ships flagged under different states where significantly different manning levels are declared as adequate. Thus, in practice, manning levels are inadequate on many ships and crew wellbeing (and, potentially, ship safety and security) may be compromised.

An ITF report (ITF, 1998) showed that two thirds of over 2500 respondents reporting working over 60 hours a week, and one quarter of them report more than 80 hours—a level exceeding the STCW 95 and ILO 180 requirements. Over half of respondents felt that their working hours endangered their own health and safety, and almost half felt that these endangered the safe operation of their ships. The longest hours worked were by watch-keepers, and most of these sensed an intensification of work. Thus, over 70% of masters, chief engineers and first officers reported a major increase in workload in the 5-10 years preceding the survey.

A landmark study on seafarer fatigue and the factors contributing to it was done at Cardiff University, based on a survey of 1856 seafarers, supplemented by diary studies and other indicators, and published in 2006 (Smith et al, 2006). One of the important findings was the inadequacy of prevailing reporting systems to capture fatigue, working hours, or other factors leading to fatigue. Specifically, ILO 180 and the EU working time directive were undermined by widespread under-reporting of actual working hours. Fatigue was especially pronounced on ships with frequent port calls, and mini-bulkers represented a “worst case” scenario, with not only frequent port calls and short port stays but changing cargos and only 2 watch-keepers.

A conference on fatigue and manning issues in St. Petersburg in 2006 (MacDonald, 2006) reflected some of the factors that facilitate under-manning and overwork and make it difficult to assess. These included the openness of guidance to interpretation (Resolution A.890(21) in that case, discussed in Section 3.3.2.1), the fact that flagging choices were made, in part, precisely, in order to obtain more lax manning levels, the difficulty of assessing fatigue directly or through logbooks during an inspection and the ease with which logbooks can be falsified, ship-owner resistance to increases in crew sizes, the barriers preventing key personnel from delegating responsibilities to junior or less competent crews, the prevalence of a flawed Two-Watch system, and so on. Also helpful was the extensive report on fatigue by TNO (Houtman, 2005) and the recently completed HORIZON project (Barnett, 2012).
The above can in some way be attributed to decade-long declines in crew sizes, and a growing concern about workload additions from a variety of causes.

A report by a seafarer on a Ro-Ro vessel is typical of the sense of ever-increasing tasks that have not been accommodated.

“Since I first went to see [sic] in 1991 we have introduced numerous additional items, such as ISPS, GMDSS, FRC training, ISM, Crisis Management Training etc., etc., which all bring with them additional workload. However we have not increased the number of people available to deal with this workload nor have we removed any obsolete items. ……”

In the following sections we describe:

1) the regulatory instruments on which ship security duties (and interrelated safe manning levels are based (3.3));
2) the current state of “safe manning” across selected EU Member States (3.4); and,
3) the security related tasks (ISPS and piracy) that began to emerge from the year 2000 onward, whose workload and manning implications are the focus of this our research and this report (3.5).

3.3 Maritime regulations relevant to the study

3.3.1 Legal framework

The maritime industry is today subject to a complex, multilevel legal framework respecting safe manning of ships. Relevant to the remit of this study are regulations relating to security duties, and their impact on the safe manning of ships.

At the international level, safe manning of ships is regulated by treaty instruments generated by the International Maritime Organization (IMO) and the International Labour Organisation (ILO). The IMO and ILO are specialised agencies of the United Nations.

Some provisions of the United Nations Convention on the Law of the Sea, 1982 (UNCLOS) are also of relevance regarding flag state prerogatives as distinguished from port state jurisdiction. The requirements of international instruments regarding manning of ships are given effect through national legislation of State parties. Each vessel registered in such a state is issued a “Safe Manning Document” by the flag state

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Administration, which sets out the safe manning scale approved to the vessel. The Safe Manning Document is subject to Port State Control (PSC) inspections.

The relevant IMO instruments include the IMO International Convention for the Safety of Life at Sea (SOLAS), adopted 1 November 1974 and entered into force 25 May 1980, which requires that contracting governments – with respect to their national ships - ensure that “from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned”. It further requires each ship to be issued with a safe manning document and to establish a working language.

Of relevance too are the IMO Convention on Standards, Training Certification and Watchkeeping (STCW) regulations and the associated Code sections addressing fitness for duty and watchkeeping arrangements and hours of rest for watchkeepers. Other instruments include IMO Resolution A890 (21) on “Principles of Safe Manning” and subsequent amendments in Resolution A955 (23). The binding nature of these guidelines is limited since these resolutions are recommendatory in nature.

The nature and text of the IMO instruments, especially as quoted above from SOLAS, leaves a lot to the discretion of the State parties. It is debatable, for a particular ship, what specific manning level, is “sufficient and efficient” from the point of view of safety of life at sea. This ambiguity has led to the permitting of varied manning scales and a resulting migration of tonnage from strict administrations (where higher scales are mandated) to more permissive regimes. The text of the law as it now stands in SOLAS may be considered to not sufficiently address this issue.

It must be noted that the definition of “safe” is exceedingly complex. In SOLAS there is really only a broad requirement that all ships must be “sufficiently and efficiently manned”. Early IMO resolutions, while interpreting this more sensibly and covering a wider range of safety (but not initially security) aspects were also deficient as a measure of work-load because they omitted many aspect of seafarer tasks (e.g., related to cargo handling and ships maintenance).

It is noteworthy that while SOLAS is primarily binding on State parties, it can be argued that it is pervasive enough to be considered customary law and thus binding on all states.

The remainder of this section of the report provides a high level overview of the relevant international and EU regulatory frameworks.

### 3.3.2 Safe Manning of Ships – IMO Instruments

The International Maritime Organisation (IMO) is the United Nations agency responsible for developing international regulation for the shipping industry. This
includes measures to deal with safety, the environment, technical cooperation, legal issues and security.

The IMO sets international standards through a number of conventions and guidelines, the three main IMO Conventions being:

- International Convention for the Safety of Life at Sea (SOLAS);
- Standards of Training, Certification and Watchkeeping (STCW); and
- International Convention for the Prevention of Pollution from Ships (MARPOL)

The IMO Conventions are important as they have a direct impact on living and working conditions of seafarers. The IMO is made up of representatives of the flag states. The International Transport Workers Federation (ITF), representing the interests of seafarers, and the organisations representing the shipping industry have observer status.

The IMO SOLAS Convention was initially adopted on January 1914, in response to the sinking of the Titanic. It entered into force in July 1915, after the First World War had already broken out in Europe. Since that time a number of revisions have been adopted.

The SOLAS Convention included a regulation on "Manning" in Chapter V (V/13) which read as follows:

"The Contracting Governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned."

In 1981 IMO adopted Assembly Resolution A.481 (XII) – Principles of Safe Manning. It provided guidance for Administrations when determining safe manning levels on ships flying their flags. The Resolution called for a document to be issued by the Administration specifying the minimum safe manning required which was called the "Minimum Safe Manning Document". However, the principles contained in this Resolution were not mandatory.

Eight years after the adoption of A.481 (XII), SOLAS V/13 was amended to require ships to be provided with a safe manning document or equivalent, as called for by the non-mandatory A.481 (XII) from 1981. The new regulation read as follows:

(a) The Contracting Governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned. * (See note below)

(b) Every ship to which chapter I of this Convention applies shall be provided with an appropriate safe manning document or equivalent issued by the Administration
as evidence of the minimum safe manning considered necessary to comply with the provisions of paragraph (a).

* Refer to the Principles of Safe Manning, adopted by the Organization by resolution A.481(XII).

In 1999 IMO adopted Assembly Resolution A.890 (21) – Principles of Safe Manning, which modified A.481 (XII) and replaced it. This new resolution, like A.481(XII), was only guidance and not mandatory. It was based on A.481 (XII) but also included additional principles regarding the importance of adequate ship manning relating to protecting the marine environment and compliance with hours of work and rest, among other things, to be considered by administrations when determining safe manning on ships flying their flag. The amendments to the resolution also included the possibility for an administration to require the company responsible for the operation of the ship to prepare its proposal for the minimum safe manning level based on the principles in the amended resolution, which the administration would then review and approve, if satisfied.

In 2002, regulation SOLAS V/13 regarding ships’ manning was re-paragraphed to V/14 as follows, and the footnote was updated with the new resolution A.890 (21):

1. Contracting Governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned*. (See footnote below)

2. Every ship to which chapter I applies shall be provided with an appropriate minimum safe manning document or equivalent issued by the Administration as evidence of the minimum safe manning considered necessary to comply with the provisions of paragraph 1.

* Refer to the Principles of Safe Manning adopted by the Organization by Resolution A.890 (21).

3.3.2.1 IMO Resolution A.890 (21) – Principles of Safe Manning

Resolution A.890 (21) “notes that safe manning is a function of the number of qualified and experienced seafarers necessary for the safety of the ship, crew, passengers, cargo and property for the protection of the marine environment and that ability of seafarers to maintain observance of the requirements is also dependent upon conditions relating to training, hours of work and rest, occupational safety, health and hygiene and the proper provision of food.”
As with many IMO resolutions, it is open to different interpretations, which can vary widely from administration to administration. This can result in the minimum safe manning requirements differing across flag administrations, sometimes significantly.

Where IMO resolution A.890 (21) is entitled ‘principles’ of safe manning, the key concept to understand is ‘principles’: the document goes little further than laying out some very fundamental first principles in terms of what should be understood by safe manning. The guidance given is broad and non-specific as illustrated by the examples below:

Annex 1 of this Resolution states that the following principles should be observed in determining the minimum safe manning of a ship. The capability to:

- maintain safe navigational, engineering and radio watches in accordance with regulation VIII/2 of the 1978 STCW Convention, as amended, and also maintain general surveillance of the ship;
- moor and unmoor the ship safely;
- manage the safety functions of the ship when employed in a stationary or near-stationary mode at sea;
- perform operations, as appropriate, for the prevention of damage to the marine environment;
- maintain the safety arrangements and the cleanliness of all accessible spaces to minimise the risk of fire;
- provide for medical care on board ship;
- ensure safe carriage of cargo during transit;
- inspect and maintain, as appropriate, the structural integrity of the ship;

Annex 2 of this Resolution states that the minimum safe manning level of a ship should be established taking into account all relevant factors, including the following:

- size and type of ship;
- number, size and type of main propulsion units and auxiliaries;
- construction and equipment of the ship;
- method of maintenance used;
- cargo to be carried;
- frequency of port calls;
- length and nature of voyages to be undertaken;
- trading area(s), waters and operations in which the ship is involved;
- extent to which training activities are conducted on board;
- applicable work hour limits and/or rest requirements.
3.3.2.2 IMO Safe Manning amendments

Following the 9/11 attacks, maritime security was introduced into SOLAS by means of Chapter XI-2 (ISPS-Code). As a consequence, in 2003 IMO amended A.890 (21), through the adoption of Assembly Resolution A.955 (23) - Amendments to A.890 (21)), to include the principle of maritime security onboard ships when considering safe manning. The footnote in SOLAS V/14 referencing Resolution A.890 was amended accordingly to take into account the amendments.

In the preamble to this resolution which amended Resolution A.890 (21) the following is stated: “...MINDFUL of the provisions of SOLAS Chapter XI-2 and the International Ship and Port Facility Security (ISPS) Code relating to the security of ships and port facilities”

The Resolution adds a further condition to the elements in Annex 2 of Resolution A890 (21) which is:

- “the provision of the approved Ship’s Security Plan”

SOLAS Regulation V/14 from 2002 and A.890 (21) as amended by A.955 (23) are the applicable requirements and recommendations, during the period relevant to this study. It should be noted that the only mandatory requirement was Regulation V/14 in SOLAS, which only references A.890 (21) as amended by A.955 (23) in the footnote (above). Footnotes in SOLAS are not part of the legal text of the Convention and thus, the Resolution referenced therein is not mandatory by SOLAS. However administrations can, and in fact many do, transpose resolutions referenced in footnotes into their national law.


The Assembly further recommended that Governments in establishing the minimum for safe manning for ships flying their countries’ flag, observe the Principles set out in Annex 1 and the procedures as set out in Annex 5 and take into account the Guidelines set out in Annexes 2 and 3; it urged Governments to ensure that minimum safe manning documents contain, as a minimum the information set out in Annex 4; it further urged Governments, when exercising Port State Control functions
under international conventions in force with respect to foreign ships visiting their ports, to regard compliance with the minimum safe manning docents as evidence that such ships are safely manned.

This Annex (17) was adopted in 2011 as IMO Resolution A.1047 (27) – Principles of Minimum Safe Manning.

### 3.3.2.3 STWC Manila Amendments

The Convention on Standards of Training, Certification and Watchkeeping (STCW) and Code had been adopted in 1978 by conference at the IMO in London but did not enter into full force until 1984. It was further amended in 1995. The STWC Convention describes minimum standards, which countries are obliged to meet or exceed, relating to training, certification and watchkeeping for seafarers. It does not however deal with manning levels – these are covered by the above IMO provisions. The continuing importance of the STCW Convention is that it applies to ships of non-party States when visiting ports of States which are Parties to the Convention.

The Manila Amendments to the STWC Convention were adopted on 25 June 2010, marking a major revision of the STCW Convention and Code. “The 2010 amendments are entering into force in a staged manner, having begun January 1, 2012 and continuing until January 2017 when full enforcement is required”. They are aimed at bringing the Convention and Code up to date with developments since they were initially adopted and to enable them to address issues that are anticipated to emerge in the foreseeable future.

Included in the amendments adopted, the issue of security training is highlighted, and now require, in addition to the existing Ship Security Officer training (which is unchanged), that all seafarers are properly trained to cope if their ship comes under attack by pirates, and to protect the ship against unlawful acts.

The Manila Amendments bring in three new levels of security training:

- Security related familiarisation;
- Proficiency in security awareness; and
- Proficiency in designated security duties

The Manila Amendments will further impact the manning of ships as they reinforce a minimum period of 10 hours rest in any 24-hour period; and 77 hours in any 7-day period. A summary of the new security training requirements in included in Annex 3 to this report.
3.3.3 ILO instruments

The International Labour Organisation (ILO) is the UN agency that sets internationally recognised labour standards to protect the rights of workers. The ILO is made up of a social partnership of governments, employers and trade unions. The ILO sets international labour standards through key international agreements.

The ILO Convention 180 – Seafarers’ Hours of Work and the Manning of Ships, 1996 – requires that ships be “sufficiently, safely and efficiently manned in accordance with the minimum safe manning document”. While the wording here is different from that found in the IMO instrument, the pith and substance of the requirement is essentially the same and leaves the definition of what is sufficient, safe and efficient to the State party.

The IMO Seafarers’ Identity Documents Convention (Revised), 2003 (No. 185) addresses the need for seafarers to obtain temporary admission into the territories of the countries visited: shore leave after working at sea for perhaps several months at a time; and permission to transit through a country to join or change ship or for repatriation.

An ILO instrument of particular importance is the new Maritime Labour Convention, 2006 (MLC, 2006). This instrument consolidated and updated the majority (68 out of 72) of the ILO’s maritime Conventions and Recommendations adopted since 1920. It is based on certification by flag states of maritime labour standards with a focus on the development of national enforcement and compliance systems. It is addressed to flag states, port states and countries with labour supplying interests.

The MLC 2006 is a comprehensive international labour convention that was adopted by the ILO at a maritime session in February 2006. It sets out seafarers’ rights to decent conditions of work and helps to create conditions of fair competition for shipowners. It is intended to be globally applicable, easily understandable, readily updatable and uniformly enforced.

It has been designed to become a global legal instrument that will be the “fourth pillar” of the international regulatory regime for quality shipping, complementing the key conventions of the IMO, (SOLAS, STCW, and the International Convention for the Prevention of Pollution from Ships, 73/78 (MARPOL).

The MLC, 2006 contains a comprehensive set of global standards, based on those that are already found in the maritime labour instruments (Conventions and Recommendations), adopted by the ILO between 1920 and 1996. It brings all, except
four, of the existing maritime labour instruments (International Labour Standards (ILS)) together in a single Convention that uses a new format, with some updating, where necessary, to reflect modern conditions and language. It is intended to be easily understandable to avoid previous problems of excessive detail in earlier ILO conventions that made ratification difficult. It is further intended to be easy to update, to keep pace with changing industry conditions, and to ensure that, unlike previous conventions, it continues to reflect contemporary working conditions on ships. Finally, the MLC, 2006 contains greater powers of enforcement and a compliance system to eliminate substandard working terms and conditions.

One objective of the MLC is to ensure that seafarers are guaranteed equal and acceptable conditions no matter which flag they sail under. It aims to create a level playing field and contains a number of principles such as non-discrimination on the basis of a seafarers race, colour, sex, religion, political opinion, national extraction or social origin. It also seeks to provide new rights to seafarers with respect to employment benefits, health and safety and accommodation.

The convention states that:

“Each Member shall require that all ships that fly its flag have a sufficient number of seafarers employed on board to ensure that ships are operated safely, efficiently and with due regard to security under all conditions, taking into account concerns about seafarer fatigue and the particular nature and conditions of the voyage.”

Further:

“Each Member shall require that all ships that fly its flag have a sufficient number of seafarers on board to ensure that ships are operated safely, efficiently and with due regard to security. Every ship shall be manned by a crew that is adequate, in terms of size and qualifications, to ensure the safety and security of the ship and its personnel, under all

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5 According to ILO FAQ – A19, the existing ILO maritime labour Conventions will be gradually phased out as countries that have ratified those Conventions ratify the MLC, 2006, but there will be a transitional period when some Conventions will be in force in parallel with the MLC, 2006. Countries that ratify the MLC, 2006 will no longer be bound by the existing Conventions when the MLC, 2006 comes into force for them. Countries that do not ratify the MLC, 2006 will remain bound by the existing Conventions they have ratified, but those Conventions will be closed to further ratification. Entry into force of the MLC, 2006 will not affect the four maritime Conventions that are not consolidated in the MLC, 2006. Those are the Conventions addressing seafarers’ identity documents of 2003 and the 1958 Convention that it revises, the Seafarers’ Pension Convention, 1946 and the Minimum Age (Trimmers and Stokers) Convention, 1921]. They will remain binding on States that have ratified them irrespective of the MLC, 2006.
operating conditions, in accordance with the minimum safe manning document or an equivalent issued by the competent authority, and to comply with the standards of this Convention.

When determining, approving or revising manning levels, the competent authority shall take into account the need to avoid or minimise excessive hours of work to ensure sufficient rest and to limit fatigue, as well as the principles in applicable international instruments, especially those of the International Maritime Organization, on manning levels.

When determining manning levels, the competent authority shall take into account all the requirements within Regulation 3.2 and Standard A3.2 concerning food and catering.”

3.3.4 Port State Control and the Paris MoU

It is clearly understood that the responsibility for ensuring that ships comply with the provisions of the relevant instruments rests upon the owners, masters and the flag States.

Port State Control (PSC) is the inspection of foreign ships in other national ports by PSC officers (inspectors) for the purpose of verifying that the competency of the master and officers on board, and the condition of the ship and its equipment comply with the requirements of international conventions (e.g. SOLAS, MARPOL, STCW, etc.) and that the vessel is manned and operated in compliance with applicable international law.

IMO has encouraged the establishment of regional port State control organizations and agreements on port State control. Memoranda of Understanding (MoUs) have been signed covering all of the world’s oceans.

In 1978, a number of European countries agreed in The Hague on a memorandum that agreed to audit whether the labour conditions on board vessels were in accordance with the rules of the ILO. After the Amoco Cadiz sank that year, it was decided to also audit on safety and pollution. To this end, in 1982 the Paris Memorandum of Understanding (Paris MoU) was agreed upon, establishing Port State Control, nowadays 26 European countries and Canada. It covers the waters of the European coastal States and the North Atlantic basin from North America to Europe.

The Port State Control inspections were originally intended to be a back up to flag State implementation, but experience has shown that they can be extremely effective, especially if organized on a regional basis. A ship going to a port in one country will normally visit other countries in the region before embarking on its
return voyage and it is to everybody’s advantage if inspections can be closely coordinated.

This ensures that as many ships as possible are inspected but at the same time prevents ships being delayed by unnecessary inspections. The primary responsibility for ships’ standards rests with the flag State - but port State control provides a “safety net” to catch substandard ships.

Annually more than 19,000 inspections take place on board foreign ships in the Paris MoU ports.

3.3.5 Piracy

International law, as codified in Article 101 of the United Nations Convention on the Law of the Sea, contains three criteria for the offence of piracy: it must be conducted (1) on the high seas against (2) another vessel and (3) for private gain. The definition used by the IMO is broader and speaks not of piracy but act of armed robbery against ships or at sea, which also encompasses attacks in territorial waters (including internal waters) and on vessels in port. There can also be a political dimension to such acts.

The nations hit worst by piracy are those with the biggest merchant fleets. Although 90% of the EU’s external exports are transported by sea, the probability of pirate attack is still fairly small. However from the commercial point of view, the enormous value of the vessels and the cargos they transport means there is nonetheless a significant financial risk, reflected for instance in increased insurance premiums.

Maritime insecurity adopts regionally very distinct forms. In West Africa and in the Gulf of Guinea there is a concentration of attacks on ships in the Port of Lagos and the nearby Nigerian coast. Here the pirates’ objective is usually to steal cargo, although frequently crew members are also kidnapped and held for ransom. Such attacks also target oil platforms, sometimes with the goal of stopping oil production.

In the Gulf of Aden the predominant manifestation is capturing vessels and holding them and their crews for ransom. In South and Southeast Asia the aim is generally to steal cargo, although for a period an extremely sophisticated form of piracy was practiced there in which whole ships were taken over, repainted and furnished with forged documents allowing their new “owners” to operate them in their own names.

In Latin America robbery is the main threat to maritime security, affecting inland waterways as well as coastal waters and ports.

Between 2000 – 2009 the pattern of attacks changed. In 2000 most incidents concerned ships anchored in port or in the territorial waters of the affected States, with the notable exception of the Straits of Malacca where ships moving at high
speed were also attacked. Since 2009 the majority of incidents have taken place on
the high seas while vessels are under way.

On 2 December 2009 the 26th regular session of the IMO Assembly adopted a
resolution on piracy and armed robbery against ships in waters off the coast of
Somalia, which, among other things, condemns and deplores all such acts,
irrespective of where they have occurred or may occur. Building on resolution
A.1002(25), adopted by the Assembly in 2007, the new resolution welcomed the
decision, taken on 30 November by the United Nations Security Council (through
resolution 1897 (2009)), to renew, for a period of 12 months, its previous
authorizations for States and regional organizations co-operating with the Somali
Transitional Federal Government (TFG) to enter Somalia’s territorial waters and use
all necessary means to fight piracy and armed robbery at sea of the Somali coast,
provided advance notification was given by the TFG to the United Nations Secretary-
General. The IMO Assembly resolution (A.1026(26)) supports the Security Council
resolution by appealing to all parties that may be able to assist, to take action (within
the provisions of international law) to ensure that all acts or attempted acts of piracy
and armed robbery against ships are stopped and any plans for committing such acts
are curtailed; and that hijacked ships and any persons on board are immediately and
unconditionally released and that no harm is caused to them. The resolution also
recommended that, when navigating through the Gulf of Aden, ships should follow
the Internationally Recommended Transit Corridor and take the advice and guidance
provided. States were strongly urged to take all necessary legislative, judicial and
law-enforcement action to enable them to receive and prosecute or extradite any
pirates or suspected pirates and armed robbers.

Under the auspices of the International Chamber of Shipping, a number of industry
organisations have contributed to the development of the Best Management Practice for
the Protection against Somali Based Piracy (BMP). On 14 September 2011, the IMO
published MSC.1 Circ. 1339 which invited Member Governments to “consider BMP, as set
out in annex 2, and advise owners, operators and managers of ships entitled to fly their
flag, as well as the shipboard personnel employed or engaged on such ships, to act
accordingly…….”. The current issue of this guidance, BMP4, is considered as a de-facto
guide to ship owners and crew transiting through areas at risk to piracy. A summary of
the crew tasks associated with BMP4 is included in Annex 2 to this study.

Commission Recommendation 2010/159/EU refers to “measures for self-protection
and the prevention of piracy and armed robbery against ships”.

Article 29 of the recent EU Transport White Paper COM(2011) - 144 Final published
on 28 March 2011 states:
“The EU should strive – in cooperation with IMO and other international organisations – for the universal application and enforcement of high standards of safety, security, environmental protection and working conditions, and for eliminating piracy.”

3.3.6 EU Maritime Regulation


At Community level, Directive 1999/63/EC of 21 June 1999, concerning the Agreement of the organisation of working time of seafarers concluded by the European Community Shipowners’ Association (ECSA) and the Federation of Transport Workers’ Unions in the European Union (FST), defined the applicable manning levels for ships registered in the territory of a Member State.

The primary EU Regulation maritime security legislative instrument is, however, Regulation (EC) No 725/2004 of 31 March 2004 on enhancing ship and port facility security. This Regulation provides for the implementation of Community policies aimed at enhancing the security of ships through measures of a preventive nature used in international trade and associated port facilities in the face of threats of intentional unlawful acts (including piracy and armed robbery at sea). The Regulation provides a basis for the harmonised interpretation, implementation and Community monitoring of the special measures to enhance maritime security adopted by the IMO in 2002, which amended the 1974 SOLAS Convention and established the International Ship and Port Facility Security Code (ISPS Code). Part A of ISPS is mandatory and Part B recommended. Included in Article 3 of Regulation (EC) No 725/2004 is the requirement that Member States shall conform to paragraph 4.28 (manning level) of Part B of the ISPS Code “as if it were mandatory”. Paragraph 4.28 is as follows:

4.28 In establishing the minimum safe manning of a ship the Administration should take into account that the minimum safe manning provisions established by regulation V/143 only address the safe navigation of the ship. The Administration should also take into account any additional workload which may result from the implementation of the ship’s security plan and ensure that the ship is sufficiently and effectively manned. In doing so the Administration should verify that ships are able to implement the hours of rest and other measures to address fatigue which have been promulgated by national law, in the context of all shipboard duties assigned to the various shipboard personnel.
Article 3 Regulation (EC) No 725/2004 also lists other sections of ISPS Part B that are to be mandatory for EU Member States. Some of these impose or may impose security-related tasks on ship crew members. The relevant ISPS Part B paragraphs are 1.12, 4.41, 8.3-8.10, 9.2, 13.6, 13.7, and 18.6.

The additional tasks are as follows for the relevant paragraphs:

- 1.12: Ship Security Officer should monitor the continuing relevance and effectiveness of the Ship Security Plan, including the undertaking of internal audits.
- 4.41: Where a ship is denied entry or expelled from a port, all known facts should be communicated to the authorities of relevant States. One or more crew members will be involved in the preparation of such reports.
- 8.3-8.10: These sections relate to Ship Security Assessments. While the Company Security Officer is responsible for the preparation of SSAs, he may delegate some of the work to others, including Ship Security Officers and/or other ship crew members, thereby creating additional tasks for affected ship crew members.
- 9.2: This relates to the Ship Security Plan. While the Company Security Officer is named as ultimately responsible for ensuring that a Ship Security Plan (SSP) is prepared and submitted for approval, the CSO may delegate some of the work to others, such as ship security officers and/or other ship crew members, thereby creating additional tasks for affected ship crew members.
- 13.6: To ensure the effective implementation of the provisions of the ship security plan, drills should be conducted at least once every three months. In addition, in cases where more than 25 percent of the ship’s personnel has been changed, at any one time, with personnel that has not previously participated in any drill on that ship, within the last 3 months, a drill should be conducted within one week of the change. This will affect all ship crew members with responsibilities specified in the SSP.
- 13.7: This section relates to exercises concerning ship security plans, to be carried out at least once every calendar year, to test communications, coordination, resource availability, and response. These exercises may include Ship Security Officers “if available”.
- 18.6: This section relates to exercises concerning port facility security plans, to be carried out at least once every calendar year, to test communications, coordination, resource availability, and response. These exercises may include Ship Security Officers “if available”.

Directive 2005/65/EC of 26 October 2005 on enhancing port security complemented the security measures introduced by Regulation (EC) No 725/2004 by making an entire port subject to a security regime. The preamble to the Directive stated that Regulation (EC) No 725/2004 was limited in scope to security measures on board vessels and the immediate ship/port interface. The Parliament and the Council determined that in order to obtain maximum protection for maritime and port activities, measures should be taken that cover all ports within a perimeter defined
by the Member State in question, thereby ensuring that security measures taken in accordance with the Regulation benefit from enhanced security within the areas of port activity. These measures should apply to all ports in which one or more port facilities covered under the Regulation are situated. The Directive also provides for mechanisms for implementing these measures and checking their conformity. The Member States were required to transpose this Directive into national legislation by 15 June 2007.

On 20 January 2009, the Commission submitted a report assessing the implementation of the Directive to the European Parliament and the Council based, among other things, on the information obtained by monitoring the implementation of this Directive by Member States. The report focused on implementation related matters and short-term results. This report found that even after an extension of 6 months after the initial 12 months granted for the Transposition of the Directive into national legislation, most of the Member States involved only transposed the Directive after this period had passed, some with a significant delay that could only be reduced by the opening of infringement proceedings.

Nevertheless, there were still some organisational and functional difficulties in terms of practical implementation at port level and the report criticised local administrations as being not fully equipped to ensure the practical implementation of the Directive.

In order to monitor the application by Member States of EU legislation on maritime security, Regulation (EC) No 324/2008 on procedures for conducting Commission inspections in the field of maritime security was adopted. This regulation laid down procedures for the monitoring by the Commission of the implementation of Directive 2005/65/EC jointly with the inspections at the level of Member States and port facilities, in respect of ports.

The objective of these inspections was to verify the effectiveness of national quality control systems and maritime security measures, procedures and structures at each level of each Member State and of individual port facilities and relevant companies. Regulation (EC) No 324/2008 required that the European Maritime Safety Agency (EMSA) participates in these inspections led by the Commission’s services and provide the Commission with technical assistance in the performance of the inspection tasks in respect of ships, relevant companies and Recognised Security Organisations.

On 11 March 2010 the Commission published Recommendation 2010/159/EU on measures for self-protection and the prevention of piracy and armed robbery against ships. The Commission requested that the Member States ensure the effective and
The harmonised application of a set of inventories and consolidated protective measures (provided in Annexes to the Recommendation) to deal with the threats which ships may face during acts of piracy and armed robbery. Included in the General Measures (Article 2 of the Recommendation) was 1) a request to Member States to inform Operators registered with them of circular MSC.1/Circ 133 adopted at the 86th session of the IMO’s Maritime Safety Committee, which set out and updated preventive measures for self-protection that ships and shipping companies are called on to implement in order to combat piracy and armed robbery wherever such risk occurs, in accordance with the International Ship and Port Facility Security Code (ISPS Code); and 2) a request to Member States to ensure above all that their ships are sufficiently and effectively manned in accordance with Rule 4.28 of Part B of the ISPS Code.

The Commission is assisted by a Regulatory Committee (Maritime Security Committee - MARSEC) acting in accordance with the regulatory procedure. MARSEC is a Regulatory Committee established by virtue of Article 11 of Regulation (EC) No 725/2004 and it also assists the Commission with regard to its activities under Directive 2005/65/EC. The Regulatory Committee is chaired by the Commission and consists of experts representing all Member States. Periodical exchange of information between Member States and Norway and Iceland, has taken place. Best practices and indications on national instructions have been shared in this forum and, most importantly, it was recently agreed to create a mechanism for secure mutual information where each Member State could insert sensitive information i.e. security levels adopted, threat evaluations and others topics relevant for the security of European shipping.

The Commission has established and meets regularly a Stakeholder Advisory Group on Maritime Security (SAGMAS) which is a forum where the stakeholders can express their views on the work of the Regulatory Committee, MARSEC. The Commission considers inviting to meetings of SAGMAS any stakeholder organisation that is a European or international (and not merely a national) organisation, and has a demonstrable professional interest in the subject of maritime security (as covered by EC legislation), and in the view of the Commission will offer an added value to the subjects under discussion at the particular meeting of the Committee.
3.3.7 Training – Directive 2012/35/EU\textsuperscript{6}

The STCW Convention was integrated into Union law for the first time by Council Directive 94/58/EC of 22 November 1994 on the minimum level of training of seafarers. Afterwards the EU rules on training and certification of seafarers have been adapted to the subsequent amendments to the Convention, while a common EU mechanism for the recognition of the systems of training and certification of seafarers in the third countries has been set up; lately, the rules of the Union on this matter have became become Directive 2008/106/EC of the European Parliament and of the Council.

In 2010 a Conference between the State Parties to the STCW Convention was held in Manila and introduced several significant changes to the Convention, amongst other elements (the prevention of fraudulent practices for certificates and in medical standards) in the matter of training on security and in technology-related matters. The Manila amendments have also introduced requirements for able seafarers and established new professional profiles, such as electro-technical officers.

The STCW Manila amendments to the Convention will (as mentioned above) initially enter into force on 1 January 2012. From that date onwards maritime training will have to meet the new requirements. Since the EU Member States are also parties to the Convention, and none of them opposed the Manila amendments, they will have to adapt their legislation to the new text of the Convention.

The objective of this Directive was to integrate into EU law the 2010 amendments to the STCW Convention, in order in particular to avoid any conflict between the international and the EU obligations of the Member States.

The area of interest to this study relates primarily to security-related training and “safe manning”;

The new Directive incorporates this and the other STCW amendments into EU law, while adapting the provisions of the STCW Convention on watchkeeping in order to bring them into line with EU rules on working time for seafarers.

With respect to training, Member States must take the necessary measures to ensure that seafarers serving on ships are trained as a minimum in accordance with the requirements of the STCW Convention.

\textsuperscript{6} Amending Directive 2008/106/EC on the minimum level of training of seafarers that entered into force on January 03, 2013
With respect to Certificates of competency, certificates of proficiency and endorsements: the text stipulates that Candidates for certification shall provide satisfactory proof of their identity, age, mental fitness, standards of competence, etc.

Member State must maintain a register or registers of all certificates of competency and certificates of proficiency and endorsements for masters and officers and, where applicable, ratings which are issued, have expired or have been revalidated, suspended, cancelled or reported as lost or destroyed, as well as of dispensations issued; and make available information on the status of certificates of competency, endorsements and dispensations to other Member States or other Parties to the STCW Convention and companies which request verification of the authenticity and validity of certificates.

All persons who are assigned duty as officer in charge of a watch or as a rating forming part of a watch, and those whose duties involve designated safety, prevention of pollution and security duties shall be provided with a rest period of not less than a minimum of 10 hours of rest in any 24-hour period; and 77 hours in any seven-day period (The requirements for rest periods need not be maintained in the case of an emergency or in other overriding operational conditions). Musters, fire fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, shall be conducted in a manner that minimises the disturbance of rest periods and does not induce fatigue.

3.3.8 EU Crewing Guidelines

Although specific EU Crewing guidelines do not exist, there are regulations which are of clear relevance to this issue. In particular, there is the EU Working Time Directive\(^7\).

To stay within these regulations it is necessary for shipping companies to employ sufficient qualified crew so that no individual seafarer exceeds the legally stipulated maximum hours of work.

Current working time directives (enforced in September 2002), as they apply to seafarers employed on board EU registered vessels, state that “...maximum hours of work...shall not exceed either 14 hours in any 24-hour period and 72 in any 7-day period..”(clause 5, 1a) or “...minimum hours of rest...shall not be less than 10 hours in any 24-hour period and 77 hours in any 7-day period” (clause 5, 1b). Furthermore, that “Hours of rest may be divided into no more than two periods, one of which shall

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\(^7\) Directive 2003/88/EC
be at least 6 hours in length, and the interval between consecutive periods of rest shall not exceed 14 hours” (clause 5, 2). The Working Time Directive therefore has relevance to the issue of safe manning in EU waters - although only to the extent that vessels in these waters are registered in the EU.

As explained earlier, the European legislative framework with respect to safe manning is governed by Council directive 1999/63/EC. This directive has universal applicability to member states as it is addressed to all of them. It requires all states to have brought into force, “the laws regulations and administrative provisions necessary to comply with the directive by 30th June 2002”.

Clause 10.3 of the directive, in consonance with the cited international instruments, requires all ships to which the agreement applies, to be “sufficiently, safely and efficiently manned, in accordance with the minimum safe manning document or an equivalent issued by the competent authority”. This is binding for all states in compliance with the directive, but as is the case for the international instruments, no specific manning levels are set.

A noteworthy deviation from the international instruments is found in Clause 12 of this directive. It requires that a shipowner “shall provide the master with the necessary resources for the purpose of compliance with obligations under this Agreement, including those relating to the appropriate manning of the ship”.

The master is further required to “take all necessary steps to ensure that the requirements on seafarers’ hours of work and rest arising from this Agreement are complied with”. The raises the issue as to whether this implies, prima facie, that the master can, by law and on reasonable grounds, decide on the augmentation of manning levels.

Legislation at the European level, as represented by Council directive 1999/63/EC, is similar to the international instruments and essentially has the same tendency of not setting specific, uniformly determinable manning scales.

Interestingly, there appears to be no provision in international and EU law for the mandatory reviewing or renewal of a safe manning document once it is approved/issued, unlike most ship documents. A determination has to be made as to what happens when the principles on which the approval and issuance of the

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8 COUNCIL DIRECTIVE 1999/63/EC of 21 June 1999 concerning the Agreement on the organisation of working time of seafarers concluded by the European Community Shipowners’ Association (ECSA) and the Federation of Transport Workers’ Unions in the European Union (FST)
document was based change for a particular ship. Currently this too seems to be left to the discretion of the company to apply for a new safe manning document when such factors as trading pattern and technology level change.

At the national level, States set the requirements for safe manning through national laws and regulations, taking into account their international and regional obligations. The ambiguity of the international and regional instruments tends to set in at this point and is exhibited in the variation and discrepancies between the methods and criteria different States use for establishing safe manning for their ships. In some countries, this is based on a table which considers ship particulars (such as Gross Tonnage and Brake Horse Power) and determines the required level of manning. The prerogative of the administration is exercised with minimum input from the shipowner. In other countries, this is done on a “case by case” basis, upon submission of a proposal for manning by the shipowner. The Administration then reviews/comments/modifies the proposal, and may require a detailed inspection of the ship by surveyors. In both cases the extent to which all the principles, as suggested by the IMO for example, are applied will vary based on what the particular administration sees as sufficient, safe and efficient either intuitively, by consultation or by self-determined formulae.

Finally, it should be noted that the Commission, on March 13, 2008, published a Document (7509/08 of 13 March 2008) a draft progress report on a proposal for a Directive of the European Parliament and the Council on Compliance with flag state requirements.

This proposal, which was part of the third maritime safety package, proposed a Directive to ensure that “Member States effectively and consistently discharge their obligations as flag states in accordance with the IMO conventions relating to maritime safety and the prevention of pollution caused by ships, by foreseeing that parts of the IMO code for the implementation of mandatory instruments (flag state Code) and the Voluntary IMO Member State Audit Scheme would become compulsory at EU level.

Although all Member States stated their support for the underlying objective of the Commission proposal, a majority of Member States considered that a legislative text at Community level would not be the right instrument to regulate this aspect of maritime safety, which is currently addressed through the Voluntary IMO Member State Audit Scheme and non-mandatory Flag state Code. Member States further considered that a significant number of provisions of the proposed Directive would duplicate existing Community legislation.
The Commission was however of the opinion that, despite the ratification of the relevant IMO Conventions and Protocols by almost all Member States, the effective level of safety and the prevention of pollution caused by ships varied considerably from one flag State to another. The Commission believed that this proposal, therefore, focused on improving the ways and means to ensure the compliance of flag states with their international obligations, thereby providing for the missing link in the panoply of maritime safety legislation.

The Commission further saw the adoption of the proposed Directive as a clear signal to the international shipping world that the EU Member States are strongly committed to improving maritime safety and the prevention of pollution caused by ships and that they are willing to make compulsory the relevant voluntary IMO instruments. In its view, the proposed Directive would have been the most appropriate measure to enhance the performance of all Member States as flag states in order to allow them to be included in the white list of the Paris Memorandum of Understanding. The original aim of the development of a flag state Code and an audit scheme by IMO had been the adoption of mandatory instruments and this objective should be pursued by the European Community and its Member States.

Lastly, it should be mentioned, that the Commission has recently tabled a proposal for a Council Decision on the position to be adopted, on behalf of the European Union, at the IMO with regard to the adoption of certain Codes and related amendments to the Conventions.

3.4 Member State implementation of safe manning

3.4.1 Approaches to safe manning

A study performed in 2007 under a 7th Framework Programme entitled Marine Transport Coordination Platform (MTCP)\(^9\) concluded that:

- Member States tend to have individual approaches with regard to the determination of safe manning levels;
- Standard tables or catalogues on safe manning are not used in the majority of member states; and,
- Safe manning levels are determined mainly based on internal experience gathered.


\(^10\) MTCP Workpackage 2.3 – D2.3-21 Study on Safe Manning Levels of Merchant Ships
The MTCP team explained that “a majority of the Member States require that the ship owners submit a manning proposal for their vessel. It is at this point where the uniformity among a vast majority of Member States ends. The one consistency in this process throughout the European Union is that there is little standardisation of the vessel manning determination process across Member States”.

This study determined that some administrations use published international standards such as SOLAS and/or the IMO Resolution “(subject to interpretation of course)”, others had their own legislation and still some stated that a determination was made using their administration expertise and on a case by case basis. It found that more than twice as many administrations did not consult any outside expertise, and out of the six that did utilize outside expertise, two relied heavily on various professional/industry “associations”, which include labour organizations. The MTCP study claimed that “This was of interest as there is the possibility that these organizations could have concerns or an agenda that is different from that of the flag state”.

3.4.2 Recent safe manning regulations/circulars published by Member States

Table 1, while incomplete, provides a review of the state of safe manning regulation/publications across a number of Member States.

The majority of Member States have not recently published new materials/enacted regulations relating to the IMO instrument (A.955 (23)) which requires taking into account the Ships Security Plan. The dates where recent changes have been introduced are highlighted.

Table 1 - Documents supporting Member State actions relating to safe manning

<table>
<thead>
<tr>
<th>Member State</th>
<th>Legislation, Regulations, Circulars relating to Safe Manning</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Circular 2011/001 Minimum safe Manning (2/9/2011)</td>
<td>To advise Shipping Companies of IMO A.955 (23) requirements for minimum safe manning</td>
</tr>
<tr>
<td>Cyprus</td>
<td>Merchant Shipping (safe manning, hours of work and watchkeeping) Law of 2001 (Law 105 (i)/200 (Circular 16/2002)</td>
<td>“Manning of Cyprus Ships”</td>
</tr>
<tr>
<td>Country</td>
<td>Statute/Implementation Details</td>
<td>Compliance Details</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Denmark</td>
<td>Act of Manning of Ships (January 1999) &lt;br&gt;<strong>2011 implementation</strong> of electronic safe manning document application form</td>
<td>Application for Safe Manning Document</td>
</tr>
<tr>
<td>Estonia</td>
<td>Implementation of IMO A.955 (23) in 2005 &lt;br&gt;MLC to be ratified in 2012</td>
<td>Determining Manning Levels</td>
</tr>
<tr>
<td>Finland</td>
<td>Government Decree on the Manning of Ships and Certification of Seafarers (1797/2009)</td>
<td>Decree entered into Force &lt;br&gt;<strong>Jan 1, 2010</strong> – applies to seafarers serving on Finnish power driven ships and their owners</td>
</tr>
<tr>
<td>Hungary</td>
<td>Update to Legislation in 2005 incorporating SOLAS into national law (2001)</td>
<td>Follow IMO Conventions in determining safe manning levels</td>
</tr>
<tr>
<td>Ireland</td>
<td>Merchant Shipping Act 2010</td>
<td>Application and proposals for the minimum safe manning of the ship</td>
</tr>
<tr>
<td>Italy</td>
<td>Circular Title: Maritime Personnel &lt;br&gt;Series: Safe Manning Documents &lt;br&gt;No: 001 &lt;br&gt;(October 20, 2010)</td>
<td>Guidelines for drawing up the minimum safe manning documents for Italian merchant and fishing vessels pursuant to IMM resolution A.955(23)</td>
</tr>
<tr>
<td>Poland</td>
<td>Introduced into Polish legislation in 2001</td>
<td>Minimum safe manning certificate</td>
</tr>
<tr>
<td>Latvia</td>
<td>In October 2003 STCW 78 incorporated into legislation</td>
<td>Determining Manning Levels</td>
</tr>
<tr>
<td>Lithuania</td>
<td>Regulations on Registration of Seagoing Ships of the Republic of Lithuania (no date provided)</td>
<td>Determining Manning Levels</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>“Consults IMO Resolutions”</td>
<td>Safe Manning Levels</td>
</tr>
<tr>
<td>Malta</td>
<td>Merchant Shipping Notice 104, <strong>December 27, 2012</strong></td>
<td>Minimum Safe Manning Certificates for Maltese Ships</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Netherlands Manning Act 2002</td>
<td>Determining Manning Levels</td>
</tr>
</tbody>
</table>
3.5 The addition of security-related tasks (ISPS and piracy threats)

3.5.1 The emergence of ISPS

The closing decades of the last century saw a range of IMO measures on behalf of ship security: resolution A.584 (14) in the wake of the ACHILLE LAURO hijacking in 1985; the Convention for Suppression of Unlawful Acts against the Safety of Maritime Navigation; MSC\Circs.622 and 623 on combating acts of piracy and armed robbery against ships; MSC\Circ.754 on passenger ferry security, and others.

A turning point was Sept. 11, 2001, with concern, particularly by the US, that ships could be used as weapons or to carry weapons or terrorists into target countries. the US Coast Guard and US delegates in the IMO urged international adoption of maritime security measures (Anstey, 2005; Balbaa, Mensah, 2003). The IMO reviewed existing security measures, and its Maritime Safety Committee (MSC) and Maritime Security Working Group (MSWG) developed the International Ship and Port Facility Security Code (ISPS), incorporated into chapter XI-2 of the SOLAS (Safety of Life at Sea) convention, which was adopted by a Conference on Maritime Security in December of 2002, and scheduled to come into force on July 1, 2004.

The ISPS code consists of a mandatory section, Part A, and a section providing guidance for implementation, Part B. The code contains measures applying both to ports (security level system, port security officer, identification of critical infrastructure, code of practice), as well as on ships. The ISPS Code applies to ships on international voyages (including passenger ships, cargo ships of 500 GT and

<table>
<thead>
<tr>
<th>Country</th>
<th>Regulations/Requirements</th>
<th>Determining Manning Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roumania</td>
<td>Minimum Safe Manning regulations &quot;are strictly following the IMO and EU Directives&quot;</td>
<td>Determining Manning Levels</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>Provisional registration requires copy of previous minimum safe manning certificate</td>
<td>Determining Manning Levels</td>
</tr>
<tr>
<td>Sweden</td>
<td>Swedish Ship Safety Act</td>
<td>Safe Manning Certificates</td>
</tr>
<tr>
<td>UK</td>
<td>MSM 1767(M - Hours of work, safe manning and watchkeeping)</td>
<td>from Sept 7, 2003</td>
</tr>
</tbody>
</table>
upwards, and mobile offshore drilling units) and the port facilities serving such ships. Requirements for ships include:

- Ship security plans;
- Ship Security Officer: All applicable ships must have a designated Security Officer;
- Company security officer(s);
- Some additional onboard equipment;
- Port State Control (PSC) will be expanded to include a system of survey certification and control to ensure that ships’ security measures are implemented; and
- A new International Ship Security Certificate is to be carried onboard. Also a new certificate of registration replaces the old Flag State Registration Certificate.

The European Parliament published Regulation (EC) no 725/2004 on March 31, 2004, which instructed member states to take into account not only the mandatory Part A of the ISPS Code, but also the guidance of Part B, including sections to be treated as mandatory. It defined applicable ships as per the ISPS model but expanded the list to include domestic Class-A passenger ships effective July 1, 2005, and other domestic ships effective July 1, 2007 (Anstey, 2005).

ISPS was readied with remarkable speed (18 months between its IMO adoption in December 2002 and entry into force with zero tolerance of non-compliance on July 1, 2004) under the pressure of events and powerful political actors (Anstey, 2005; Mukherjee, 2007). Though the ISPS Code was an important move forward for shared security measures, the unprecedented rapidity of its adoption instituted concrete procedures but left aspects of its logic and substance, only partially clarified (Mukherjee, 2007), less than full integration with other measures (Loginowsky, n.d.), with maritime industry practices, training, and impact evaluation, trailing behind. As stated in Lloyd’s 2009 review of maritime security, since the 2004 adoption of ISPS security requirements were commonly met by the maritime industry with apathy, indeed, at times, antipathy. (Lloyds, 2009, p. 88).

The current project can be seen as part of the effort to evaluate and study these measures, specifically their interactions with the crew workload and manning context into which they were inserted.

3.5.2 The re-emergence of piracy risk

A second new set of security-related tasks emerged with the resurgence of piracy, which had existed at a low level for some time (see Figure 3) and became a major factor for the maritime community around 2008 (Cook, 2012), some years after the implementation of ISPS. As shown in Figure 1, a first wave of incidents in Southeast Asia began to wane in the mid-1990s, replaced in the 2000s as incidents...
rose sharply around the Horn of Africa since 2007. In 2011, 439 incidents of piracy and armed robbery were reported worldwide, over half of these attributed to Somali pirates (Menefee, 2012). A variety of responses emerged from various quarters within the maritime system, and some of these entailed measures conducted on ships by crew members—that is, an additional contribution to workloads.

In the following sections we discuss these. As specified in the project’s terms of reference, a key benchmark for these added tasks is the Best Management Practice guide for deterring piracy, first published in early 2009, and now in its 4th edition. A detailed listing of the tasks suggested in this guide appears below.

The surge of piracy since 2007 has had large human and financial consequences, with a range of responses emerging from the maritime industry itself, national authorities, and the international community. At the level of a single vessel or company, asides from rerouting ships to avoid risky areas, the key avenues for protection are joining convoys accompanied by naval protection, reliance on naval or military “Vessel Protection Detachments” (VPDs), the hiring of private armed security guards, and the adoption of various on-board measures that help vessels avoid, deter, or delay attacks, and decrease their consequences. In this study we examine
these on-board measures, which have the major impact on crew workloads.\textsuperscript{11} The role of private security guards is considered briefly, both because of its interactions with crew and their workloads, and because it is essentially an example of the outsourcing of added security tasks that might constitute an interesting and provocative test case for the outsourcing of other security tasks.

A useful benchmark for the added workload due to security measures are the “Best Management Practices to Deter Piracy” an informational guide and set of recommendations evolved by maritime industry and security professionals, now in its 4\textsuperscript{th} iteration (BMP4). Though not mandatory nor universally adopted, this document provides a minimal set of core practices that ships might reasonably be expected to adopt for their protection while transiting piracy-prone areas. Annex II contains a listing of the tasks entailed by piracy-related security.

A rapidly growing form of response to piracy is the use of private security forces by governments (Richard, 2010) and companies. While the presence of armed personnel on ships was discouraged by governments and the maritime industry, it has proven effective in hindering piracy incidents, and the phenomenon has grown in prevalence and acceptability, with the IMO recently issuing interim guidance on the topic (MSC.1/Circ.1443, 25 May 2012), and the formation of an industry organization (SAMI, the Security Association for the Maritime Industry), an accreditation program, and standardised contracts. These guards interact with the crew and their workload to varying degrees (training them in how to improve their watchkeeping or how to respond to attacks) and also conducting some of the tasks—watched, or, even, the “Ship hardening” setup in advance of a transit. A typical 4 person team can cost $5,000 a day—a cost of between $20,000-50,000 per transit. The presence of these guards may be a significant mediating factor in the piracy-related workloads of crew, depending on the extent of uptake of private guards as a regular feature of travel along certain routes, and the nature of their interaction with crew, and we incorporated this element in our interviews with seafarers.

Thus, the last eight years or so have seen the rise of circumstances that have imposed two new sets of security-related tasks on the already heavy workloads of ship crews – those associated with ISPS and those related to the heightened

\textsuperscript{11} Other measures have indirect impacts. For example, employment of private security guards for the duration of transits through dangerous areas can place a cap on the manning levels on smaller vessels (these added passengers require cabin space), and increase the load of the cook. Similarly, the increase or decrease of speed in order to coincide with the transit of a secure convoy can alter the schedules and workloads of crews.
incidence of piracy attacks. While the schedule, workload, and operation of ships and their crews form an organic whole, these two categories of security duties—those related to ISPS and those related to piracy—differ in many respects (timing, character, and contexts of the tasks, the extent of exposure to them, and the data sources needed to quantify their impacts). For this reason, they are treated in separate parallel tracks in our analysis (system mapping, data flow, cost calculations, etc.) and the report structure, with separate sections for each.
4. Data Sources, methods and limitations

4.1 Existing Studies

Part of our mandate was to identify, review and draw on existing efforts rather than to duplicate them. Our initial scoping identified a great deal of stakeholder concern and anecdotal discussion (reviewed in Section 4.2) of the workload and manning implications of security tasks, especially ISPS. These were reflected in a series of attempts to cost out the overall financial impacts of ISPS (focusing on port-side impacts primarily) and of piracy with only glancing mention of the workload impacts of security tasks made in other systematic reports. However there was only one systematic study of the issue we were tasked with, assessing the impacts of security tasks on workload and manning. In this section we review this almost unknown study by Longinovsky et al (2005), as well as other several other useful reports that provide background material on prevailing levels of manning and the existing or desirable procedures for their determination, and on evaluating crew workloads and fatigue: studies whose accomplished research was “critical path” for our own research. Other sources of more broadly contextual relevance are utilised and referenced in the appropriate place in other sections of the report.

Extensive efforts and resources had already been devoted to the research projects we report on here, allowing us to focus on other aspects of our task where less had been done. Basically, existing studies (including some sponsored by the EU) have surveyed the minimum manning levels on EU-flagged vessels and the procedures by which they are determined (World Maritime University, 2007), have provided principled approaches to modeling and determining crew workloads and their relation to manning levels (National Academy of Science, 1991; FORCE, 2010; Micro Analysis & Design, 2002). These demonstrated empirically as well as modeled how undermanning affects fatigue and safety (a variety of sources mentioned in other sections), and argued that ISPS-related tasks add to this workload in a zero-sum way (performing the new tasks led to the non-performance or under-performance of other tasks) that undermines safety, security, and the overall functioning of ships (Longinovsky et al, 2005).

Taking these results into account, we could emphasise the next tier of questions: did manning levels rise in response to these added tasks and increased workloads, and, if not, why not? what are the sites in the EU maritime system likely to be of particular concern with respect to the workload additions of security tasks? what are the overall (fleetwide) scales and costs of these new tasks? and how might regulators build on existing knowledge as well as our own findings to improve the regulation, in
a concerted manner, of security tasks, manning levels, and work and rest hours so as to assure the security, safety, proper functioning of crews and fleets, and the well being of their crews within the dynamic contemporary maritime legal and economic context?

4.1.1 Linginovsky et al’s Analysis of ISPS, workloads and on-board resources

The single systematic study we have found that specifically addressed the ISPS workload/manning question was a Bayesian analysis of the interaction of ISPS with onboard crew resources conducted by Loginovsky and others in the Navigation Department, Admiral Makarov State Maritime Academy, St Petersburg. In order to create their baseline crew resources model, the research team consulted a variety of experts and data sources and administered an 86 question questionnaire on “Sufficiency of resources for performing conventional duties,” to over 150 crew members—all of them Masters, Chief Officers or Officers on Watch.

The sweeping and holistic description of the background and motivation for this study, based on a sustained depth of maritime experience, are worthy of citation at some length.

“Nowadays, the influence of resources on safety and security at sea is one of the most critical elements of the existing management system. Ship officers are responsible for planning, communication, navigation, ship handling and many other routines, including procedures under the ISPS Code. To enhance safety and security at sea we must ensure that the right people are in the right place at the right time to counteract a possible intrusion. With the introduction of the ISPS Code, the “Principles of Safe Manning” were challenged to consider how additional shipboard security duties may contribute to crew member fatigue and thus might create a hazard to the continuous safe navigation of the world’s merchant fleet.

The shipping industry already constrained by SOLAS, STCW, MARPOL, ISM Code and ISPS Code requirements, is also constantly exposed to extremely tight commercial pressure to minimize the operational costs. . . To cope with competitors, shipping companies have to resort to measures aimed at cost reduction. Very often this leads to lower wages for crew, resulting in lower competence and reduced numbers of crew, or longer contracts. The number of seafarers trained in developed countries is constantly decreasing. Unpopularity of seafaring as a profession may lead to a lack of professionally qualified staff. This situation might be aggravated by faster promotions. It is often claimed that the new generation of seafarers is less experienced. Sometimes it takes only 2 years for a junior officer to become Chief Mate. Navigation and ship handling are no longer an art. . .

Multinational crews are common nowadays. Anecdotal evidence shows that cases where the Chief Officer was of Polish nationality, the 2nd and 3d Officers were of
Russian nationality, ratings were of PR Chinese nationality are not at all exceptional. This loosens the ties between the Shipping Company and the crew member on board the company ships. Different languages, different cultures, as well as different wages and contract duration do not encourage cooperation, safety or security. In addition we would argue that often crews are being recruited from developing countries which have no tradition of a “safety culture”.

At the same time ship traffic is increasing every year, becoming more and more intensive. To ensure fast turn-around, the time a ship is staying in the port is decreasing mostly due to the introduction of modern cargo handling technology. All this leads to a violation of STCW 95 and ILO Convention No. 180 requirements, resulting in excessive fatigue, decreasing level of safety and security. The impact of manning levels on the implementation of ISPS Code as well as on the implementation of many other regulations is a legitimate matter of concern of the IMO, National Maritime Administrations and ship managers. Attempts to rectify these deficiencies lead to tightening of inspections, increased bureaucracy and resulted in a so-called “paper-safety” culture. This term denotes safety on paper but not in reality due to lack of resources. The ISM Code was initially introduced to solve some of these problems. Unfortunately it does not seem to be effective in many companies. Numerous and tedious inspections will again put more stress on already exhausted crews in general, and deck officers in particular.

It is obvious that the “Principles of Safe Manning” should require a security component and that this regulation – if it is to achieve its desired result – may be asking too much of many of the already overloaded shipboard personnel. An already enormous regulatory workload of crew under ISM Code, STCW, SOLAS and MARPOL was increased due to ISPS Code requirements. Together with reduced numbers of crew, this situation might endanger safety and security at sea. It begs the question: Do we have enough resources to provide for additional security measures according to level 2 or 3?

The main challenge of this research is to develop a model showing the impact of the ISPS Code on workload and crew performance. Such an impact on crew workload should not be considered separately from all of the other duties of the ship’s crew. A limited number of crew members, often only the barest necessity to meet the requirements for rest hours specified by the above mentioned conventions (STCW and ILO 180) demands a systematic approach to an analysis of the impact the ISPS Code has had on shipboard organization. Such an analysis is especially necessary in the case of ships employed in short -sea navigation and at Maritime Security Level 2 and 3.”

Loginovsky et al’s Bayesian models suggest that the combination of cost reduction pressures and eroded skill base on the one hand, and the load increase due to ISPS, on the other, have created a dangerous combination. With crew resources at their current inadequate level, they argue, ISPS Code compliance, ISM Code compliance,
and ordinary watch-keeping duties constitute a zero-sum game, with increases in one realm (especially for Security Levels 2 and 3) necessarily impacting negatively on other realms. Survey respondents were also of the opinion that given the constrained resources of ships, security duties under the ISPS code were in practice compromising safety as well as other aspects of crew duties. (Many of our interviews with more experienced seafarers echo these concerns, with crew feeling that overwork, due in part to the burden on bureaucratic tasks formally associated with safety and security, were undermining safety and security, as well as the maintenance, and smooth running of their ships.\(^{12}\)

4.1.2 The USDOT and Cardiff SIRC study of crewing levels

Perhaps the best single cross-cutting historical record of crewing levels is the dataset assembled by a large survey conducted in 2003 by Seafarers International Research Centre (SIRC), in which they gathered and analysed crew lists for almost 4000 vessels of all flags in selected ports around the world (Winchester et al, 2006). The data includes the type and age of vessel, gross tonnage, vessel flag, number and kind of crew positions, and the nationalities of those who occupy these. As discussed in subsequent sections, we conducted detailed discussions with SIRC on how to leverage that data in a way that would both serve our project on the impact of security measures on crewing levels as well as be useful to them. The Maritime Administration of the U.S. Department of Transport also conducted a substantial and comprehensive review of the nationalities and size of the crews of foreign-flag cargo vessels calling at ports in the United State in 2006. Unfortunately, as we discuss below, these are “snapshots” of crewing levels, and while there is data that would allow a proper time series analysis of changes in crewing, and, in particular, changes with the implementation of ISPS or in certain categories of vessels, this data is not available to researchers.

4.1.3 Studies on EU determination of manning level (MTCP, FLAGSHIP)

The various potential but only partially available sources from which one might systematically assess changes in manning levels are discussed in section 9.1. We did

\(^{12}\) A claim of this nature has recently been put strongly in a testimony of the International Organization of Masters, Mates, and Pilots, which testified before the US House of Representatives Committee on Transportation and Infrastructure that “the burden of ensuring and documenting regulatory compliance has become a safety issue in that it diverts substantial amounts of time away from the traditional shipboard tasks that are the basis of good seamanship and ship safety.” (Marcus, 2012)
not pursue the procedures and standards of manning determination within EU member states since this avenue had been conducted in a comprehensive and energetic manner as part of a MTCP contract under the Sixth Framework, by a team from World Maritime University, NTUA, and AMRIE, which published a 100+ page final report (World Maritime University, 2007). This report demonstrated the considerable variation in manning levels (deck and engineering/engine officers as well as ratings) for feeder container, product carrier and Ro-Ro ships (see Figure 4), the reticence to establish or divulge the criteria through which manning levels are determined, and the prevalence of pressures to accommodate the shipping industry and prevent their flight to competing flags. The conclusions of that report are worth quoting:

“The outcome of this study indicates that there are wide variations in both policies and practices between EU Member States in the way safe manning of merchant ships are determined.

In terms of policies although almost all countries indicated that they follow IMO requirements and guidelines, the actual policies varied from establishing manning levels from a pre determined table; to asking the ship-owners to make a recommendation; to leaving it to the judgement of a surveyor.

The three case studies revealed a great deviation in the number of Officers, from 2 to 5 for Master and Mates and from 1 to 5 for Chief Engineer and Engine Officer. These results may be due to the unilateral interpretation and application of the IMO guidelines on this matter in each individual Maritime Administration according to the National legislations.

In general terms, there is no a common rule applicable for a sample ship. Eight of the 19 Administrations answering the case study questionnaire issue the Safe Manning Document on an individual basis considering different factors, in particular those included in the annexes I and II of the IMO Resolution A.890(21) adopted on 25 November 1999.

Some Member States have very elaborated National legislation for this specific aspect of the maritime safety as United Kingdom, The Netherlands and Sweden. Other countries have less developed legislation or they do not have provided this information in the questionnaire, in particular Slovenia is interested to receive recommendations on this issue.

Lack of reliable and up-to-date data which has been mentioned in previous reports, was also noticed in this study. Some administration had the data readily available, and some others claimed that thy do not maintain a data base to provide the required information.

The research team recommends that:

1. Taking into account the findings of this study, DGTren to consider launching a major programme to analyse in depth the situation aimed at the harmonization of the minimum level of manning for merchant ships and the proposition of new EU

2. Absence of a harmonized approach may be reduced through the adoption of EU legislation on the basis of the IMO resolutions on Safe Manning of Ships. MTCP ID M23.21.04.051.002 WP 2.3 – 21 Safe Manning levels for Merchant Ships Page 81 of 105

3. To direct Maritime Administrations to store and provide data when requested by research teams working on behalf of the EC.”
Adapted from Table 1, “Summary of minimum level of manning for three sample ships in the EU countries,” in MTCP (2007).

The sample ship types were specified as follows:

**FEEDER CONTAINER**
- Gross Tonnage: 2815
- KW: 2400
- Cargo: Containers
- Trading area: No restrictions

**PRODUCT CARRIER**
- Gross Tonnage: 2500
- KW: 1800
- Cargo: Refined products
- Trading area: No restrictions

**RO-RO**
- Gross Tonnage: 3727
- KW: 1455
- Cargo: Trucks/passengers
- Trading area: Restricted

**NOTES:**
- NA: Information not available
- 1/0a): In some ships, regarding the machinery attendance level
- 3/2b): Trading area must be considered
- 0*: Engine room cleaning carried out by interdepartmental flexibility agreement
- 1**: Cooks duties may be carried out by a member of the crew when trading in the near continental area

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**Figure 4 - Manning Levels for three sample ships in EU Countries**
Another EU project, the Work Process Analysis of the FP6 Flagship project (FLAGSHIP, 2009) also addressed criteria for appropriate manning numbers, though its focus was on how new technologies impacted work processes on board ships. It collated information from 13 EU countries, as well as from EU and IMO crewing guidelines, and surveyed seafarers to identify sources of resistance to new technologies. While the small size of this study (22 ships) did not allow for generalisable results, it did help provide an in-depth portrait of 10 work processes on ships, especially as these related to technology. An initial stage of the research surveyed EU 13 countries regarding the procedures for establishing safe manning levels, and specifically if and how technology was taken into account in these. The survey template had 4 questions:

1. How does the flag state currently calculate minimum crew sizes for vessels? (i.e. is there a formula? What factors are considered?)

2. To what extent is the level of technology onboard a ship accounted for in the crew size calculations?

3. To what extent is the level of technological training onboard a ship accounted for in the crew size calculations?

4. Historically, how did crewing calculations change when the following technologies were introduced to the industry? (a) GPS (b) ECDIS (c) UMS?

While the emphasis of the survey was on the role of technology and technological innovations in shaping manning levels, the one key finding relevant for our inquiry into manning levels changes in response to new security tasks merits quoting is:

“Currently levels of safe manning are largely not calculated on the basis of any specific formula in Europe. Instead, safe manning most often comes down to a case-by-case approach where owners/operators submit a crewing proposal which is then reviewed and possibly scrutinised further by the flag state. Examples of countries employing such a system include Finland, France, Germany, the Netherlands, Italy, Spain and the UK. The closest to any kind of formula for crewing comes in the form of manning tables which are used by some countries (e.g. Cyprus, Turkey, Greece - on passenger vessels). Even with registers using manning tables, however, the number of factors considered is often limited e.g. vessel size, vessel type, vessel power and trade. There is therefore little evidence that the industry and authorities have formally assimilated new onboard technologies in terms of investigating how work processes and crewing levels need to be adapted and changed.

This state of play in terms of calculating crewing based on a broad ‘judgement’ of appropriateness has filtered down from the approach adopted at an International level by IMO. IMO Resolution A.890 (21) adopted on 25 November 1999 – ‘Principles Of Safe Manning’ recommends that Governments, in establishing the minimum safe manning levels for ships flying their countries’ flag, should observe
a set of goal-based principles. Where IMO decided to introduce broad principles of safe manning rather than providing precise information on how crewing levels should be calculated, it is clear that such a broad and non-prescriptive approach has been adopted at a national level by shipping registers. It must be acknowledged, however, that given the wide differences between vessels, equipment, trade and crew qualifications, even within vessel types, a fixed set of specifications might be difficult or even impossible to design and implement. Indeed, there is evidence of flag states that have used manning tables in the past now deciding to adopt a case-by-case approach instead. Equally, however, a non-formulistic approach may not be best suited to accommodating for the changing role of a vessel over its lifetime. If there are no fixed criteria for determining how many crew are required to sail a vessel, then there is the potential for a minimum safe manning certificate issued on first registration to be kept in place despite factors such as trading route and onboard technology changing. If changes in these factors do not automatically lead to safe manning adjustments then concern should naturally be raised.

Interestingly in this regard, no mention was made in any of the reviews of IMO resolution A.955 (23) (an amendment to resolution A.890) which added considerable security duties to a ship’s workload. If crews were required to largely ‘absorb’ this extra work-load without extra manning resources, arguably a prescriptive system might have better suited the industry in terms of forcing manning adjustments across the board. If such requirements are introduced universally then no competitive advantage is afforded to any one operator and fairness is maintained. In the current climate of broad manning ‘principles’ it is therefore impossible to precisely determine the impact of new technologies on the industry in terms of crewing arrangements”.

The tension between formulaic and prescriptive versus interpretive and “judgment-based” determination of manning levels takes place at some remove from the development of tools that could provide useful decision-support tools for workload analysis and manning requirements specification—tools that could provide a way beyond this gridlock. We reviewed these tools and their EU implementation, described in the following section.

4.1.4 Workload and manpower requirements modeling

The massive discussion of maritime manning levels and fatigue is remarkably isolated from a set of literatures and tools for workload and manpower modeling. Industry has used modeling to evaluate manpower need for decades, and beginning in the 1970s the US Department of Defence began developing methods for modeling human systems, which began to be taken up by the US Navy in the 1990s, iterating
through several tools that detailed watchstander operations, and a Total Crew Model (TCM) that gave detailed modeling of crew activity and fatigue levels (Micro Analysis and Design, 2002). Thus, the TCM can give informed analysis of whether a given crew can perform all the required tasks, how changes in ship design and schedule will affect workload and fatigue, how limited resources could be optimised—all of this with consideration, also, of crew quality of life issues (personal time, sleep, work hours, meals, etc.). This model underwent validation against actual data and ships, and has subsequently been joined by a new generation of software. Yet this kind of analytic approach to workload and manning level analysis, which has been steadily moving forward for “human systems integration” on naval vessels (DiDonato et al, 2004), where performance supersedes commercial considerations, has scarcely intersected with debates and practices on these issues within the merchant marine community.

As the implications of drastically reduced manning began to be felt in the late 1980s, a comprehensive review of the smaller crews on ship operation and safety was conducted through a US National Academy of Sciences project, resulting in a major report on Crew Size and Maritime Safety (National Academy of Sciences, 1991). The study included a survey of manning determination procedures and criteria in several classification societies and maritime agencies, as well as the relevant regulatory instruments in the US and internationally, heard presentations by a range of maritime labour and professional organizations, reviewed previous research on shipboard task analysis and offered its own shipboard task analysis model as the basis for its work (see Figure 5). Security tasks were, understandably, absent in this pre-ISPS list.
**TABLE 4-1 Shipboard Functions Identified in Committee’s Functional Model**

<table>
<thead>
<tr>
<th>TASKS TO BE EVALUATED</th>
<th>TASKS TO BE EVALUATED</th>
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<tbody>
<tr>
<td><strong>1.0 CARGO</strong></td>
<td><strong>4.2 Maintenance</strong></td>
</tr>
<tr>
<td>1.1 On-load</td>
<td>4.2.1 Unscheduled</td>
</tr>
<tr>
<td>1.2 Off-load</td>
<td>4.2.2 PMS</td>
</tr>
<tr>
<td>1.3 Maintenance of cargo equipment/deck stores/wares and ballast tank cleaning and repairs of cargo, deck equipment, stores and wares</td>
<td>4.3 Record keeping</td>
</tr>
<tr>
<td>1.4 Record keeping (port logs)</td>
<td>4.3.1 Records and record keeping</td>
</tr>
<tr>
<td>1.5 Repair</td>
<td>4.3.2 Soundings</td>
</tr>
<tr>
<td>1.5.1 Reefer-maintenance</td>
<td>5.0 AUXILIARY EQUIPMENT</td>
</tr>
<tr>
<td>1.5.2 Inspection</td>
<td><strong>OPERATIONS</strong> (all non-main engine propulsion equipment)</td>
</tr>
<tr>
<td><strong>2.0 BALLAST</strong></td>
<td><strong>5.1 Generators</strong></td>
</tr>
<tr>
<td>2.1 On-load</td>
<td>5.1.1 Operations</td>
</tr>
<tr>
<td>2.2 Off-load</td>
<td>5.1.2 Unscheduled maintenance</td>
</tr>
<tr>
<td><strong>3.0 NAVIGATION</strong></td>
<td>5.1.3 PMS</td>
</tr>
<tr>
<td>3.1 Track keeping</td>
<td><strong>5.2 Fuel oil systems</strong></td>
</tr>
<tr>
<td>3.1.1 Day—good visibility</td>
<td>5.2.1 Operations</td>
</tr>
<tr>
<td>3.1.2 Night—good visibility</td>
<td>5.2.2 Unscheduled maintenance</td>
</tr>
<tr>
<td>3.1.3 Restricted visibility</td>
<td>5.2.3 PMS</td>
</tr>
<tr>
<td>3.2 Maneuvering</td>
<td><strong>5.3 Boilers</strong></td>
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<tr>
<td>3.2.1 Chart correction</td>
<td>5.3.1 Operations</td>
</tr>
<tr>
<td>3.3 Collision avoidance</td>
<td>5.3.2 Unscheduled maintenance</td>
</tr>
<tr>
<td>3.4 Voyage/passage planning</td>
<td>5.3.3 PMS</td>
</tr>
<tr>
<td>3.5 Record/chart keeping and update/bridge logs/charts and navigation information</td>
<td><strong>5.4 Evaporators</strong></td>
</tr>
<tr>
<td>3.6 Maintenance</td>
<td>5.4.1 Operations</td>
</tr>
<tr>
<td>3.6.1 PMS</td>
<td>5.4.2 Unscheduled maintenance</td>
</tr>
<tr>
<td>3.6.2 Unscheduled</td>
<td>5.4.3 PMS</td>
</tr>
<tr>
<td><strong>3.7 Test vital systems</strong></td>
<td><strong>5.5 Refrigerator/air conditioning</strong></td>
</tr>
<tr>
<td>3.7.1 Prior to leaving port</td>
<td>5.5.1 Operations</td>
</tr>
<tr>
<td>3.7.2 Prior to entering port</td>
<td>5.5.2 Unscheduled maintenance</td>
</tr>
<tr>
<td><strong>3.8 Bridge housekeeping</strong></td>
<td>5.5.3 PMS</td>
</tr>
<tr>
<td><strong>3.9 Weather monitoring</strong></td>
<td><strong>5.6 Sewage systems</strong></td>
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<tr>
<td>3.9.1 Reporting</td>
<td>5.6.1 Operations</td>
</tr>
<tr>
<td>3.9.2 Planning</td>
<td>5.6.2 Unscheduled maintenance</td>
</tr>
<tr>
<td><strong>3.10 Hull Performance</strong></td>
<td>5.6.3 PMS</td>
</tr>
<tr>
<td>3.10.1 Monitoring</td>
<td><strong>5.7 Inert gas systems</strong></td>
</tr>
<tr>
<td>3.10.2 Maneuvering</td>
<td>5.7.1 Operations</td>
</tr>
<tr>
<td>3.10.3 Planning</td>
<td>5.7.2 Unscheduled maintenance</td>
</tr>
<tr>
<td><strong>3.11 Training (equipment operations, procedure review, standard operations)</strong></td>
<td>5.7.3 PMS</td>
</tr>
<tr>
<td><strong>4.0 ENGINE OPERATIONS</strong></td>
<td><strong>5.8 Electrical/electrical control systems</strong></td>
</tr>
<tr>
<td>4.1 Operations—routine and watch standing</td>
<td>5.8.1 Operations</td>
</tr>
<tr>
<td></td>
<td>5.8.2 Unscheduled maintenance</td>
</tr>
<tr>
<td></td>
<td>5.8.3 PMS</td>
</tr>
</tbody>
</table>
Thought the NAS report appeared over two decades ago, as the effects of reduced crewing levels were first becoming recognised, many of its findings and recommendations have not lost their relevance. The report discussed the inconsistency and variation in manning levels, the need for increased use of formal analytical methods for determination of these, the need to better link manning level determination with safety criteria, the tensions between economic incentives and adequate manning, and the discrepancies between actual and reported work.

More recently, and in a European context, the FORCE technology and the Danish Maritime Authority initiated the definition of a “Safe Manning” simulator, which was then funded by the Danish Maritime Fund and implemented by FORCE and the Danish Technical University—over 5,000 man-hours were devoted over 2.5 years. Its
structure bore similarities to the TCM, and using detailed studies of two ships as a case study a simulator was developed that could use inputs regarding the vessel type, schedule, and manning in order to map out the distribution of work and rest. The tool was emphatically not intended to find the best manning level “automatically,” but can be used to analyse past scenarios, explore development options in an interactive way, and pinpoint both bottlenecks and redundancies in workload and manning. This model is discussed at greater length in our recommendations Section 9.2.

To conclude, our review of disparate literatures identified several solid bodies of work already performed, often quite energetically. In these, the frameworks and criteria for establishing manning levels in EU flags had been surveyed, crew levels sampled (at least at their pre-ISPS levels), frameworks for modeling workloads and their interaction with crew size developed, and the effects of under-manning on fatigue, safety, and crew quality of life explored, including an EU project intended to serve as a decision-support tool for maritime stakeholders. And, in a single exception to the almost total absence of systematic studies specifically examining the workload and manning impacts of security tasks, Loginovsky’s study offered a sophisticated and empirically grounded analysis, whose results confirmed what many maritime stakeholders had been arguing in less formal ways. Since these parts of the broad picture had been established, our work could focus on identifying particular points of workload stress, quantifying the overall scale of the phenomena in time and monetary terms, examining whether, indeed, manning levels had not responded to added security tasks, trying to understand the broader contextual factors that drove manning levels down, and suggesting fresh ways in regulators might tackle which the systematic, consistent, and persistent under-manning of ships.

4.2 Materials, methods and approach

4.2.1 Evaluating impacts in a complex, dynamic system

One initial aspect of our research was to review prior efforts directly on our mandated task, as discussed in Section 4. A second was to map out the broader maritime context impinging on the issue, since new security tasks are inserted into a complex equation of vessel workloads and manning levels, which, in turn, is embedded in a maritime system that is complex, dynamic, and adaptive. This review underscored how tracing the effects of these particular added tasks, and arriving at some aggregate account of these impacts at the scale of the EU fleet would be a
significant challenge, especially given the following features of the security-related tasks and the system into which they are introduced.

- The tasks are incremental additions to a workload that is already overstrained. Thus their impacts are less predictably related to the marginal addition of hours, with small additions possibly leading to disproportionate consequences or discomfort. Overload, fatigue, and diminishing discretionary time for crew are acknowledged as chronic and broadly felt problems. An officer might serve as a Security Officer, as required by ISPS, but, at the same time, be the Safety Officer, the Health Officer, as well as doing other duties, and the tradeoffs between these functions are real. In such a context, security tasks that would not ordinarily be unduly burdensome in themselves could present a real strain, their impacts magnified by low tolerances and depleted reserves, and, thus, more likely to result in damage (to ship safety and maintenance levels, crew health and quality of life, etc.).

- Stated in a different way, security workloads draw on and interact with various ship resources, and their effects are, therefore, dependent on the overall availability of these and the changing tasks of a given vessel. As the recent IMO Resolution A.1047 (27) suggests, manning levels should consider “the interdependencies and interactions of operational elements that influence the amounts of crew member workload.” However, new regulations are often applied to the workload of crews with insufficient attention to their interaction with the quantity and quality of existing ship resources needed to ensure their implementation (Loginovsky, 2005). This can lead to additional overload, partial implementation, or “paper implementation,” (Longinovsky), which can not only waste resources but do so with little benefit. In fact, there is also the risk of increasing hazard, when crew are distracted from critical tasks, or when attempts to cover the same tasks without added labour budget requires the employment of less mature or well-trained crew, and multilingual crews with less communicational facility, decreasing safety and security effectiveness (and, in a vicious cycle, requiring further regulation).

- The workload and manning context that is already “in motion,” that is, evolving due to a host of other technological, commercial, and political forces. These include, for example, the following:
  
  - On the economic side, the economic, policy, and structural changes in the world economy that shape international trade, and maritime trade in particular (Meersman, 2009);
  - EU regulation that has opened up national maritime markets to competition (Council Regulations 4055/86/EEC and 3577/92/EEC);
  - The emergence of multinational mega-companies and alliances;
• The growth of flags of convenience and resulting outflagging, as well as the development of “second” or “international” registers that allow owners to choose more convenient regulatory systems, taxation regimes (and, more recently, tonnage tax arrangements), and costs—including labour costs (Mansell, 2007; Mansell, 2009; Hoffman, 2005; Alderton, 2002; Llacer, 2003). These in turn have led to a situation in which owners domiciled in EU states control over 40% of the world fleet, but only a small portion of the world fleet is EU flagged (Adam and Traxler, 2008);

• The drop in the number of EU maritime workers (Adam and Traxler, 2008), and the associated multiculturalisation of crews (Progoulaki, 2006);

• Technological and other developments that have led to a shift in ship types (and, especially, the fundamental changes wrought by containerization (Levinson, 2006), and market and regulatory developments that have encouraged new travel patterns, such as short sea shipping. Other technological changes have led to significant crew size reductions for most types of ships.

• A transition to a more multi-level form of maritime governance, in which authority is dispersed both vertically to other territorial levels and horizontally, to non-state actors, or, even, polycentric or network governance (Roe, 2008). In particular, the security (Stasinopoulos, 2003) and labour regulations that impinge directly on our study are particular instances of the halting evolution of attempts to govern this complex and multi-leveled globalised industry (Sampson and Bloor, 2007).

• These tasks produce effects that are often dependent on the specifics—of vessel categories, sizes, ages, and routes, for example, or on the watch system already in place, or crew composition (size, nationalities, training, etc.). The security→workload→manning situation varies considerably from vessel to vessel, and one context to another. (Indeed, opinions regarding the inadequacies of scale-based safe manning level determination, and the need for careful context-dependent determination of manning levels were often voiced in our interviews). For example, post-ISPS security-related work constituted a smaller addition burden for some ship types, such as cruise ships, or routes (for example, certain ferries to the UK), which had pre-existing high levels of security sensitivity. Larger ships with a crew of 20 can more readily absorb an additional gangplank watch while unloading/loading a vessel, whereas a 6 or 8 person crew can scarcely spare someone for this duty.
A full search of a ship for stowaways, however, is scale-dependent, being far less demanding on physically smaller ships. Piracy-related work burdens are also variable. Of course they do not affect ships not traversing these waters, and they variably affect ships that do—for example, container ships and ships raised 10-14 M above the water surface are more readily hardened against piracy attacks.

- The new tasks can have impacts and costs that are diffuse, delayed, and cross-cutting. While the new security tasks may, on the face of it, seem to have been “absorbed,” their performance may, in fact, have caused the performance of other tasks to suffer. On an undermanned ship frequently in port, and even more so when at a Level Two alert, or in areas of piracy threat, maintenance tasks are postponed, and fatigue can build up rapidly over the course of days. Even the private security guards, whom are “off budget” in terms of manning, and take on some of the watch-keeping load, may keep the ship’s cook busier. Thus, it is a real challenge to determine whether new tasks have been incorporated without manning increases through intelligent rescheduling and reallocation of resources, that is, elimination of slack in the system, or whether this “slack” time that is removed was, in fact, needed in important but less visible ways within a complex crewing system. Just as redundancy is important in mission-critical hardware, an analogous “redundancy” of human systems is also important to assure adequate maintenance, recuperation, and spare mental and physical capacities for dealing creatively with for unexpected events. These are human as well as monetary questions: displaced or underperformed tasks and compromised sleep can add costs that are just as real as overtime hours, additional crew, or outsourcing of work.

- Additions to workload can be partially or largely offset (and, thus, rendered less visible) by changes in the overall maritime context. These changes in crew, practices, expenditures, etc., whether planned or circumstantial, can “absorb,” displace, or buffer the economic and other consequences of new tasks. The additional of security-related tasks since 2003-4 occurred at the same time as other ongoing inter-locked changes and trends in the maritime sector, which also affect workload and manning. Manning levels have been declining for decades. Some of this is due to more automation and technology on board (engine operation requires less watch-keeping, for example), but, there are other factors as well, including sheer intensification in a labour market where new and cheaper entrants are ready to take the place of those unwilling to work at these increasingly intensive levels. (Currently, for example, Filipinos, who constitute about a quarter of seafarers (Wu and Sampson, 2004), are being undercut by Indian and Chinese
seafarers.) Another trend is the decline of levels of expertise as crews become more internationalised, lowering operating expenses because of lower salaries, but also exposing operators to crews with less reliable qualities of training and certification. And, overall, crewing patterns have been shifting: for example, the third officer position is less prevalent, except among tankers. In short, workloads and manning levels on EU-flagged vessels are dynamically determined within a complex globalised “ecosystem” (interacting with the broader non-EU maritime labour markets, training facilities, manning agencies, etc.)

- A consequence of the preceding points is the extent to which the vessel crew system can absorb new security tasks by delicate system-wide offsetting changes that are not reflected in manning levels, but, certainly present in other ways. The crew composition, size, and level of training is the result of a complex and dynamic negotiation between various forces and stakeholders: the EU flag states, ship-owners, the ship master, the insurance companies, manning agencies, the crew, and market competition. Small shifts, such as new security situations and tasks, are accommodated by multiple subtle changes over different time scales. For example, perhaps over time a single EU-national has been replaced by two nationals from developing countries whose salary might be less than half—that is, more manning for less cost. Or the same crew is kept, but more overtime is done, resulting in larger salary costs for the same crew, as well as making the position one suited to younger crew members who can absorb the periods of little sleep better. And, perhaps, the greater workload simply results in the ship log diverging to a greater extent from hours actually worked, that is, there will be more violations of minimum rest requirements, even if not bureaucratically visible. Possibly, other kinds of tasks (related to safety or maintenance, for example), will decline in the trade-off between those demands and security-related ones. Other offsets are possible by having some of the bureaucratic tasks related to ISPS be done land-side, by other staff in the ship’s company, which would be excluded from the crew workload and manning equation accounting.

- The category of “manning” itself is undergoing some fragmentation as security-related tasks are “outsourced” to private security crews for piracy threats or a private security guard for in-port gangplank watch. These very real and sometimes substantial security-related labour costs would not be considered as additions to “manning” in the traditional sense, and they would not accrue to the same accounting category as other crewing costs. Thus, an estimated one third or more of vessels transiting the Gulf of Aden and Indian Ocean areas exposed to piracy (i.e. somewhere between 1000-2000 vessels a
month) have private security crews, averaging 3 people, at a cost of $5000 a
day. In other words, on a ship with EU-national officers and non-EU national
ratings, the daily costs of these private security professionals can significantly
exceed the daily salaries of the entire crew during these transits, which can
last from 7 to 10 or more days. As discussed in the conclusion of this report,
another possible mechanism for absorbing security-related tasks in the critical
port/ship interface would be hiring local security guards to maintain access
control or fulfill other security tasks or even on-ship cargo-handling while in
port. In both cases, the use of external manpower with specialised training to
cover the heightened work security-related workloads for short periods of
time is an efficient way to operate, but these will not be reflected in
“manning” costs.

As a way of capturing the complexity of this system, our early reports included the
following diagram (Figure 6) which contained an indicative sketch of a portion of
these complex relations. The research methods summarised in the following section
were designed to draw on both qualitative and quantitative approaches to provide
firm assessments of the workload and manning implications of security tasks despite
their occurrence amidst this swelter of adaptive and interlinked mechanisms.
Figure 6 – Indicative Causal Loop Diagram of the contexts and impacts of security-related tasks on workloads and manning
4.2.2 Overview of sources and data flows

We adopted a mixed method approach whose key elements are the following:

- Extensive background research in the secondary trade and academic literatures on the evolution of the security task/workload/manning equation over time and those aspects of the broader maritime system that shape this. Works cited directly appear in the reference list, as well as some additional sources surveyed as part of the project appear in an annex. We also reviewed and monitored the blogs and discussion boards of seafarers as well as the sites of NGOs, trade organizations, and government agencies in the maritime sector.

- Formal interviews and discussions with a wide range of stakeholders, including seafarers, shipping company staff, maritime security experts, and academic maritime researchers. A partial listing of these appears in Error! Reference source not found..

- The processing and analysis of a massive dataset of transponder data representing a large representative sample of the EU general cargo and container fleet in order to systematically characterise ship movements over 4 years, and especially port stay patterns. This is described in Section 4.3.4.

- Based on the foregoing, the derivation of estimated probability distributions for the key parameters needed to quantify the extent and costs of security-related workloads at the scale of crew member (ratings and officers), the vessels they man, and the overall EU fleet overall.

- The construction and execution of a formal Monte Carlo model that uses these empirically derived distributions to provide robust probabilistic estimates of the workload and a measure of the potential cost of security duties on EU-flagged vessels. The overall logic of this model appears in Figure 7. In this figure, the yellow, green, and purple areas and their contributions to the blue boxes contain the core of our analysis. Key intermediate calculations are placed in boxes, and the sources for these are without boxes. The lower blue box is a quantitative analysis, while the upper two represent more qualitative ways of integrating the data.

These sources are described and illustrated in the following sections.
Figure 7- Indicative sketch of parameters of cost model and sources

NOTE: Consideration of parameters and dynamics can be disaggregated by ship type, capacity, flag, prevailing security level, etc.
4.2.3 Qualitative primary sources: description and examples

Interviews were held by phone, in person, and via correspondence. Most of the interviews were recorded (after obtaining the permission of interviewees) and either transcribed, in the case of particularly dense interviews, or summarised.

Seafarers

In Annex II we have included materials resulting from interviews with seafarers and various stakeholders. They represent under 10% of the overall interview hours and an even smaller fraction of the blog and industry material reviewed. While these kinds of qualitative materials were typically very rich, they are also idiosyncratic—giving a deep fragmentary picture from the perspective of one participant.

The interviews with seafarers took place in the social facilities, especially Missions and hostels, uses by seafarers in 3 port cities (Antwerp, Rotterdam, and Bristol (Portishead)). Maritime agencies and officials

These interviews were conducted by emails and phone, or in person in their offices or at conference settings. Often officials were more guarded and “politically correct” in their responses, but sometimes quite informative. The annex contains a typical summary of a phone interview with the person in charge of determination of manning levels in a European maritime agency.

Commercial stakeholders

We spoke and met with a range of people with various and, sometimes, unexpected points of contact with maritime security and manning issues—from security officers at the company and ship level to the people who developed workload/manning simulation software to ship designers (an attempt to reconstruct changing manning levels from the cabin space in new ships . . . ) to those who insure and finance ships (in an attempt to obtain a time series of crewing levels and operating expense records over time).

An integrative viewpoint: external engine maintenance engineers

Sometimes, unique viewpoints were offered by less conventional stakeholders in the maritime system. For example, the Annex contains interviews with maintenance engineers who service and repair vessels on call worldwide. Their position affords them a multi-player and longer term perspective. They are in a good location to observe the complex interactions between various stakeholders (manning agencies, ship owners and operators, crew), various factors (flag, crew nationality and training, declining crewing levels, duration of port stay), and to see how various factors can conspire to
create technical problems and degraded equipment. One of the engineers himself served as an engineer in the past.

**Seafarer newsletters and blogs**

Seafarer discussion has moved to social media sites, providing a direct and relatively unrestrained window into the maritime community. Some sites are operated by NGO and commercial organizations, some use large social networking sites (Facebook, Linked-In, Yahoo, Google groups), but, also, literally hundreds of independent individual and collective efforts using bulletin boards and blogs. Some of these cater to particular nationalities (especially Filipino and Indian seafarers), while others to particular categories of crew. The focus is often on jobs opportunities (providing us a useful way to cross-check typical salaries for different maritime positions), but often larger concerns and debates about maritime conditions and events are discussed, and issues of relevance to us (undermanning harsh working conditions, piracy) are often the topic of energetic and eloquent discussion. For example, the following is a blog entry by an Indian seafarer.

"A simple equation can illustrate the problem: ‘Commercially driven lowering of manning; training levels + higher demands of turnaround times and efficient operations = taking short cuts in operations (deviating from the ordinary practice of seamen) finally leading to incidents.’

The think tanks identified the right hand side of the equation, but failed to see that it will always be the case as long as the factors on the left hand side are not nullified. Simply forcing a process of over check-listing tasks is an ostrich syndrome solution to the problem. It is not physically possible to achieve good and safe operations with the same resources available at hand, when there is an increase in the commercial demands which leads to a reduction in manning.

Now, the seaman had to not only work under higher pressures to satisfy the industry’s commercial demands, but he was further burdened by the legislative pressures of recordkeeping and checklist based operations.

This overburdening of the seafarer has lead to many a case of filling up checklists after the operations are complete. I can, in many cases, empathise with this attitude. You don’t expect a seaman to start filling a 4 page “Navigation in congested/

---

13 March 21, 2011 blog post on "http://shanovarunaha.blogspot.co.il/"
restricted waters" checklist for navigation in high traffic areas when he sees vessels crisscrossing him at high speeds in all directions. I’d rather that he navigates the vessel safely using the ordinary practice of seamen instead of colliding the vessel and polluting our seas because he was filling a checklist when instead, he should have been keeping a lookout.

The solution to this core cause can only be found in the left hand side of the above equation. But commercial pressures, faster turnarounds and reduced manning are the norms of the day. They are here to stay, because shipping, like any other industry is a profit driven one. In the cut-throat world of smallest margins making the biggest differences of who stays in the game and who is out, even safety cannot come in the way of commercial gain. This is a very insensitive statement, one would say and I would most agree. But it is, nevertheless factual."

4.3 Secondary literature and data sources for quantitative model

A central part of our efforts was producing a model to estimate the extent and cost-equivalent of time spent on security tasks for the entire EU-flagged fleet. This model offers not simply a robust estimate, but also an extensible framework for continued future improvements in the estimate as input variables are clarified or change. The overall model logic is sketched in Figure 7, the modeling procedure itself is described in Section 7, and the following sections present the sources from which the model parameters were derived.

4.3.1 EU-flagged fleet size and composition

The classification of ship sizes and types is only gradually converging on harmonised categories, and it is sometimes unclear to which categories secondary statistics apply. As discussed in Section 9.1, the “human dimension” is at the tail end of the gradual improvement in data access and harmonization. Many statistics (even official ones, such as the EU EMSA/Equasis) rest to some degree on commercial databases, such as that of IHS Fairplay.

Our mandate was to study the vessels subject to ISPS, eliminating the more than 33% of vessels (at the global fleet level) that are under 500 GT (EMSA, 2012). The vessels larger than this are overwhelmingly in the medium (500-25,000 GT) range, which is dominated by general cargo (33%), tankers (17%), bulk carriers (10%), and offshore
vessels (12%). As further discussed the 500-1,000 GT discrepancy causes many difficulties—the category falls between the lower threshold of ISPS applicability and the 1,000 lower threshold of many statistics. Some of the sources drawn on in our work were the following:

- UNCTAD, UNCTADstat: Merchant fleet by flag of registration and by type of ship, annual, 1980-2012 (categories are: Oil tankers; Bulk carriers; General cargo (combines passenger and cargo); Container ships; Other). (UNCTAD, 2013)
- EQUASIS, The world merchant fleet, annual up to 2011. (EMSA, 2012)
- CIA Factbook,

Figure 8, Figure 7, Figure 10, and Figure 11, indicate the key relevant data, and the strong dependency of ship type and flag: the German emphasis on container vessels, for example, or the Maltese on bulk carriers.

(From Publications Office of the European Union, 2011: Ships of 1000 grt and over, on January 1st, 2009)

<table>
<thead>
<tr>
<th></th>
<th>Total fleet controlled</th>
<th>National flag</th>
<th>Foreign flag (including other EU)</th>
<th>Share of foreign flag in total fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number miodwt</td>
<td>Number miodwt</td>
<td>Number miodwt</td>
<td>Number miodwt</td>
</tr>
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<td>3,538 127.9</td>
<td>8,083 290.0</td>
<td>EU27</td>
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</tr>
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</tr>
<tr>
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<td>0.150</td>
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<td>17 0.1</td>
<td>IE</td>
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<tr>
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</tr>
<tr>
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<tr>
<td>LV 127</td>
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<td>102 2.4</td>
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The Impact of Security Tasks on Crew Workloads and Manning Levels of EU - flagged vessels

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<th>Ships</th>
<th>Mldw</th>
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<th>%Total</th>
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<td>16</td>
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<tr>
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<td>46</td>
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<td>438</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
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<td>79</td>
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<td>29.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MK</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>TR</td>
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<td>1,015</td>
<td>69.1%</td>
<td>78.9%</td>
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<td></td>
</tr>
<tr>
<td>CH</td>
<td>102</td>
<td>102</td>
<td>74.5%</td>
<td>71.2%</td>
<td></td>
<td></td>
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</tbody>
</table>

Source: ISL merchant fleet databases; aggregates based on updates from the Lloyd's.

DK: including international registers and vessels registered at territorial dependencies.

Russia: 1418 ships, 17.302 mldw; Monaco: 68 ships, 3.176 mldw; Ukraine: 386 ships, 2.817 mldw; Gibraltar: 10 ships, 0.224 mldw.


Figure 8 - EU Merchant Fleet - (flagged & controlled)
### EU Flag Vessels, 2010, based on CIA Factbook Merchant Marine listings (1000 GT and higher)

<table>
<thead>
<tr>
<th>Country</th>
<th>Total</th>
<th>Bulk Carrier</th>
<th>Container</th>
<th>Passenger + Passenger/Cargo</th>
<th>Petroleum and Refined Products</th>
<th>Roll on/roll off</th>
<th>Other Cargo Ships</th>
</tr>
</thead>
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<td>Austria</td>
<td>2</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Belgium</td>
<td>81</td>
<td>21</td>
<td>4</td>
<td>2</td>
<td>34</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>37</td>
<td>16</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>12</td>
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<td>Cyprus</td>
<td>839</td>
<td>267</td>
<td>193</td>
<td>27</td>
<td>79</td>
<td>13</td>
<td>260</td>
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<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Denmark</td>
<td>347</td>
<td>4</td>
<td>87</td>
<td>40</td>
<td>42</td>
<td>6</td>
<td>168</td>
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<td>24</td>
<td>1</td>
<td>17</td>
<td>2</td>
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<tr>
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<td>20</td>
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<td>55</td>
<td>29</td>
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<td>293</td>
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<td>0</td>
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<tr>
<td>Ireland</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>81</td>
<td>22</td>
<td>183</td>
<td>81</td>
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<td>3</td>
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<td>4</td>
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<td>10</td>
<td>19</td>
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<td>Malta</td>
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<td>24</td>
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<td>Poland</td>
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<td>0</td>
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<tr>
<td>Portugal</td>
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<td>8</td>
<td>8</td>
<td>18</td>
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<td>1</td>
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</tr>
<tr>
<td>Romania</td>
<td>15</td>
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<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
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<td>Slovakia</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>Slovenia</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
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<tr>
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<td>41</td>
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</tr>
<tr>
<td>Sweden</td>
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<td>12</td>
<td>32</td>
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<td>190</td>
<td>74</td>
<td>30</td>
<td>29</td>
<td>174</td>
</tr>
</tbody>
</table>

| Total          | 6958  | 1263         | 1042      | 791                          | 909                            | 265            | 2688             |

| %              | 18.2% | 15.0%        | 11.4%     | 13.1%                        | 3.8%                           | 38.6%          |

**Figure 9 – EU Flag Vessels 2010 (>1,000 GT)**
Figure 10 – EU flagged ships by Ship Category and Member State

(Note: All states with median (=81) and above total vessels; vessels are above 1000 GT).
Figure 11 - EU flagged ships by Member State and ship category

(Note: All states with median (=81) and above total vessels; vessels are above 1000 GT).
4.3.2 Crew on EU-flagged vessels: numbers, positions, nationalities

The existing work and data on employment of seafarers on EU-flagged vessels was recently reviewed as part of the task force on maritime employment established by DG-MOVE (Sulpice, 2011). While the focus in this effort was primarily on EU nationals, motivated by concern for the preservation of maritime know-how and adequate skilled labour supply, this work contains valuable collation of the available information that was useful for our purposes as well. As the Sulpice report emphasises repeatedly (and see our recommendation on data fusion in Section 0), the existing data is often incomplete, unreliable, and unharmonised. Additionally we drew on the data in Mitroussi(2008), FST/ECSA (1998), McLaughlin(2012), and the USDOT (2011) study and accompanying report by PriceWaterhouseCoopers, and others.

4.3.3 Manning costs and crew wages

Our main sources are Branch(2007), especially the chapter on Manning, and for the broader picture, Stopford’s (2009) Maritime Economics. Salary levels and background information are given in the ISF (2006) annual survey of salaries, the salary rates used in the OECD evaluation of ISPS, Balyk (2006), the older figures used by the EC(1995) in a study of the effects of cabotage regulation, Sulpice (2011), Gekara (2008), and the wider debates over manning costs as a factor in outflagging decisions. Triangulation with seafarer bulletin boards helped validate the accuracy of these sometimes older sources.

4.3.4 Analysis of port stay patterns using AIS transponder data

The importance of reliable port visit information and potential sources of data.

Since our initial research indicated that much of the load of ISPS occurs in the approaches to port (mostly related to paperwork) and for the duration of the port stay (extra gangway watches, patrols, escort of visitors). Thus, a solid quantification of ISPS’s workload impacts requires a solid estimate of the duration and frequency of port visits for the EU-flagged fleet.

The “duration of the vessel's stay in port” or turnaround time is an important and standard port performance indicator (PPI), defined as the time of arrival to the time of departure (Mokhtar, 2006; Langen, 2007). Traditionally expressed in days, it is more often expressed in hours as statistics and data logging capacities have improved. A related derivative PPI is “average turn around time per ship,” which is the total hours in port divided by the number of ships handled in that period. This is an operational indicator that ship owners and operators care about as they compare various aspects of
port functioning, and it is also a useful parameter for the port itself, as they attempt to optimise their operations and allocate resources efficiently.

However, these statistics are not typically released by ports at a scale useful to us. De Langen (2007) is emphatic on this point:

“Even though ship turnaround time is already discussed in academic literature for more than 30 years (see Heaver and Studer, 1972), no port systematically reports the ship turnaround times. . . . Even though this is clearly relevant for shipping lines, ports do not report turnaround time in annual reports or other publications.”

In addition our analysis requires the perspective of a vessel (stopping in various ports), rather than the port (serving various vessels).

The need for and generation of port call estimates—and from the perspective of vessels, rather than ports—arises from research on topics that are un-related to port efficiencies: those attempting to model emissions of maritime vessels (Psaraftis, 2009), the spread of invasive species via maritime traffic (Hewitt, 2011; Lewis, 2003; Sylvester, 2011), or the epidemiology of seafarers (Haiming, 1985; Hooper, 1978; Wickramatillake, 1998). Since the location and intensity of emissions, the movement of biological vectors between vessels and habitats, and seafarer practices is quite different in port and sea, and may be a function of the frequency and duration of port calls, such researchers have similar data needs.

Existing estimates of number and duration of port stays are crude, or based on a narrow evidence base, and not disaggregated by flag, or studied over time. For example, Psaraftis and Kontovas (2009) in their modeling of CO2 emissions for the world commercial fleet acknowledges that:

“One critical source of uncertainty in this analysis concerned the values of sea-to-port time ratios (s/p) .... In reality, these ratios may vary even within the same ship type and size category, and the only way to ascertain them with precision would be to perform an analysis of all ship movements worldwide. As this was way outside the scope of our study, we took both parameters s and p as best estimates, after discussions with industry representative and perusal of other sources.”

The authors adopt an estimate of port calls a year drawn from the literature (about 60 for the medium cargo vessels of 5000-100,000 dry weight, for example), and calculate 1.5 days average for each port call for all size classes (Figure 12). (Our empirical analyses suggest that the number of port calls of EU-flagged ships, including the Greek ones, is considerably lower, while the duration of these port stays is considerably longer).
The carefully conducted hull fouling study of Sylvester et al was based on 40 vessels observed in two ports. The vessels in one of the ports spent 73 days annually in port (26, 23, and 17 days a year in the first, second, and third most visited ports), versus 56 days a year for the vessels sampled in the other port (48, 9, and 7 in the most visited 3 ports), with average port stays of 1 and 1.7 days respectively. The extensive biofouling risk assessment by Hewitt et al (2011) offers an Appendix (D) showing total and average residency periods of vessels (by category) from 2002 to 2007 across IUCN bioregions and the Australian Provinces, based on a Lloyds MIU dataset, but this does not allow for extraction of EU-flagged vessels, nor the required precision.

While this imprecision might be less consequential for a parameter within an emissions model or analysis of the exposure of hulls to colonization, a model of ISPS impacts—in which time in port is at the heart of an economic model—would benefit from greater precision and systematic coverage.

A potential source of precise information on port stays is the LRIT (Long Range receiver) data on ship movement collected by commercial firms and EMSA (European Maritime Safety Agency), but we were informed by EMSA that information on number and duration of port stays was “either not in EMSA’s possession or confidential in nature.” For this reason, we decided to perform our own primary analysis of port stay parameters of the EU fleet, as a basic input into the ISPS cost model.
Our use of AIS transponder data for studying port calls. As described above and in greater detail in some of our intermediate reports, the source of our vessel movement data is a unique extraction of AIS (Automatic Identification System) transponder broadcasts for a large sample of vessels, which was initially conducted by Carlos Pais Montes of Centro Universitario de Riazor (CUR) for a project on maritime networks (Pais Montes et al, forthcoming), and then jointly reworked and analysed with our team for the specific purpose of extracting port stay information.

Since 2005, AIS broadcasts have been required by the International Maritime Organization’s (IMO) International Convention for the Safety of Life at Sea (SOLAS) on all international cargo vessels of more than 300 tons displacement, all cargo vessels of more than 500 tons displacement, and all passenger vessels. These transmitters periodically announce their position, speed, and course, as well as other ship information for use in navigation, collision avoidance, and other purposes. AIS receivers on shore or other vessels access this information. In addition, over the years, an extensive “ecosystem” has grown that complies and uses these messages for a variety of other purposes, including research purposes, such as our own, that need to reconstruct the movements of maritime vessels. AIS transmissions can also be linked to ship databases, to gain more detailed information about the ships in question.

AIS databases are commonly used to model ship emissions (Marin, 2008; Miola, 2011; Jalkanen, 2009) and for collision and accident modeling (Ladan, 2012), and, more recently, for port and maritime network analysis (Pais, forthcoming), and navigation (Gunnar, 2009). It has seldom been used for estimating port stays. The data format and protocols of this data are complex, and only partly public, and very extensive processing is required to ready it for research purposes.

While a large portion of the world fleet now carries AIS transponders, time and computing capacity constraints led to the using a very large, but still manageable subset of the world fleet container and general cargo fleet. Only vessels built before 2007 were considered, only active ships were included, and after ordering the vessels in ascending order of capacity (size), every third vessel was dropped, to reduce the sample size to just under 2000 vessels of each type.

Very briefly, our processing was as follows. The AIS data is in a raw form, requiring considerable cleaning in order to isolate the key information fields. Next, the routes for each vessel must be reconstructed by stringing together the sequence of its broadcasts, removing those that are non-port. These records of the AIS broadcast database must be linked to a ship database (which contains capacity and flag information). For each vessel, one can calculate the total number of port stops between any given time period, and the port stay for each of these port stops derived by subtracting port arrival time from the departure time from the same port.
In order to validate the accuracy of our data, several cross-checks were performed. For example, we compared the breakdown by flag of the AIS data with the official statistics. As shown in Figure 13, we found these to be in almost complete agreement: 98% of the variance in the number of vessels in the AIS dataset we used could be predicted explained by the actual number of vessels registered to that flag (R²=0.98; F Ratio=710.5; n=14; p<0.0001).

![Figure 13 - Validating the AIS sample by flag comparison](image)

### 4.3.5 Piracy exposure and costs

Initially we attempted to use the same AIS dataset for the derivation of piracy exposure: the number and duration of transits through waters defined as being at risk. Together with our Spanish collaborators and a team of Czech researchers we conducted a proof-of-concept exercise on a subsample of the AIS data demonstrating that given a port pair, a maritime route-finding algorithm could establish the route through risky waters, defined with the rectangles of Figure 14. Given port departure and arrival times between the port pairs, this allowed the extraction of that portion of voyage (hours) spent in piracy risk. The port pairs used in this proof-of-concept are given in Figure 15, and visualised in Figure 16.
Historical record of pirate attacks in the 2003-2010 period (red dots) and rectangular areas (white shading) defining areas at piracy risk. Figure from Besley, 2012.

Figure 14 – Piracy attacks and risk areas

<table>
<thead>
<tr>
<th>Arrival Port Name</th>
<th>Departure Port Name</th>
<th>Trip duration (hours)</th>
<th>Days In Danger zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Port Said Bypass</td>
<td>Mina Zayed</td>
<td>216H</td>
<td>0</td>
</tr>
<tr>
<td>Alexandria (Egypt)</td>
<td>Ashdod</td>
<td>528H</td>
<td>0</td>
</tr>
<tr>
<td>Chennai</td>
<td>Mumbai</td>
<td>120H</td>
<td>2.356818023</td>
</tr>
<tr>
<td>Dammam</td>
<td>Kolkata</td>
<td>1350H</td>
<td>12.36275884</td>
</tr>
<tr>
<td>Mombasa</td>
<td>Karachi</td>
<td>264H</td>
<td>0.4009981</td>
</tr>
<tr>
<td>Bandar ShahidRejaie</td>
<td>Abu Dhabi</td>
<td>0H</td>
<td>0</td>
</tr>
<tr>
<td>Kakinada</td>
<td>Paradip</td>
<td>480H</td>
<td>0</td>
</tr>
<tr>
<td>Mumbai</td>
<td>Jebel Ali</td>
<td>240H</td>
<td>0</td>
</tr>
<tr>
<td>Dammam</td>
<td>Bandar Imam Khomeini</td>
<td>24H</td>
<td>0</td>
</tr>
<tr>
<td>Karachi</td>
<td>Jebel Ali</td>
<td>696H</td>
<td>0</td>
</tr>
<tr>
<td>Jubail</td>
<td>Mumbai</td>
<td>432H</td>
<td>0</td>
</tr>
<tr>
<td>Mumbai</td>
<td>Chennai</td>
<td>144H</td>
<td>2.828181627</td>
</tr>
<tr>
<td>Bandar ShahidRejaie</td>
<td>Mumbai</td>
<td>96H</td>
<td>0</td>
</tr>
<tr>
<td>Beira</td>
<td>Matola</td>
<td>96H</td>
<td>0</td>
</tr>
<tr>
<td>Bandar Imam Khomeini</td>
<td>Jebel Ali</td>
<td>264H</td>
<td>0</td>
</tr>
<tr>
<td>Jawaharlal Nehru Port</td>
<td>Port Rashid</td>
<td>96H</td>
<td>0</td>
</tr>
<tr>
<td>Dammam</td>
<td>Port Rashid</td>
<td>360H</td>
<td>0</td>
</tr>
<tr>
<td>Alexandria (Egypt)</td>
<td>El Dekheila</td>
<td>0H</td>
<td>0</td>
</tr>
<tr>
<td>Jebel Ali</td>
<td>Bandar ShahidRejaie</td>
<td>24H</td>
<td>0</td>
</tr>
<tr>
<td>Umm Qasr</td>
<td>Bandar ShahidBahonar</td>
<td>312H</td>
<td>0</td>
</tr>
<tr>
<td>Limassol</td>
<td>East Port Said Bypass</td>
<td>27H</td>
<td>0</td>
</tr>
<tr>
<td>Haifa</td>
<td>East Port Said Bypass</td>
<td>144H</td>
<td>0</td>
</tr>
<tr>
<td>Larnaca</td>
<td>Ashdod</td>
<td>0H</td>
<td>0</td>
</tr>
</tbody>
</table>
However, data confidentiality constraints of the holders of the AIS data prevented transfer of the full data set of port pair data to the Czech researchers, and we had to put these direct measurements on hold and pursue alternative means of estimation. We drew on a variety of sources (interviews with maritime security experts, trade press, and detailed data from the Suez Canal) to obtain estimates of the overall number such risky transits annually and their typical duration, and to scale these numbers to the EU flagged fleet.
5. Maritime community concerns regarding workload and manning implications of ISPS (2003-present)

5.1 Workload and manning implications of ISPS: past concerns and studies

Given the pre-existing concerns about lowered manning levels and overwork of crews, it is not surprising that any additional workload, would be the subject of debate. This was especially the case since ISPS was instituted very rapidly, and was an unknown quantity for many in the maritime industry. If one examines the kinds of crew tasks entailed by ISPS (as listed in Annex II), we can understand these anticipatory concerns. In this section, we describe these concerns, whether they were, in fact borne out, and to what extent manning increases were felt to be needed and, in fact, carried out, both before and after the fact.

This section reveals two curious bifurcations. One is between the widely shared sense among maritime professionals and their organizations that workload would rise, and, later, that it had, indeed risen, requiring increases in manning, on the one hand, and the sense conveyed by many maritime administrations and ship-owners on the other, that the increased tasks could be (and, later, had been) absorbed by existing crew. A second discrepancy is between the very large extent of discussion of the need for and lack of changes in crewing levels and the paucity of solid information about how crew levels have, in fact, changed over time.

Our discussion is a chronological one, tracing this discussion before and after ISPS, up to the present, and then documenting our attempts to put the question of crewing level changes over time in response to ISPS (and, in general) on a former empirical footing.

5.1.1 In anticipation of ISPS

In the year leading up to implementation of the ISPS code there was considerable trepidation about its economic and other impacts. Some of this concern was for the one time gearing up for ISPS (Jones, 2009), and of the unknowns of how these rapidly implemented measures might be assimilated and coordinated within the maritime system. Other concerns were for the ongoing costs to ports, shipping companies, and crews. A range of ex ante cost studies were conducted, which were summarised by Bichou (2008), as show in the table of Figure 17. These assessments tended to focus on port and company-side costs, rather those entailed by increased crew workloads.
Table 8: Summary of ISPS ex-ante cost estimates as computed by various regulatory risk assessment impacts

| Source of estimates | Cost items                                                                 | Scope                                                                 | Initial Costs* | Annual Costs* | Total cost* over 10 years (2003-13) @ 7% DFC |
|---------------------|---------------------------------------------------------------------------|                                                                     |                |              |                                               |
| **USCG**            | Total ISPS US ports                                                      | 226 port authorities, of which 500 facilities are computed (from Fairplay) ISPS Parts A & B MARSEC Level 1 | 1125           | 656          | 5399                                          |
|                     | Total ISPS US-SOLAS and non-SOLAS vessels subject to the regulation      | 3800 US-flag vessels, as well as domestic and foreign non-SOLAS vessels (i.e. operating in US waters) ISPS Parts A & B MARSEC Level 1 | 218            | 176          | 1388                                          |
|                     | Automated Identification System                                          |                                                                      | 30             | 1            | 50                                            |
|                     | Maritime Area (contracting government)                                   | 47 COTP US zones                                                    | 120            | 106 (for 2004) | 477                                           |
|                     | OSC facility (offshore installations)                                    | 40 US OCS Facilities under US jurisdiction                          | 3              | 5            | 37                                            |
|                     | U.S cost for ISPS implementation                                        | (ISPS parts A and B)                                                 | 115            | 884          | 7331                                          |
|                     | Aggregate Cost of elevating MARSEC level from 1 to 2                    | Based on twice MARSEC level 2 per annum, each for 21 days            |                |              | 16 per day                                    |
| **UK**              | Total ISPS UK port facilities                                           | 436 facilities ISPS Part A MARSEC Level 1                            | 26             | 2.5          |                                               |
|                     | Total ISPS UK-flagged ships and company related costs                   | 620 UK-flag vessels ISPS Parts A MARSEC Level 1 (Calculations based on an exchange rate of UK£1.6 USD) | 7.4            | 5.2          |                                               |
| **OECD**            | AIS                                                                        | Based on 43,291 international commercial fleet of more than 1,000 GT (Passenger and cruise vessels not included) MARSEC Level 1, ISPS Part A only | 649.3          | Unetermined  |                                               |
|                     | Other vessel measures                                                   |                                                                      | 115.11         | 14.6         |                                               |
|                     | Ship operating companies                                                |                                                                      | 1163.89        | 715.4        |                                               |
|                     | Total ships & shipping companies                                         |                                                                      | 1279           | 750          |                                               |
|                     | PPSA, PPSA, PFSP                                                        | 2,180 port authorities worldwide, of which 6,500 facilities are computed (from Fairplay) ISPS Part A only MARSEC Level 1 | 390.6          | 356.9        |                                               |
|                     | Total ISPS ports                                                         |                                                                       |                |              |                                               |
|                     | Global cost for ISPS implementation                                     | (MARSEC Level 1, ISPS Part A only)                                   | Unetermined     | Unetermined  |                                               |
| **Australian Government** | Total costs for Australia                                      | 70 Australian flag ships and 70 ports, of which 300 port facilities | 240 AUD        | 74 AUD       |                                               |
| **Shipowners' association** | Total costs for vessels                                            | 47 Australian vessels                                               | 29855 AUD      |               |                                               |

Source: this is Table 8 in Bichou (2008). Note: All cost figures are in 2003 USD $ million, except for Australia, which is 2002 AUD $ million.

Figure 17: ISPS ex-ante cost estimates computed by various regulatory risk assessment
While not reflected in anticipatory costings of ISPS, the concern about workload and added crewing costs was prevalent and often strident. The following comments half a year before the deadline, capture the sentiment among those on the front line of the changes.

“Without question there will be a considerable workload on the SSO and one of the major questions owners ask is: “Who is going to have time to be the SSO?” In these days of reduced manning the entire ship staff are already under intense pressure. As soon as the vessel arrives in port, and after it has been cleared by Customs and Immigration, there are a host of people waiting to get on board including Port State Control, Charterer’s Representatives, Vetting Inspectors, Chandlers and others.

Who then is the person most able to act as the SSO? The Chief Officer will usually be involved with the terminal/port facility regarding loading/discharging sequences and the need to start cargo operations as soon as possible. The Chief Engineer and Second Engineer will usually be desperate to start essential maintenance work. The Master will be dealing with Customs and Immigration and then PSC.

But, one person must be in charge and the Officer appointed SSO must be able to make decisions that could affect all operations on board the vessel. Because of this the Marshall Islands Administration has stipulated that the SSO should be a management level officer and it is highly recommended that it is the Master.

However, it is very important to remember that the SSO does not have to perform all the above duties himself and does not have to remain on board the vessel at all times. Moreover, an owner may also decide that there should be more than one SSO on board any vessel. There is no stipulation within the code as to who should be the SSO; it is up to the Company and the CSO to decide. But, it should be noted that the responsibilities detailed in the Code are such that only a senior officer will have the experience and authority on board to satisfactorily carry out the SSO’s duties.

In any case no matter who is appointed the Master has overriding authority under the Code and any SSO is answerable to the Master and the CSO. A number of Companies are intending to place another Officer on board the vessel to take care of Safety and Security matters, however not all companies wish to take this step and indeed many smaller vessels may not even have the accommodation space for another officer. [Emphasis added]. (McCuskey, 2003)”

Another observer surveying anticipated costs expected that this would extend to workloads, which would be difficult to measure.

As is typical of any new rule or regulation however well written, there is always associated cost. The ISPS Code and MTSA of 2002 are no different. . . The ISP codes and associated regulations as written are not intended to place a burden on the ships officers and crew. However, it will take some time to fully access if the code is creating hardship. ... Some cost can easily be quantified such as increased overtime and payroll costs for added watch-standers and security details. Other costs are more difficult to
measures, for example, extra watches translate into less sleep, less liberty, and a tired crew. (Albani, 2004.)

The OECD (2003) conducted a systematic estimate of the economic impact of ISPS and estimated the initial burden on ship operators to be at least $626 million and $168.2 million per year thereafter. This included equipment, the Company Security Officer (CSO), the Ship Security Officer (SSO) and Ship Security Assessment (SSA) and Security Plan, security training and drills, and tallying up the ISPS Code-related ship and company costs estimated that:

. . . the initial ISPS Code compliance burden on ship operators to be at least ~USD 1 279 million and USD 730 million per year thereafter. Not included in these estimates are the costs of implementing IMO AIS requirements (since these were only accelerated by the MSC 76 SOLAS modifications) and the indirect costs of operating under level 2 and 3 security alerts (potentially very large). The addition of the latter two into these estimates would possibly change the order of magnitude of costs under consideration.

Curiously, beyond the efforts of the SSO, the assessment did not seem to have included the ongoing workload for the crew as a whole, in particular that associated with extra watches. Its conclusions regarding the costs of additional crew labour were, thus, were the following:

At the time of this report’s writing, only 3 months after MSC 76, it had already become apparent that the vast majority of ship operators will fold the responsibilities of the SSO into an existing post onboard – most likely that of the Master. For the purposes of this analysis we assume that security duties occupy the Master 5 days per year (principally for security inspections). Using the International Transport Workers’ Federation’s Grade B benchmark wage rate of USD 4 080/month, we estimate SSO costs for the internationally-trading commercial fleet to be approximately USD 29 million per year.

Since seafarers and their spokesmen seemed to anticipate workload consequences of broader cope, one would expect that this would channel into pressures for revision of manning levels, especially since the entry point for this addition was contained in the code itself. As the British loss prevention trade magazine reminded its readers in a special briefing on all aspects of the new ISPS regulations published a month after their approval by IMO, “Up till now safe manning levels have only related to the safe navigation of a ship. Part B of the ISPS code advises flag states to consider the additional workload that may result from implementation of new security measures when setting the safe manning levels of ships.”

Our interviews with experts knowledgeable about the period leading up to the 2004 implementation of ISPS suggest that after considering the question national maritime agencies and ship owners reached a consensus that ISPS would not constitute any
Substantial additional work burden, and would, therefore, not require any upward revision of Manning levels. In only one case, Singapore, new safe Manning documents were issued to the whole fleet to demonstrate that Manning levels had been evaluated in light of the new requirements, but, as if to underscore the point, the Manning levels in these new documents were identical to those in the ones they superseded.

5.1.2 Subsequent to the implementation of ISPS

Seafarers, seafarer organizations, and academic analysts of maritime labour were less sanguine in their predictions regarding the workload implications of ISPS and their concerns did not subside after the fact (Suppiah, 2009; Balbaa, 2005; Bateman, 2007; Graham, 2009; Burmester, 2005). Writing a year after its implementation, Balbaa (2005) gives a fairly typical voicing of these:

“IT IS KNOWN THAT SEAFARERS WORK IN A TRULY GLOBAL INDUSTRY, OFTEN FALLING BETWEEN THE GAPS IN NATIONAL AND INTERNATIONAL LAWS. THE ISPS CODE CAME INTO BEING TO ENHANCE THE MARITIME SECURITY AND PROTECT THE PASSENGERS AND CREW ON BOARD. TO TAKE SUCH MEASURES, IT WAS REQUIRED FROM SEAFARERS TO DO SOME TASKS TO KEEP THE STANDARDS, BUT THESE TASKS HAVE ADDED EXTRA LOADS ONTO THE SEAFARERS IN ADDITION TO THE OTHER TASKS THEY PERFORM: MAINTAINING SAFETY AND PROTECTING THE MARINE ENVIRONMENT. …THE ISPS CODE CONTAINS PROCEDURES TO PREVENT STOWAWAYS REACHING SHIPS VIA PORTS, WHICH MEANS THAT A SHIP’S OWN SECURITY SYSTEM WILL HAVE TO TRY AND PREVENT STOWAWAYS FROM BOARDING THE VESSEL. FIGHTING PIRACY AND PREVENTING STOWAWAYS ARE TASKS OF A SHIP’S CREW; THE OWNERS SEEM TO COVER THEMSELVES AND APPLY THE INTERNATIONAL AND NATIONAL MEASURES BY ISSUING COPIOUS INSTRUCTIONS FOR CREW ON EXTRA WATCHES, EXTRA LOOKOUTS, EXTRA PRE-PLANNING AND POST-INCIDENT RESPONSE, BUT NO WORD ABOUT EXTRA CREW TO CARRY OUT ALL THIS EXTRA WORK IS ADDED TO SEAFARERS, BESIDE THE OTHER MAIN TASKS RELATING TO SAFETY AND MARINE POLLUTION PREVENTION. AT THE SAME TIME THE CODE WILL DO LITTLE TO ADDRESS THE PIRACY PROBLEM BECAUSE PIRACY IS DIRECTED AGAINST SHIPS AND NOT SOVEREIGN STATES. WE MUST ENSURE THAT WE DO NOT INCREASE THE WORKLOAD OF ALREADY OVERTIME SEAFARERS AND THAT THEIR FUNDAMENTAL RIGHTS, FREEDOMS AND BASIC DIGNITY ARE PROTECTED. (BALBAA, 2005)”

A report on fatigue in the shipping industry that same year (TNO, 2005), cited ISPS as well ISM codes and other inspections and audits as increasing workload and working hours, and thus fatigue, while another review of ISPS’ implementation noted that the ISPS tasks “will increase the already high workload which arises when the crew have to supervise cargo loading and unloading and deal with all those who may visit, as part of the formalities of arrival,” in addition to documenting several additional less anticipated concerns, notably the hardships due to cancellation of shore leave, the requirement that seafarers arriving in US ports obtain visas in advance, and that vessels produce a length history of prior port calls (Goulielmos, 2005).
Regarding manning, there were claims that “[t]he ISPS Code imposes significant additional costs on ship-owners, including possibly having to employ extra crew” (Bateman, 2006), though in our extensive search we have been able to find only a single report of this actually occurring in any significant way, when a company increasing manning across the board.

“Capt Bülow told a maritime symposium in northern German Elsfleth (Lower Saxony) that Leonhardt& Blumberg has increased the crews of all its ships by one or two members in order to cope with the new requirements under the ISPS Code. (Berkenkopf, 2004)”

In fact, shipping company stakeholders we interviewed conveyed an opposite impression, explaining that by simply scheduling their existing crew in a more intelligent way they were able to weather ISPS without manning additions. (The sample interview in Annex II is typical of these claims).

It was during this period that the only systematic study of the workload and manning implications of ISPS that we have identified was published, documenting the research by Longinowsky et al discussed in Section 0. While this study seems to have had almost no uptake in the maritime community, another study on the impacts of ISPS, including the workload/manning/security nexus, had considerable exposure. This was a survey conducted by ITF through a questionnaire circulated to the more than 120 ITF Inspectors in ports around the world and to 230 affiliated seafarers’ unions. These Inspectors and union officials discussed the questionnaire with crews and their members. Responses came from Turkish, Greek, Ukrainian, Indonesian, Chinese, Filipino, Latin American, Polish and Croatian seafarers, along with reports from ITF inspectors. While the distinctively non-random context of elicitation and fairly low response rate (58 completed questionnaires), and the fact that they are of the global fleet, place bounds on the results, for our purposes, they are, nonetheless, strongly suggestive. The responses on the key questions are given in Table 2 (Our own survey, described in Section 6, reports on a considerably larger sample of seafarers working mostly on EU Flagged Ships).
Table 2 - ITF Survey responses on key questions

<table>
<thead>
<tr>
<th></th>
<th>Yes %</th>
<th>No %</th>
<th>Other %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has the introduction of the code had a negative impact on your members?</td>
<td>56</td>
<td>39</td>
<td>5</td>
</tr>
<tr>
<td>Has the implementation of the code resulted in an increase in the number of crew?</td>
<td>96</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>In the experience of your members have flag states re-examined the minimum safe manning of ships after the entry into force of the code?</td>
<td>11</td>
<td>85</td>
<td>4</td>
</tr>
<tr>
<td>Has the code resulted in extra work and adversely impacted on crew performance and well-being?</td>
<td>58</td>
<td>37</td>
<td>5</td>
</tr>
</tbody>
</table>

The headlines used to report on these findings were direct: “More work, same pay and crewing.” (Jump, 2006), and the reports conclusions as well: “Attention should be paid to sufficient manning levels and appropriate compensation for increased responsibilities and workload.”

Similar claims were made by Erol Kahveci (2007), a staff member of the seafarer research and advocacy centre, SIRC, in a brief report entitled “The Maritime Security Code three years on”:

“One of the major impacts of the ISPS code on seafarers is that it has increased their workload. Since its introduction, seafarers have had to work longer hours to implement it because it requires gangways and ramps to be manned while vessels are in port, passes to be checked and visitors to be accompanied while on board. New security regulations for ports and ships are putting seafarers under more stress and helping to make them more isolated. A Mission to Seafarers’ port chaplain expressed concerns about the pressure on crews. “There have to be more seafarers on watch, so this means fewer of them coming to the Mission. Masters are complaining they are having more and more work to do, but no extra crew to do it. I am not sure how long this level of pressure can be sustained before someone cracks,” he said.’

In the following year, another large seafarer advocacy organization, Nautilus (2008), also urged ship owners and flag states to “recognise the workload demands arising from the ISPS Code,” and this was also one of the resolutions (“Resolution 2/2008 - PIRACY AND
SECURITY”) adopted in the annual general meeting that year of the International Federation Of Shipmasters’ Associations IFSMA Bremen, Germany 34th AGA, resolved that:

“Shipowners and flag states must recognise the workload demands arising from the ISPS Code and the post of SSO. The additional duties created by the Code and by the industry guidelines for combating piracy must be reflected when determining minimum manning certificates, and in the review of the STCW Convention, as well as in assessing compliance with hours of work and rest period requirements. (IFSMA, 2008).”

Writing in the organization’s Annual Review for that year, IFSMA President, Christer Lindvall, emphasised that “IFSMA sees the revision of the STCW-Convention as a very important tool to ease the workload for masters and officers, which has increased enormously during recent years by the introduction of the measures such as ISPS and ISM codes (Lindvall, 2008).

In the January Bulletin of the International Maritime Human Element, in an impassioned article, “ISPS-- Use Or Disuse: An [sic] Human Element Issue,” Captain Shahrokh Khodayari (2009), a Master Mariner, Accident investigator, and management systems auditor elaborated themes that had become widespread, echoing Loginovsky’s “zero sum” argument (though without the benefit of Bayesian modeling . . .)

“Should we ask ourselves that how ISPS code & its requirements have affected the life at sea; we may be disappointed by the reply received from the mariners. It is unfortunate that the dislike amongst the seafarers towards the security code is much more than those who take it as granted. Let us try to discuss some of its drawbacks:

1. Increase in paper-work. No doubt that in today’s maritime activity that a lot of shortage is felt about the manning levels & introduction of many new codes & legislations; ISPS code has created a large burden for the paperwork. There are many ports that still have not adapted the uniformity in reporting of the security matters & the seafarers calling these ports will have to fill out strange & tiresome forms. On the other hand the authorities take the security related matters with higher stringency & consequently if any form is wrongly filled or delayed for dispatching, there can be lots of troubles coming up. At some occasions that the distance between the ports are very short, the master has to send various forms while the ship is still in the previous port & surely there will be a lot of information not exactly or properly done. This has an adverse effect on the personnel running the vessel & creates unfounded responsibility for them.

2. Increase in work-load. The introduction of the security code has necessitated a lot of extra watches & patrols without having justified this increase in the work-load. It is unfair to keep the same number of people on board—or even at occasions reduce them—& expect the crew to do additional errands or activities. Moreover many charterers or ship-owners do not take the security issues a top priority & expect the master & crew to care for the commercial activities rather than a very inefficient policing job. We care
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU - flagged vessels

about the STCW & ILO stipulated watch/rest periods & audit/inspect/control ships for such abiding but at many occasions, considering the patterns like having a 6 hours continuous rest can not really be followed. If we listen to the seafarers; we will see that many complain of this extra work. Then we go to Human Element issues & fatigue, thereafter the incidents which can have root causes in this lack of rest & too much of work, we can conclude that quite oftentimes we stretch the crew so much the safety is hampered; so shall be the security of-course. Hence the essence of the code may be fading away.

5. Conclusion. The writer of these lines is not trying to ignore the good things that the ISPS has provided, but the emphasis is on the point that the achieved results are not much in favour of the seafarers & the human elements issues related to the actual & factual driving force & operators of the industry are being ignored. We should be reasonable & accept that the security code has not offered the mariners much of a joyful ride. It may be a high time that we look at the realities in today’s world. We want ships running & making good money. We better start treating these poor amphibians like human too. They need to go ashore, They need to be protected against various harms & amongst all the security dangers. In the ports we can provide shore watchmen to guard their gangways & let them do the assigned nautical tasks. The training of the seafarers should be more practical with regard to all aspects especially the security matters. If we want the merchandise to be carried all over the world, it may be a requirement to provide the safety & security of those ports as well, perhaps by sanctions & increasing the freight rates or escorting by a navy patrol. We cannot have the same number of people on board & expect them to be guarding our assets as well as their own lives by stretching the working hours or introducing numerous codes & regulations. The Facilitation of maritime traffic should spend more effort on uniformity of forms & procedures in all areas, specifically the security requirements. There are bitter feelings at the very hearts of mariners, we must taste a bit & pay the price too. Consideration of human element issues is surely an investment not expenditure. After all we should take safety first; shouldn’t we? “

One of the more authoritative institutional expressions of concerns about the workload implications of ISPS was given in a chapter on ISPS in the Lloyd’s Lloyd’s MIU Handbook of Maritime Security (Jones, 2009). The shifts in responsibilities and duties of SSO, master, and other personnel are mapped, and he is clear about the fact that given low manning levels existing duties were already on the verge of being untenable before the introduction of ISPS (even at level 1, and certainly higher)—at least of we are to take ship SSPs at face value.

Writing in the Maritime Transport & Navigation Journal the following year, in a review of key issues related to ISPS, Xhelilaj (2010) returns to these same issues:

“This is mainly because the new security measures are putting extra burden on the already limited resources of ships, charging thus the seafarers with additional workloads without correspondingly increases in ship manning levels. To evaluate the
success of the Code’s implementation would be to determine whether seafarers are capable to achieve its objectives of efficiently deterring and thwarting unlawful acts and mitigating the consequences of security incidents. Ship crews, however, are already in disadvantage due to the existing manning level which has brought about a situation where average sized ships would today be manned by only 15 crew-members. This manpower reduction coupled with the increased workload leads to a concentration of responsibilities by the specialists who before were responsible for particular tasks, resulting, therefore, in lack of specialized knowledge for emergency situations, which is crucial for the safety and security onboard. Flag states, in this respect, are failing in their responsibilities to reassess the principles used for issuing Safe Manning Certificates within the context of the Code’s requirements, bringing about a situation which have resulted in seafarers’ exploitation, it has become a health hazard and, for seafarers onboard, it is becoming unfeasible to carry out their security duties together with the standard tasks diligently, efficiently and consciously (ITF, 2007). The significantly increased workload and the introduction of additional procedures appear to have negative impact and time implications for crews. Masters are complaining of having additional work after the new security measures came into force, but no extra crew to carry out (Kahveci, 2007). This is a key issue to consider, because studies, in this respect, have revealed that the excessive workload in ports and ships is the main reason for maritime accidents (Ordemann et al, 1993).”

The following year, ISFMA Secretary General, Captain MaDonald (2011), speaking on the topic “The Master’s Increased Workload,” portrayed a situation that had, if anything, worsened, with no end in sight:

“No new technology in the world has helped reduce the master’s workload. Automation has reduced Manning levels, while added responsibilities of MARPOL, the ISM Code, the ISPS Code have not been matched by increased Manning levels. More and more paperwork has to be completed now. The result is tiredness.

Captain MacDonald related a common scenario in the English channel with a product tanker. The vessel is legally manned to minimum legal levels: Master, two mates, three engineers, and nine ratings. Over the previous 48 hours, visibility is poor and requires extra watch-keepers. The Master handles radio traffic in the busy channel. The vessel will move through four different berths. By the time the vessel approaches the Rotterdam Pilot station, both the master and chief mate have only had six hours of sleep in the past 48 hours. In addition to doubling up on watches, the master has sifted though the 37 mandatory documents he needs to keep valid to ensure the vessel is legally seaworthy, while the chief officer prepares the handover notes for his relief and Port State Control.

To add to the stress, the ship will welcome a number of visitors to keep the master occupied: pilots, immigration, customs, agents, bunkers, suppliers, port state control officer, cargo surveyors, class surveyors, P&I Club, off-hire/on hire surveyors, and possibly port health. Masters can’t get off the ship anymore!

Safer ships and cleaner seas are the whole purpose of the IMO conventions, all done with minimum safe manning levels. Even potentially disastrous combinations as
mechanical failures, bad weather, bad ship design, tight schedule, the leadership and ingenuity of the master and the flexibility of a good crew, can somehow hold this altogether. He pondered that perhaps this one of the worse problems – seafarers can do it – because they have to. The point is that they shouldn’t have to.

The EU has 48 hour work week directive, and it’s even lower for other transportation workers. Yet, we expect seafarers to legally work 98 hours per week. The Manila Amendments to STCW Chapter 8 Watch-keeping increases the minimum rest hours from 70 to 77 hours per week. What is worrisome is that over 48 hours, the four-hour break does not need to be consecutive and includes meal breaks.

The Master’s workload continues to increase and there is no sign of improving minimum safe manning levels. The industry realises fatigue is a problem; Danish and Swedish research shows there can be a solution, but it is ignored. More can be done by administrations, PSC, underwriters, and shippers, but the solution really lies in the hands of the ship-owners and managers.”

Eight years after if first approved ISPS in 2003, the IMO’s (2011) draft Maritime Security Manual: Guidance for port facilities, ports and ships reiterated once more that ISPS demands are additional, and that manning levels should be adjusted to them, as follows:

“Manning levels 2.9.45: Administrations should ensure that, when determining the safe manning level of each national ship, they take into account any additional workload that may result from the implementation of the approved SSP. Consideration should be given to the workload associated with the performance of security responsibilities, the capacity of the shipboard personnel to handle the additional workload while recognizing the need to implement the hours of rest and other measures for addressing and avoiding fatigue among ship personnel.”

That year, and against this background of continued concern, DG-MOVE (EC, 2011) issued an invitation to tender for the research reported on in this present report:

“The purpose of this contract is to assess the possible impact, including financial consequences, of security duties including the measures for self-protection and the prevention of piracy and armed robbery against ships, on the workload of all categories of ship crew and the interaction of security levels with manning level of ships. Ships to be considered in particular are those subject to article 3.1and article 3.2 of Regulation 725/2004.”

5.2 The absence of systematic time series data on crewing levels

In the preceding sections we have traced here almost a decade of concern that security tasks would increase workloads and, thus, require an increase in manning requirements, and, also, the widespread sense that such increases have, in fact, not occurred to any significant degree. However, there is little consistent available data or study that would
allow us to evaluate this systematically. A series of ex-post reviews of the cost of ISPS exist (see Bichou 2004, 2008), which were done using various methods (survey studies, economic impact studies, financial and insurance risk modeling, trade flow impacts, transfer costs). However, these are of marginal use to us, as they focus on broad range of security costs (and benefits), but scarcely reference the crewing cost component, from which manning impacts might be inferred, and, also, they generalise from small sample to the entire fleet, and yield inconsistent results.

Earlier, in Section 4.1 we discussed two substantial studies of crewing level, by Seafarers International Research Centre (SIRC) and USDOT, but these are snapshots at a single point in time, and what is needed is some kind of time series, especially one that straddles the 2004 implementation of ISPS, which was the major addition to workloads. We attempted to use the SIRC crew list study and obtain operating expense data to create more reliable evidence of manning level changes as a consequence of the implementation of ISPS, and of changes in manning over time more generally.

The SIRC survey conducted in 2003 gathered and analysed crew lists submitted upon entry to port for almost 4000 vessels of all flags in selected ports around the world. The data includes the type and age of vessel, gross tonnage, vessel flag, number and kind of crew positions, and the nationalities of those who occupy these. We visited SIRC’s offices in Cardiff and conducted detailed discussions with them on if and how this data might be leveraged in a way that would serve our project on the impact of security measures as well as be useful to them. We first considered the possibility of a second follow-up crew list survey of the same kind. Since the SIRC data was collected prior to 2003, collection of current data would allow us to see the shifts in crew number, kind, and nationality that have occurred over the last decade or so, and their relation to ship size, type, and flag. (A new survey could also examine the current declared safe manning levels for vessels of different kinds and nationalities—actual crewing levels sometimes exceed these, since Safe Manning levels are a minimum, allowing operation under emergency conditions). Since a resurvey would provide crewing characteristics at two snapshots in time (2003 and 2012), this analysis would not isolate ISPS-related changes alone, but would give a unique insight into the totality of manning changes that have occurred over this period. However, since SIRC estimated that the cost of fully replicating the 2003 survey to exceed 80,000 British Pounds, this was deemed infeasible.

We then considered ways to conduct an elegantly focused and cost-effective survey of our own, that might obtain partial information from a smaller survey. However, it seems that obtaining approval by some port authorities to allow us to review the crew lists that are regularly collected, by them as was done in the initial SIRC survey would be difficult, especially in a post-ISPS environment. Our request for assistance in this issue from the European Sea Ports Organisation (ESPO) did not bear fruits. A second avenue we attempted was a re-sampling a large enough portion of the very same ships sampled in
2003. This was an unlikely but, potentially, high reward avenue, allowing a very pointed comparison, so worth the try. A sample of 40 vessels was taken from the database, and using the IMO number recorded by SIRC the EQASIS database used to verify that the names matched the ship description and whether the ship’s name had changed. Of the 40 ships, only 26 were in service, the others having been mostly broken up (11) or lost. Of these 26, only 6 could be found in online shipping databases. Thus, the resample of identical ships did not seem feasible.

In parallel to our discussions with SIRC, we explored other potential repositories of past and obtaining current crewing lists. (Our understanding is that ports usually destroy these records after a short period, and we have not uncovered any that would be exceptions.) We requested assistance from Louis Baumard, Communication Officer at EMSA, since EMSA’s first workshop on the development of an STCW Information System discussed collecting and archiving crew lists for research purposes, which would be exactly what we need for our analysis. However, we were informed that this information was unavailable or confidential.

We also explored obtaining a time series of crewing lists and manning levels from 2000 onwards from one or more cooperative companies. Most companies are sensitive about crewing and salary parameters, and such data has not been forthcoming at this point. One large maritime insurance company holds a time series of vessel operating expenses of several hundred vessels before and after the 2004/5 implementation of ISPS, and we approached them to see if we could obtain this, disaggregated as far as possible—ideally with labour costs as a separate category. (The portion of costs typically associated with manning is indicated in Figure 18 and Table 3). This data might allow a multivariate regression model to isolate any "signal" of ISPS implementation (added OPEX costs due to increase in manning) and get some sense of the magnitude of this addition. This model, would include a dummy variable for before/after ISPS, with ship size and age and other time series variables (such as fuel prices, which also rose sharply around the time ISPS began to be implemented) as control variables. This might allow us to isolate and quantify any ISPS-related signal, were this to exist, and to pinpoint which categories and sizes of ships were most affected. Or, in the absence of significant effects, we would have a strong argument that ISPS had not significantly affected OPEX.

However, despite willingness of an individual analyst to allow us access to the needed data, obtaining official clearance to be able to proceed was not possible in a reasonable timeline.
Table 3 - Annual operating cost figures for 3 ship categories

<table>
<thead>
<tr>
<th>Vessel Name</th>
<th>Container Ship</th>
<th>Bulk Carrier</th>
<th>Multi Carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Weight Tonnage</td>
<td>5,600</td>
<td>11,483</td>
<td>13,700</td>
</tr>
<tr>
<td>Year Ended</td>
<td>31-12-06</td>
<td>31-12-06</td>
<td>31-12-06</td>
</tr>
<tr>
<td>Currency</td>
<td>USD</td>
<td>USD</td>
<td>USD</td>
</tr>
<tr>
<td>Operating days in 2006</td>
<td>365</td>
<td>365</td>
<td>365</td>
</tr>
<tr>
<td>Crew Wages</td>
<td>661,009</td>
<td>1,272,805</td>
<td>971,382</td>
</tr>
<tr>
<td>Stores</td>
<td>184,996</td>
<td>150,593</td>
<td>270,660</td>
</tr>
<tr>
<td>Repairs and Maintenance</td>
<td>217,952</td>
<td>333,143</td>
<td>476,436</td>
</tr>
<tr>
<td>Insurance</td>
<td>167,147</td>
<td>249,647</td>
<td>336,843</td>
</tr>
<tr>
<td>Administration</td>
<td>173,903</td>
<td>219,876</td>
<td>191,627</td>
</tr>
<tr>
<td>Total</td>
<td>1,347,007</td>
<td>2,248,066</td>
<td>2,246,948</td>
</tr>
</tbody>
</table>

Note: Container ships are cellular vessels which are built to carry only containers. Bulk carriers are built with large holds for the carriage of large quantities of dry homogeneous cargoes like grain and coal. Multipurpose vessels are those which carry all types of cargoes in small packages. These are labour intensive and have been largely replaced by purpose-built vessels like container ships. Container ships and bulk carriers do not normally require large crews. A container ship of the size given here will carry a crew of around 16 while the bulk carrier will have around 22 and the multipurpose one will have 30.

Source: One UK-based shipping company participating in the study.

Source: Fig. 16 in Gekara (2008)
Figure 18 – Major costs of running a bulk carrier
6. Structured survey of 335 seafarers on security duties

6.1 Background on survey and respondents

We approached a variety of large discussion maritime groups (Annex ii), including those often used by seafarers seeking employment to obtain permission to conduct a web-based survey of seafarers. Where permission was granted, the invitation notice provided background on the goal of the survey and invited interested seafarers to visit a survey web-site to answer a set of questions related to their experiences regarding nature and workload impacts of security tasks. A text format of the web-based survey is available in Annex II.

At the time of closure of the survey, at the beginning of May, 2013, 335 people had responded to the survey, representing a broad distribution of 51 different nationalities (Table 4) and crew positions, especially the deck officers.

Respondents were asked to state the flag under which they had the bulk of their maritime experience, using one of the three categories shown in Figure 20, which shows that 44% (106 people) of those answering this question worked mainly on EU flagged vessels, and another 23% worked equally on EU and non-EU flags. Thus, over 67% of the respondents had at least half of their maritime experience on EU flagged vessels, and their answers could be said to represent these.
Table 4 - Nationality of Respondent

<table>
<thead>
<tr>
<th>Nationality of seafarer</th>
<th>Count</th>
<th>% of total</th>
<th>Nationality of seafarer</th>
<th>Count</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danish</td>
<td>46</td>
<td>19.3</td>
<td>Indonesian</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>Indian</td>
<td>19</td>
<td>8.0</td>
<td>Malaysian</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>Filipino</td>
<td>16</td>
<td>6.7</td>
<td>South African</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>American</td>
<td>15</td>
<td>6.3</td>
<td>Turkish</td>
<td>2</td>
<td>0.8</td>
</tr>
<tr>
<td>Croatian</td>
<td>13</td>
<td>5.5</td>
<td>Australian</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Romanian</td>
<td>10</td>
<td>4.2</td>
<td>Cape verdean</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Ukrainian</td>
<td>9</td>
<td>3.8</td>
<td>Colombian</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>British</td>
<td>8</td>
<td>3.4</td>
<td>Cote d’Ivoire</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Bulgarian</td>
<td>7</td>
<td>2.9</td>
<td>Estonian</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Russian</td>
<td>7</td>
<td>2.9</td>
<td>German</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Latvian</td>
<td>6</td>
<td>2.5</td>
<td>Irish</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Swedish</td>
<td>6</td>
<td>2.5</td>
<td>Maltese</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Dutch</td>
<td>5</td>
<td>2.1</td>
<td>Myanmar</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Canadian</td>
<td>4</td>
<td>1.7</td>
<td>Namibian</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Greek</td>
<td>4</td>
<td>1.7</td>
<td>New Zealand</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Iranian</td>
<td>4</td>
<td>1.7</td>
<td>Peruvian</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Italian</td>
<td>4</td>
<td>1.7</td>
<td>Republic of Korea</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Pakistani</td>
<td>4</td>
<td>1.7</td>
<td>Singapore</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Belgian</td>
<td>3</td>
<td>1.3</td>
<td>Slovenia</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Egyptian</td>
<td>3</td>
<td>1.3</td>
<td>Spanish</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Finnish</td>
<td>3</td>
<td>1.3</td>
<td>Sri lankan</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Lithuanian</td>
<td>3</td>
<td>1.3</td>
<td>Tanzanian</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Norwegian</td>
<td>3</td>
<td>1.3</td>
<td>Togolese</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Polish</td>
<td>3</td>
<td>1.3</td>
<td>Uruguay</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Faroe Islands</td>
<td>2</td>
<td>0.8</td>
<td>Yemeni</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Icelandic</td>
<td>2</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Frequencies

A total of 238 respondents. Two reported dual nationality, and were entered under that first listed.
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU - flagged vessels

<table>
<thead>
<tr>
<th>Level</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>102</td>
<td>100%</td>
</tr>
<tr>
<td>All other</td>
<td>25</td>
<td>25%</td>
</tr>
<tr>
<td>Master</td>
<td>22</td>
<td>22%</td>
</tr>
<tr>
<td>Chief engineer</td>
<td>16</td>
<td>16%</td>
</tr>
<tr>
<td>Chief officer</td>
<td>14</td>
<td>14%</td>
</tr>
<tr>
<td>AB</td>
<td>10</td>
<td>10%</td>
</tr>
<tr>
<td>Second officer</td>
<td>10</td>
<td>10%</td>
</tr>
<tr>
<td>Third officer</td>
<td>5</td>
<td>5%</td>
</tr>
</tbody>
</table>

Figure 19 - Current/recent position-broad categories (over 5% of total)

As shown in Figure 21, the mean time at sea of respondents was 19 years (a median of 16 years), and about 75% of the respondents had experience both before and after the beginning of ISPS enforcement in 2004 (Figure 22), placing them in a good position to judge the workload impacts of this legislation. (As described below, this was an important factor to consider.)
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU - flagged vessels

Figure 21 - Years experience at sea

Figure 22- Respondents denoting they were employed at sea during each of the following periods

Given their seniority, most respondents had risen through the ranks of crew positions, and were very familiar with the overall workloads of all the deck officer positions, as well as those of the ratings (Figure 23). This experience was across all major vessel types (Figure 24), with a mean of 5 years experience on each type.

15 The dashed red line in the figure represents mean years of experience across all vessel types. Grey boxes delimit the central 50% of observation, with the white line indicating the median number of years.
Figure 23 - Respondents rating of their familiarity with workloads of various crew positions

Figure 24 - Experience on various vessel types

Thus, the survey polls seafarers with a collective 4,500 years of experience at sea in a range of crew positions, primarily on EU-flagged vessels of all kinds, and, as we shall see, with extensive exposure to the nature and contexts of ISPS and piracy-related security duties. By the end of
the survey, close to 300 respondents had expressed explicit interest in receiving the final results of the survey and/or offering additional information as needed, and have provided their emails as a way to do so. This would allow a very qualified and committed focus group for future Delphi method (an approach that summarises and feeds initial data collected from a group of experts in an iterative convergent process) or other approaches to focused follow-up research.

6.2 Security-related tasks and their contexts

Given their broad experience and seniority, respondents were well positioned to evaluate the kinds and extent of security-related tasks. In fact, as shown in Figure 25 more than half (53%, or 113 people) had served as a Ship Security Officer (SSO). (Interestingly, a crosscheck showed no significant difference between the estimates made by those with and without direct SSO experience on a variety of parameters, such as time required by SSO duties.)

<table>
<thead>
<tr>
<th>Frequencies</th>
<th>Level</th>
<th>Count</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
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<td>113</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>102</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>215</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

The survey form posed questions regarding security duties overall as well as more particular questions regarding the task associated with ISPS and piracy, and to the relevant voyage phases and different security levels. Some of these were contextual and numerical (number and duration of port calls and piracy transits, for example), and others asked respondents to list the tasks they experienced as most time consuming before, during, and after the two main events that trigger security duties: ports stays and transits through piracy-threatened waters.

A total of 112 people responded regarding ISPS security tasks and 71 regarding piracy-related tasks. As shown in Figure 26, 75% of respondents reported having made a transit through piracy threatened waters at some point, and 48% of those who had (or 35% of all respondents) had done so within the last 6 months. Thus responses on the piracy questions were very largely based on direct and, as often as not, quite recent experience. (As described below, how recently, and extent, of direct exposure to piracy threat seems to be an important
factor affecting reported adequacy of manning levels and security measures, and presence of fatigue.)

<table>
<thead>
<tr>
<th>Contingency Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit in last 6 months?</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Total %</td>
</tr>
<tr>
<td>Col %</td>
</tr>
<tr>
<td>Row %</td>
</tr>
<tr>
<td>Nc</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Ever made a piracy trans</td>
</tr>
<tr>
<td>Nc</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>Ever made a piracy transit?</td>
</tr>
<tr>
<td>Nc</td>
</tr>
<tr>
<td>Nc</td>
</tr>
</tbody>
</table>

Figure 26 - Experience of piracy transit

As the survey progressed, we noticed that over half the respondents had served as a SSO yet not one listed this as their position. We decided to add an additional small set of questions to the survey to explore the SSO experience in more detail, and these were answered by the last 57 respondents. This confirmed the striking fact that the SSO is almost always one of the existing crew members: most often the chief officer (55%), to a lesser extent the captain—who is mentioned alone (6%) or as part of a “chief officer or captain” response (14%)—the second officer (14%), and only very occasionally the chief engineer, or even an AB. In other words, as a rule, the security duties are directly added onto the existing workloads of senior officers.

How much workload did these SSO duties entail? The distributions for the set of people who answered these SSO questions (27, or 66%, of whom, had themselves served as a SSO) appear in Figure 27. These figures are important, since SSO duties represent the bulk of officer workload, whereas estimates for rating workloads rely to a greater extent on other sources. As expected, these results are right-skewed. That is, most observations have low values compared to the very high values of a few exceptional individuals. For example, half the respondents estimated that the SSO spends 3 or less hours per port stop, but a few estimated more than 10. In such skewed distributions, the mean is often larger than the median (the value that has an equal number of observations above and below it)
through the influence of such outliers. For example, the single Croatian chief officer (record 2598316157) on a vessel that spends much of its time in waters at risk from piracy is such an outlier, whose responses contribute markedly to the average (but barely at all to the median).

Table 5 summarises the SSO data from the respondent subset as well as the full set of respondents. To summarise these, in approximate terms (using the 25% and 75% quantiles as a kind of trimmed centre of the data), half the respondents report that SSO tasks require 2-4 hours per port stop and 3-9 hours per piracy transit, and somewhere between 6 and 30 hours a month overall. They report 2-6 port calls monthly and under 4 experiences of Level 2 security a year, each of between 2 and 24 hours duration, and adding between 2-6 hours to their workload for every 24 hours. They report an average of piracy transits a year, of between 1-8 days in duration.

Since the parameters of Table 5 were used in our cost model of the entire fleet, we needed to check whether overall averages could be used or whether the parameters differed significantly for different vessel types. A variety of tests on the survey data showed no statistically significant differences between vessel types, so aggregate averages for all vessel types could be used.16

16 All the table parameters (monthly port calls, times above Level 1 security in typical 6 months, typical duration of level 2 episodes, hours of work added daily at Level 2, transits in piracy area in last 6 months, days in last piracy transit) were tested as a function of vessel type using an One-way Anova, as well as an Analysis of Means and Tukey-Kramer HSD comparison of all pairs. Despite reasonable statistical power with the given sample size, there were no significant effects or even anything approaching a significant p value for any vessel type.
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU-flagged vessels

Figure 27 - Extent of SSO duties

<table>
<thead>
<tr>
<th>Quantiles</th>
<th>Summary Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.0% maximum</td>
<td>Mean: 3.5714286</td>
</tr>
<tr>
<td>99.5% maximum</td>
<td>Std Dev: 2.9395773</td>
</tr>
<tr>
<td>97.5% maximum</td>
<td>Std Err Mean: 0.4535866</td>
</tr>
<tr>
<td>90.0% maximum</td>
<td>Upper 95% Mean: 4.4874654</td>
</tr>
<tr>
<td>75.0% quartile</td>
<td>Lower 95% Mean: 2.6553918</td>
</tr>
<tr>
<td>50.0% median</td>
<td>▼ 42</td>
</tr>
<tr>
<td>25.0% quartile</td>
<td>▼ 42</td>
</tr>
<tr>
<td>10.0% median</td>
<td>▼ 42</td>
</tr>
<tr>
<td>2.5% maximum</td>
<td>▼ 42</td>
</tr>
<tr>
<td>0.5% minimum</td>
<td>▼ 42</td>
</tr>
<tr>
<td>0.0% minimum</td>
<td>▼ 42</td>
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<table>
<thead>
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<th>Quantiles</th>
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<td>Std Dev: 8.6232286</td>
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<tr>
<td>97.5% maximum</td>
<td>Std Err Mean: 1.4788715</td>
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<tr>
<td>90.0% maximum</td>
<td>Upper 95% Mean: 10.06761</td>
</tr>
<tr>
<td>75.0% quartile</td>
<td>Lower 95% Mean: 4.0500366</td>
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<tr>
<td>50.0% median</td>
<td>▼ 34</td>
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<tr>
<td>25.0% quartile</td>
<td>▼ 34</td>
</tr>
<tr>
<td>10.0% median</td>
<td>▼ 34</td>
</tr>
<tr>
<td>2.5% maximum</td>
<td>▼ 34</td>
</tr>
<tr>
<td>0.5% minimum</td>
<td>▼ 34</td>
</tr>
<tr>
<td>0.0% minimum</td>
<td>▼ 34</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Quantiles</th>
<th>Summary Statistics</th>
</tr>
</thead>
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<td>Mean: 20.853655</td>
</tr>
<tr>
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<td>Std Dev: 20.864517</td>
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<td>Std Err Mean: 3.25849</td>
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<td>90.0% maximum</td>
<td>Upper 95% Mean: 27.433913</td>
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<td>▼ 41</td>
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</tr>
<tr>
<td>10.0% median</td>
<td>▼ 41</td>
</tr>
<tr>
<td>2.5% maximum</td>
<td>▼ 41</td>
</tr>
<tr>
<td>0.5% minimum</td>
<td>▼ 41</td>
</tr>
<tr>
<td>0.0% minimum</td>
<td>▼ 41</td>
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Table 5 - Extent and contextual parameters of SSO duties and security duties

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<th>Parameter</th>
<th>Statistic</th>
<th>SSO subset</th>
<th>All respondents</th>
</tr>
</thead>
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<tr>
<td>SSO duties per port stop (hours)</td>
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<td></td>
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</tr>
<tr>
<td>Median</td>
<td>3</td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td>Mean</td>
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</tr>
<tr>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSO duties per piracy transit (hours)</td>
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<td></td>
<td></td>
</tr>
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<td>75.0% quartile</td>
<td>8.5</td>
<td></td>
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</tr>
<tr>
<td>Median</td>
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<tr>
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<td></td>
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<td>Std Err Mean</td>
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<td></td>
</tr>
<tr>
<td>N</td>
<td>34</td>
<td></td>
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<tr>
<td>Monthly hours needed for SSO duties</td>
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<td>30</td>
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<td>Median</td>
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<td>Mean</td>
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</tr>
<tr>
<td>N</td>
<td>41</td>
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<td></td>
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<tr>
<td>ISPS--monthly port calls</td>
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<tr>
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<td>6</td>
<td>7</td>
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<tr>
<td>Median</td>
<td>4</td>
<td>4</td>
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<td>25.0% quartile</td>
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<td>7.8</td>
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<td>9.13</td>
<td>6.89</td>
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<td>Std Err Mean</td>
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<td>70</td>
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<tr>
<td>Times above Level 1 security in typical 6 months</td>
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<td>2</td>
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<tr>
<td>Median</td>
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<td>0</td>
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<tr>
<td>25.0% quartile</td>
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<tr>
<td>Mean</td>
<td>1.35</td>
<td>1.72</td>
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<tr>
<td>Std Dev</td>
<td>2.23</td>
<td>3.04</td>
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</tr>
<tr>
<td>Std Err Mean</td>
<td>0.50</td>
<td>0.37</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>20</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Typical duration in hours of level</td>
<td>75.0% quartile</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Parameter</td>
<td>Statistic</td>
<td>SSO subset</td>
<td>All respondents</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-------------------</td>
<td>------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>2 episode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>25.0% quartile</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>15.53</td>
<td>36.39</td>
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<tr>
<td></td>
<td>N</td>
<td>19</td>
<td>62</td>
</tr>
<tr>
<td>Hours of work added daily at Level 2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75.0% quartile</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>2.75</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>25.0% quartile</td>
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<td>2</td>
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<tr>
<td></td>
<td>Mean</td>
<td>4.63</td>
<td>6.21</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>5.333</td>
<td>11.15</td>
</tr>
<tr>
<td></td>
<td>Std Err Mean</td>
<td>1.19</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>20</td>
<td>56</td>
</tr>
<tr>
<td>Transits in piracy area in last 6 months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75.0% quartile</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>25.0% quartile</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>1.10</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>1.79</td>
<td>2.15</td>
</tr>
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<td></td>
<td>Std Err Mean</td>
<td>0.39</td>
<td>0.24</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>21</td>
<td>79</td>
</tr>
<tr>
<td>Days in last piracy transit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75.0% quartile</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>25.0% quartile</td>
<td>1</td>
<td>1.38</td>
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<tr>
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<td>Mean</td>
<td>5.53</td>
<td>6.44</td>
</tr>
<tr>
<td></td>
<td>Std Dev</td>
<td>4.81</td>
<td>10.44</td>
</tr>
<tr>
<td></td>
<td>Std Err Mean</td>
<td>1.24</td>
<td>1.42</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>15</td>
<td>54</td>
</tr>
</tbody>
</table>

In order to move beyond these overall estimates of added workload to particular tasks, each respondent was asked to list the most time consuming tasks at each of the three phases of port stops and piracy transits (before, during, and after), and, when possible, to give the number of minutes associated with each task. In order to relate these to particular crew positions and vessel types in each case, respondents were asked to state in advance of their listing of tasks the vessel type and crew position whose ISPS-related duties they were most familiar with, and the vessel type and crew position they
themselves occupied during their last transit through a piracy-threatened area, and to answer with respect to these. This is shown (in the case of ISPS) in Figure 27.

**Duties related to ISPS (page 2 of 4)**

Our questions on this page are regarding ISPS duties for the position and vessel type you are most familiar with. This is not necessarily the vessel you currently work on. All of the questions refer to the vessel/crew position combination you specify as being most familiar with.

11. I am most familiar with and will answer regarding ISPS duties on this vessel type

- Roll-on/roll-off
- Refrigerated cargo
- Vehicle Carrier
- Chemical Tanker
- Bulk carrier
- Petroleum tanker
- Liquefied gas
- Container
- Passenger
- Cargo
- Bulk carrier
- Other

12. I am most familiar with ISPS duties for the following position on this vessel (my answers on ISPS will refer to this position)

- Captain/Master
- Chief officer/first mate
- Second officer/second mate
- Third officer/third mate
- Deck cadet
- Engineering Department
- Stewards Department
- Rating (OSA9)

Figure 28- Section of questionnaire specifying vessel type and crew position

As can be seen in the mosaic plots of Figure 29 (in which the size of each square represents the number of respondents in that particular vessel/position category), a broad mix of crew positions on all vessel types are represented in a fairly even way.
Figure 29 - Number of survey respondents on security duties by vessel type and crew position\(^\text{17}\)

\(^{17}\) Note: The thin bar on the right represents crew positions for all vessel types. The number in each “mosaic” is the number of respondents in the designated vessel type/crew
The results for ISPS tasks are given Annex I, broken down by vessel type and crew position. Despite the absence of statistically significant differences in the estimates of overall extent of workload addition for different vessel types, as described above, we do see an indication of the differences in the kind of tasks mentioned for different vessel types.

These listings of tasks were generated using an open response form, as we wanted to elicit respondents’ independent suggestions of which tasks they considered to be most “time consuming.” It is interesting to compare this listing of the salient tasks from this practical perspective, in Annex II, with the officially mandated ISPS tasks in Annex I. However, our survey of open-ended task listings from 335 respondents showed that it is not feasible to provide a systematic collation of the relevant tasks and quantitative estimates of their extent for all crew positions and vessel types. The task list (for ISPS-related duties) is included, however, for its indicative value, and their use as the basis for “probe questions” in in-depth interviews.

6.3 Experiences, and attitudes related to security, workload, and manning

An additional important section of the survey addressed the attitudes toward the security/workload/manning equation through a set of attitude questions, shown in Figure 30, and the omnibus open text question on security duties in Figure 31.

position category. The top figure is respondents on ISPS duties, and the lower one on piracy-related duties. Totals 112 and 71 respectively

18 Given well-documented low survey response rates, it would be impractical to undertake a survey that would yield reliable estimates across 12 ship categories and 8 crew positions. To systematically explore variation in tasks and times in quantitative terms would require a fairly complete inventory of tasks for each of nearly 100 vessel/position combinations, and our survey showed limited convergence with 4-6 respondents per combination. An initial survey with open-ended responses with triple this number of respondents (close to 1000) would be required in order to “saturate” a list of task for each of these 100 categories, and then a closed-question survey conducted to yield 2000 respondents (if respondent vessel/position could be chosen in advance, and double this if not), in order to provide sufficiently precise numerical estimates of the time extent of each of these tasks. With prevailing response rates, his would require approach emails sent to between 100-200,000 seafarers. This somewhat exceeds the 190,000 seafarers employed on all ‘European Economic Area’ flagged vessels (see Mitroussi, 2008)—that is all the EU countries with the addition of Norway, Iceland, and Liechtenstein.
Figure 30 - Section on attitudes from survey

| 27. Which opinion most closely describes your overall experience on these issues |
|--------------------------------|----------------|----------------|----------------|----------------|
| ISPS duties are adequately performed on most ships | Very much agree | Somewhat agree | Don’t agree | Strongly disagree |
| In my current or most recent position at sea, fatigue was a problem | | | | |
| Proper performance of piracy protection measures (such as BMP4) makes a real contribution to ship security | | | | |
| Piracy protection measures (such as BMP4) are adequately performed on most ships | | | | |
| In my experience, the vessel on which I currently or most recently served is adequately manned | | | | |
| Fatigue is a common and worrying aspect of maritime life as a whole | | | | |
| Proper performance of onboard ISPS code duties makes a real contribution to ship security | | | | |

Figure 31 - Omnibus open text question on security duties

An overview of these responses is given in Figure 32 and Figure 33. We can see that 90% of respondents felt that “Fatigue is a common and worrying aspect of maritime life as a whole,”
while 73% of respondents admitted it to be a problem on their own vessel. More than half were somewhat hesitant about the manning level on their vessel (15% of them thinking it inadequate). Between 33% and 50% of respondents strongly endorsed the importance and degree of implementation of ISPS and anti-piracy security measures, such as BMP4, with only 10-18% actively doubting these. In short: fatigue is a major concern, and half the respondents felt strongly that manning levels are adequate and that security measures are both needed and adequately performed, with most others agreeing to a partial degree.
<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Strongly disagree</th>
<th>Don't agree</th>
<th>Somewhat agree</th>
<th>Very much agree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fatigue is a problem on my vessel</strong></td>
<td>2</td>
<td>16</td>
<td>28</td>
<td>21</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td><strong>Fatigue is a common and worrying aspect of maritime life as a whole</strong></td>
<td>0</td>
<td>7</td>
<td>18</td>
<td>45</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td><strong>My vessel is adequately manned</strong></td>
<td>2</td>
<td>9</td>
<td>28</td>
<td>33</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td><strong>ISPS duties adequately performed on most ships</strong></td>
<td>2</td>
<td>8</td>
<td>28</td>
<td>33</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td><strong>Piracy protection adequately performed on most ships</strong></td>
<td>0</td>
<td>7</td>
<td>38</td>
<td>24</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td><strong>Proper performance of onboard ISPS a real contribution to ship security</strong></td>
<td>7</td>
<td>7</td>
<td>24</td>
<td>34</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td><strong>Proper piracy protection a real contribution to ship security</strong></td>
<td>5</td>
<td>4</td>
<td>22</td>
<td>38</td>
<td>69</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 32 - Number and percentage of respondent at each rating level*

19 Red shading indicates a worrying trend, green shading a reassuring trend.
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU-flagged vessels

The vessel on which I currently or most recently served is adequately manned

In my current or most recent position at sea, fatigue was a problem

Fatigue is a common and worrying aspect of maritime life as a whole

ISPS duties are adequately performed on most ships

Piracy protection measures (such as BMP4) are adequately performed on most ships

Proper performance of onboard ISPS code duties makes a real contribution to ship security

Proper performance of piracy protection measures (such as BMP4) makes a real contribution to ship security

Figure 33 - Overview of responses to attitudinal questions

Beyond these overall averages, the variations in these attitudes between different groups reveals a lot about the security/workload/manning equation. For example, there are no differences found between the different vessel types or the current position of the respondent (including whether they are in a Captain or Chief Officer position). There were also no differences at all between the more or less equal number of respondents who had or had not served as a SSO. Other sub groupings do reveal differences, and these are instructive. For example, those who choose the position of Captain or Chief Officer in response to the question “I am most familiar with ISPS duties for the following position on this vessel (my answers on ISPS will refer to this position)” were much less likely to agree with a statement that their vessel was adequately manned. As shown in Figure 34, among those who claimed most familiarity with the ISPS duties of these positions, only 1 in 5 fully endorsed the adequacy of manning on their vessels, compared with 3 in 5 among those reporting familiarity with other positions. And almost twice as many endorsed a statement that manning was inadequate. Thus, there is something about being very familiar with the ISPS duties of
the Captain or Chief Officer that strongly shapes respondents’ sense of the adequacy of manning.

![Bar chart](chart.png)

**Figure 34 - "My vessel is adequately manned"**

There is another allied clue in the fact that attitudes toward the adequacy of manning and several other questions is strongly affected by whether or not they were at sea before 2004 (when ISPS came into effect) or are “old timers” in the maritime world. As shown in Figure 35, seafarers with any pre-ISPS experience (or, at least, old timers), are clearly far more doubtful of the contribution of ISPS and anti-piracy security measures to ship security, and of the adequate implementation of these measures. They were also less satisfied with the adequacy of the manning level on their vessel. (Their perception of fatigue on their own vessel or in general remains the same.) Importantly, this is not simply an effect of number of years at sea—that factor taken alone has no statistical relation to the responses on any of these questions—but to when their seafaring experience was.

---

20 The right bar is the pooled average of all respondents, with the number of respondents in each category indicated (a total of 70 respondents). The two left bars show how these 70 responses are allocated rather differently between the two groups: the respondents who are in the position of Captain or Chief officer, versus all other respondents. This result, which is quite clear visually, is also statistically significant: Chi squared of 9.39, and p=0.0092.
The elapsed time and extent of piracy exposure also shape these responses in significant ways. Those who have been exposed to piracy in the last 6 months experienced fatigue to be a greater problem on their own vessel (with no difference in their perception of fatigue as an aspect of maritime in general), and were more doubtful of the contribution of ISPS and anti-piracy security measures to ship security, and of the adequate implementation of these measures. (Note that those who had recently been exposed to piracy risk were especially doubtful of the contribution of anti-piracy security measures to ship security). They experienced fatigue on their own vessel to be more of a problem, with little difference in their sense of fatigue in general or the adequacy of manning on their vessel.

---

21 Error diamonds indicate the mean (middle of diamond) and the zone in which the true mean is located with 95% confidence. If there is not overlap between the diamonds of yes/no groups, their mean responses are statistically significant at the 0.05 level.
As might be expected, beyond the effects apparent in the subset of respondents who had or had not experienced piracy in the last 6 months, there seem to be effects related to the frequency and duration of such transits for those who have made them. The indicative spline fits in the following figures show that the more frequent the recent transit were the more likely was the respondent to experience fatigue as a problem on their vessel (Figure 37) and to feel that anti-piracy security measures contributed to their security (Figure 38). And the longer the duration of these transits, the less likely they were to consider ISPS and anti-piracy measures to have been adequately performed (Figure 39 and Figure 40). These are only indicative results,

22 Error diamonds indicate the mean (middle of diamond) and the zone in which the true mean is located with 95% confidence. If there is not overlap between the diamonds of yes/no groups, their mean responses are statistically significant at the 0.05 level.
since the number of respondents with piracy experience in the last 6 months is small, and contains some influential outliers, but they do point to the possible stress associated with such transits.

Figure 37- Relation of transit frequency to perception of fatigue as a problem

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23 Red line is a smoothing spline. Reflects answers by all respondents (those with no recent piracy transit entered “0.” Results should be considered indicative given the influence of outliers at upper end. Contours depict density of observations.
Piracy protection (BMP4) is a real contribution to ship security.

Figure 38 - Relation of transit frequency to “anti-piracy measures contribute to ship security”

Red line is a smoothing spline. Reflects answers by all respondents (those with no recent piracy transit entered “0.”) Results should be considered indicative given the influence of outliers at upper end. Contours depict density of observations.
Figure 39 - Relation of transit duration to sense that ISPS duties adequately performed

Figure 40 - Relation of transit duration to sense that anti-piracy duties adequately performed

25 By respondents who made a transit in last 6 months. Results should be considered indicative given the influence of outliers at upper end. Contours depict density of observations.

26 By respondents who made a transit in last 6 months. Results should be considered indicative given the influence of outliers at upper end. Contours depict density of observations.
7. Cost Model

“All models are wrong, but some are useful”

-- George Box, "Robustness in the Strategy of Scientific Model Building," (Launer and Wilkinson, 1979)

7.1 Introduction

We would like to quantify the impacts of security-related tasks in the EU-flagged fleet in quantitative terms in the relevant units: additional hours incurred by these tasks, the salary equivalent for those performing them, and the added percentage of overall workload they represent. Such figures are the basic starting place for thinking about if and how these “new” tasks are absorbed within the existing (and often already full) workloads of existing crew and/or through increases in manning levels.

However, any attempt to produce an overall assessment of the impacts of security related tasks in quantitative terms is stymied by a number of factors:

• the massive complexity of the maritime system
• the dearth of systematic and reliable information in several key realms
• the heterogeneity of the EU fleet (vessel flags, types, capacities, routes, ages, operating companies and ownership, etc.)
• the shifting and subtle nature of security-related tasks
• the cross-cutting displacements and adaptive self-organising adjustments of this system to new inputs (such as imposition of new security-related tasks)

After much study, however, we have developed an approach that offers a robust and useful model despite the complexity and size of the system modeled. Our approach has been to develop this model in a way that is:

(1) founded on the most solid parameters available with the level of precision and specificity now feasible,

(2) incrementally improvable through future refinement in the specification of parameter and dynamics, and

Some of the parameters described in this section were somewhat updated in light of recent survey results on SSO work hours and Level 2 and 3 frequency and duration. These are referred to in this section, and the overall updated cost model results are reported the summary of findings appearing in Section 2.2.
(3) probabilistic—that is our estimates of parameters and outputs have their uncertainties built in; we estimate both the likely value as well as the spread of possible divergence from it.

We draw on an extensive literature review and interviews to obtain a robust range estimates of the building blocks (times, numbers of vessels, salaries, ship schedules) and credible ranges for these. So, for each key input (for example officer salary, annual days in port, etc.) and many linking assumptions (for example, the factor to scale from cargo/container vessels to other vessel types) we specify both the likely value for each variable and how the possible values of each variable are distributed around that likely value. Some variables are normally distributed; others are distributed where each possible value has the same probability of occurring; and some are characterised as a triangular distribution, where a minimum value, likely value, and maximum value are specified. These various distributions governed the calculation of the outputs of interest to us using a statistical method called Monte Carlo modeling.

This method was developed by physicists in the 1940s in order to model phenomena with significant uncertainties in inputs, and was named after the casino in Monaco. It generates random samples of values for the variables, based on the defined probability distributions. In our case, calculations of workloads and their costs were not calculated from single point estimates of the parameters and assumptions; rather calculations were performed 1000 times -- for each of 1000 “runs” the values for each of the dozens of parameters were randomly generated based on the probability distributions determined for each on the basis of our empirical research.

This approach was chosen to allow us to build a reliable model that reflected both the range of possible values for a variable as well as the uncertainty in our estimates. For example, while there is only one true value of how many EU-flagged vessels passed through the Gulf of Aden in a given year, we don’t know it precisely. We might know the average number of days EU vessels spend in port, or the average percent of crew that are higher-salaried EU-nationals; but each of the hundreds of EU-flagged vessels likely vary from these averages, some quite considerably. A vessel that both makes frequent port stops and Gulf of Aden transits and has an expensive crew would be projected to have quite high security-related costs. But how likely is such a combination? By running 1000 runs, we obtain 1000 separate cost estimates. The probability distribution of these cost estimates is the outcome of the array of probability distributions assumed for the variables in the model. The likelihood that a given run will be at the extreme upper end of crew cost and port stops and piracy area transits is quite small, and almost none of the 1000 runs will yield the value derived from these. This approach, which is often used in financial decision-making and risk analysis, has been shown to produce better and more useful estimates than deterministic point estimates or “what if” sensitivity testing that gives equal or unspecified weight to all scenarios.
This approach allows us to deliver a robust self-contained model answering the question we have been tasked with. But there is more: it is a model that can be extended in the future if and when further refinement is needed. That is, it provides a solid estimate for immediate use, and, also, a model that can serve as a work in progress whose precision grows to the degree that the input values and relations become better specified over time. Thus, some of the parameters in the model are quite precise and based on primary research: for example, considerable effort was invested in obtaining very reliable and representative port stay information using a massive sample. Other parameters are based on our synthesis of information in the secondary literature in which statistics are imprecise or contradictory and/or at varying levels of aggregation, or on interviews with seafarers and experts. If and when better information becomes available, whether as a matter of course or a decision to invest additional resources, the model can be upgraded—that is, the probability distribution of the inputs can be revised (presumably improved), resulting in better output estimates. For example, our recently available survey results gave improved estimates of SSO workloads and exposure to Security Levels 2 and 3, and the updated “bottom line” of this more inclusive estimate is reported in the summary of Section 2.

Our model provides what we feel to be the most robust “big picture” answers to the questions posed within the resources available for the present study, while also offering a platform for further work, as needed. In the future, other researchers can build on this framework by devoting resources to targeted improvements in the input data (for conducting a survey or the purchase of commercial databases, for example). The most significant data improvements, we imagine, would be further clarifying through systematic observation and task analytic approaches (this would require permission for extensive time by researchers on board a range of ships), and on estimating the costs of cross-cutting impacts such as declines in training of a maritime workforce made increasingly transient by the demands of overwork, accidents, deferred maintenance, etc.

7.2 Parameter choices and estimation procedures

As portrayed in Figure 7, the key variables needed for our model are the average extent of vessels’ exposure to circumstances in which security tasks are performed (most substantially the number and duration of port stops and piracy transits), the number of vessels that are thus exposed, the workload implications of each such exposure (days work, and by whom), and the costs of this additional workload. The sources for each of these has been described in general terms in the methodology section of this report (Section 4.2), and the following sections discuss the use of this information and the choices made regarding the values and parameters used. More explicitly, the spreadsheet
section where the minimum, maximum, likely values and distribution shape for each parameter is given in Figure 47.

**Port visitation patterns.** Early on in our research, it became clear that despite many subtle and diffuse impacts of security-related tasks, the bulk of workload impacts are associated with port visits and piracy zone transits, and we dedicated considerable efforts to obtaining reliable estimates of these, as described in Section 4.3. Existing estimates in the literature of number and duration of port stays are crude, or based on a narrow evidence base, and not disaggregated by flag, or studied over time. Our analysis of port visitation patterns was, therefore, based on an analysis we performed of the AIS transponder signals for a large sample of the EU-flagged general cargo and container fleet over four full years (2007-2010). This sample represents 27% and 41% respectively of the entire EU cargo and container fleets over 1000 GT, registering almost 60,000 cargo port call and over 80,000 container port calls. By tracking single vessels over the course of these 4 years (using their IMO numbers) and subtracting the port departure time from arrival time, we could derive the total number of port stays and the duration of each, from which averages and variances are calculated. The distributions and parameters of these are depicted below, in Figure 6, and were used as one of the variables in the Monte Carlo modeling (see Figure 11).

**Scaling from the AIS sample to entire EU fleet.** Since general cargo and containers represent almost 40% of the EU fleet in the > 1000 GT size class, our data on the number and duration of port stops based on a very large sample of these two vessel types provide a fairly good basis for extrapolation to the fleet as a whole. (In Figure 41 the portion of the EU fleet sampled by our AIS data is shown in blue).

---

28 Averages were derived on a per-vessel basis, rather than pooling all stops. Vessels with same day arrival and departure dates were assigned a half day (=12 hour) stay. The estimate here is based on only those 97.3% of port stays of 7 days or less. The 2.7% of port stays longer than this would incur the same ISPS tasks, and raise the cost estimate (they would contribute 16 additional days to the average annual days in port). However, in a statistical sense they are outliers, and probably represent some other underlying process whose nature should be investigated before inclusion in the estimates.

29 The cargo values in the Monte Carlo model were actually drawn directly at random from the observed values for the 394 vessels in the AIS sample. Since the raw AIS database is held only on the premises of our Spanish collaborators, and we did not have the values for container vessels available on a per vessel basis, the Monte Carlo model used a synthetic normal distribution with the observed mean and standard deviation calculated from the empirical data during our on-site work with the dataset. (While the empirical distribution is best fitted with a 3 normal mixture model, it was fairly well described by a single normal model. A value of 1 given to all values below this, resulting in the slight low end thickening observed in the synthetic distributions for containers).
The representativeness of these estimates would seem to be further enhanced by the fact that they probably represent different ends of the port stop spectrum: container vessels stop more often and for short periods than general cargo vessels. Thus, we felt confident to scale our port and other parameters from these two types to the fleet as a whole.

Since the ISPS code applies to vessels above 500 GT, an additional scaling up is needed from the approximately 7,000 vessel EU flagged above 1000 GT, which is commonly (and often implicitly) referenced in maritime statistics to the larger ISPS-relevant fleet, which includes the approximately 2,500 additional EU flagged vessels between 500 and 1000 GT. Here things get trickier for workload estimates in a number of ways. These smaller vessels were excluded at source by the providers of the AIS data in order to “avoid the noise of short sea shipping.” And they are, indeed, likely to have more frequent port calls on the one hand, and be less exposed to piracy on the other. Crews will be smaller than the fleet-wide average of 22, but the ISPS tasks remain more or less the same. (Indeed, our interviews consistently show that ISPS workload impacts are most severe on precisely smaller vessels and those with frequent port stops.) In order to reflect to some extent these several inherent uncertainties, the scale-up factor from our sample to the full ISPS-relevant fleet was done through a mediating variable in the Monte Carlo modeling, with a distribution randomly varying normally around 3.8 (the ratio of the full fleet to the AIS sample size)
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU - flagged vessels

Figure 42 - Distribution of port stops and stays (AIS data)

Piracy exposure. As discussed in the Section 4.3.5, we attempted to use the AIS data for the derivation of piracy exposure: the number and duration of transits through waters defined as being at risk. Together with our Spanish collaborators and a team of Czech researchers we conducted a proof-of-concept exercise on a subsample of the data.
demonstrating that these parameters could be extracted from the AIS data through application of a maritime route-finding algorithm on all port pairs requiring a transit through risky waters. This allowed the extraction of that portion of voyage (hours) spent in piracy risk. However, the data confidentiality constraints of the holders of the AIS data prevented transfer of the full data set of port pair data to the Czech researchers, and we had to put these direct measurements on hold and pursue alternative means of estimation. We drew on a variety of sources (interviews with maritime security experts, trade press, and detailed data from the Suez Canal) to obtain estimates of the overall number such risky transits annually and their typical duration, and to scale these numbers to the EU flagged fleet, as shown below in Figure 43. Subsequently, a survey of seafarers yielded an additional source of information on the frequency and average duration of piracy exposure.

![Data flow for estimating piracy risk exposure](image)

**Figure 43 - Data flow for estimating piracy risk exposure**

**The extent of security-related workloads.** Our estimates of security-related tasks were based on the ship-side tasks mandated by the ISPS code and by BMP4 and interviews with numerous crew members, both officers and ratings. ISPS is more or less uniformly implemented, and the non-mandatory BMP4 to a considerably lesser extent. While there were a range of smaller tasks (paperwork, drills, equipment checks, etc.) associated with both, the main workload addition seems to be the gangway watch in port and the setup
and takedown of hardening measures before and after a piracy transit. The former was modeled at a full person continuously in port (24 hours per day of port stay), and the latter as two 8 hour days by two crew members (16 hours per transit). Though these estimates vary by source, we assume that an estimated 35% of transits are accompanied by armed guards, considerably (but not entirely) reducing the additional watches by crew members. (The armed guards and their off-cycle watches generate longer hours for the cooks, to be sure, but that is another matter . . . ). Based on our interviews with crew and experts, we chose not to disaggregate workloads at ISPS security levels 1, 2 and 3. The occurrence of Level 2 and certainty Level 3 is far rarer than the default Level 1 that pertains to all vessels/ports most of the time, and the entailed workloads are felt to be crippling—even Level 2 cannot be sustained for more than 48 hours.

The complex ways in which added security tasks are inserted into the overall system of watches and workload makes it difficult to trace the amounts of labour added. For example, a crew might shift from 4-8 watches while underway (requiring 8 hours of watch a day from each of 3 participants) to a 6-6 watch while in port (requiring 12 hours daily from each of two participants), with these two crew members as well as the one “freed up” conducting several other tasks related to the cargo and paperwork during their “off” hours.

Most of the extra work falls on ratings, an important factor in cost calculations, as described below. For this reason, our estimates are disaggregated by officer versus ratings, using estimates derived from recent statistics on the EU maritime labour supply (Sulpice, 2011). By probabilistically combining estimates of the overall security-related workload entailed for each port stay/piracy transit and day of port stay/piracy-transit with the estimates of the overall number and duration of port stays and piracy risk transits described above, we calculated the overall workload associated with these security measures. These appear below. Since days in port or underway in a piracy risk area demand constant (24-hour) work, days are expressed in terms of work days (24 hours of work each day—so approximately 2 person days given the average 12 hour work day of maritime crew). The cost estimates, described below, of course use this latter person-day figure.

The distributions for these workload figures are given below, in Figure 44. They are intentionally put on a uniform horizontal axis: aesthetically annoying, but important to convey the fact that the overall workload emanating from security tasks is primarily due to ISPS and done by ratings. For this reason, ISPS receives considerably greater emphasis in this report and our recommendations.

**Generating cost estimates.** One approach to attaching a cost estimate to the projected increased workload would be to value the additional hours worked by the salary rates of those performing the extra work. This is the approach used in our cost model.
to the officer/rating distinction, discussed above, an additional key factor is whether the crew are first or second tier in salary terms: that is, EU nationals or not. Since many EU flags allow considerable portions if not all of their crew to be non-EU nationals, with salaries one half or one third of their EU counterparts, this is an important distinction. We draw here on salary scales and ranges drawn from ISF (2006) and OECD (2003) statistics as well as our interviews to estimate the distributions of Tier 1 and Tier 2 salaries, and on statistics from Sulpice (2011) and Mitroussi (2008) to model the portion of officers and ratings who are in each of these salary/nationality categories. We were surprised to note in these statistics the large portion (almost half) of ratings on EU flagged vessels who are EU nationals—our interviews had led us to anticipate that this parameter would be considerably lower. Some of this might be explained by the fact that on passenger vessels (some cruise ships, but mostly ferries) many of the ratings are in the hotel and catering departments. In this case, the percentage should be brought down to reflect the fact that these ratings will not be the ones performing the security-related tasks in ports.

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30 In this model we disregard the increasing portion of crew from Eastern European countries who occupy an intermediate location between Tier 1 and Tier 2 salaries.

31 Michael Bloor, personal communication, February 2013.
7.3 Overall results of the model

Cargo ships make an average of 38 stops annually, and container vessels about 47—to almost one a week on average. For the entire EU fleet, these two classes of vessels make over 100,000 port stops annually, which scales to almost 400,000 port calls for all vessels.
in the EU fleet (of all types and over 500 GT.) This is the number of times annually in which security tasks related to port arrival and departure are performed. In addition, there are security tasks performed each day in port, primarily gangway watches. Cargo vessels spend an average of 57 days in port, and containers 45, so 7-8 weeks annually. Scaling up again for the entire EU fleet >500 GT, we estimate just under 500,000 24-hour days in port a year in which gangway watches must be performed. This is over an order of magnitude larger than the less than 30,000 days spent in 9,000 piracy transits annually by EU vessels (>1000 GT). Given the portion of the security workload performed by ratings versus officers, we estimate that 545,000 24-hour days of crew work (primarily by ratings) are performed annually, with the probability distribution portrayed in Figure 45, which translates into over a million person days of work. Given the portion of Tier 1 and Tier 2 salary scale nationalities among officers and ratings, and their respective pay scales (averaging $30 a day for ratings), the annual salary cost of this labour would be just under $30 million, as shown in Figure 46. Both distributions are right skewed, so there is a small but not dismissible chance that the real figure could be double this amount.

These security tasks represent an addition of 2.4% to the workload of the crew as a whole, but, since they fall mostly on ratings, they represent an addition of 3.9% to their workload, or a bit over 3 hours a week. The implications of these figures are discussed in the following section.

Figure 45 - Crew days (24 hour) devoted to security tasks annually
Figure 46 - Annual costs of crew security tasks on EU flagged vessels ($ mil)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Distribution</th>
<th>Expected</th>
<th>Standard Dev.</th>
<th>FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average port stops annually (cargo)</td>
<td>Empirical (AIS)</td>
<td>37.9</td>
<td>26.1</td>
<td>=INDEX('cargo AIS'!D4:D397, RAND()*394+1)</td>
</tr>
<tr>
<td>Average port stops annually (container)</td>
<td>Normal</td>
<td>47.7</td>
<td>20.8</td>
<td>=MAX(1,NORMINV(RAND(),G191,G192))</td>
</tr>
<tr>
<td>Port stops annually of EU cargo fleet &gt;1000 GT</td>
<td>Derived</td>
<td>47.7</td>
<td></td>
<td>=F194*E11</td>
</tr>
<tr>
<td>Port stops annually of EU container fleet &gt;1000</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=G194*E13</td>
</tr>
<tr>
<td>Port stops annually of EU cargo and container fleet&gt;1000 GT</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=I194+H194</td>
</tr>
<tr>
<td>Multiplier to scale from EU cargo &amp; container to all EU fleet over 500 GT</td>
<td>Normal</td>
<td>3.8</td>
<td>0.5</td>
<td>=MAX(0,NORMINV(RAND(), K191, K192))</td>
</tr>
<tr>
<td>Port stops annually of all EU fleet &gt; 500 GT</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=K194*J194</td>
</tr>
<tr>
<td>Average total days in port annually (cargo)</td>
<td>Empirical (AIS)</td>
<td>71.3</td>
<td>33.9</td>
<td>=INDEX('cargo AIS'!E4:E397, RAND()*)394+1)</td>
</tr>
<tr>
<td>Average total days in port (container)</td>
<td>Normal</td>
<td>45.3</td>
<td>20</td>
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</tr>
<tr>
<td>Days in port annually of EU cargo fleet &gt;1000 GT</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=M194*E11</td>
</tr>
<tr>
<td>Days in port annually of EU container fleet &gt;1000 GT</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=N194*E13</td>
</tr>
<tr>
<td>Days in port annually of EU cargo &amp; container fleet&gt;1000 GT</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=O194+P194</td>
</tr>
<tr>
<td>Days in port annually--all EU fleet &gt; 500 GT</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=Q194*K194</td>
</tr>
<tr>
<td>Estimate of world fleet annual transits through piracy areas</td>
<td>Triangular (22-55,000)</td>
<td>38,500</td>
<td></td>
<td>=TRIANINV(RAND(),S189,S191,S190)</td>
</tr>
<tr>
<td>% of piracy transits that are by EU flagged vessels</td>
<td>normal</td>
<td>24%</td>
<td>4%</td>
<td>=MAX(0,NORMINV(RAND(),T191,T192))</td>
</tr>
<tr>
<td>EU flagged Piracy transits annually (only &gt;1000 GT considered)</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=S194*T194</td>
</tr>
<tr>
<td>Average duration of piracy area transit (days)</td>
<td>normal</td>
<td>3.0</td>
<td>0.5</td>
<td>=MAX(0,NORMINV(RAND(),V191,V192))</td>
</tr>
<tr>
<td>Days spent in piracy transits annually (EU)</td>
<td>Derived</td>
<td></td>
<td></td>
<td>=U194*V194</td>
</tr>
<tr>
<td>Variable</td>
<td>Distribution</td>
<td>Expected</td>
<td>Standard Dev.</td>
<td>Formula</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>--------------</td>
<td>----------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Annual crew cost of ISPS ($ mil)</td>
<td>Derived</td>
<td></td>
<td></td>
<td>((24/E164)^*(\text{AG194} \cdot \text{AS194}) + (\text{AH194} \cdot \text{AT194}))/1000000</td>
</tr>
<tr>
<td>Annual crew cost of piracy measures ($ mil)</td>
<td>Derived</td>
<td></td>
<td></td>
<td>((24/E164)^*(\text{AI194} \cdot \text{AS194}) + (\text{AJ194} \cdot \text{AT194}))/1000000</td>
</tr>
<tr>
<td>Annual costs of crew security tasks on EU flagged vessels ($ mil)</td>
<td>Derived</td>
<td></td>
<td></td>
<td>(\text{X194} + \text{Y194})</td>
</tr>
<tr>
<td>% of officers tier 1</td>
<td>normal</td>
<td>77%</td>
<td>10%</td>
<td>(\text{MIN}(\text{AA190}, \text{MAX}(0, \text{NORMINV}(\text{RAND}(), \text{AA191}, \text{AA192}))))</td>
</tr>
<tr>
<td>% of ratings tier 1</td>
<td>normal</td>
<td>48%</td>
<td>10%</td>
<td>(\text{MIN}(\text{AB190}, \text{MAX}(0, \text{NORMINV}(\text{RAND}(), \text{AB191}, \text{AB192}))))</td>
</tr>
<tr>
<td>Tier 1 salary--officer</td>
<td>normal</td>
<td>$ 5,500</td>
<td>$ 600</td>
<td>(\text{MAX}(0, \text{NORMINV}(\text{RAND}(), \text{AC191}, \text{AC192})))</td>
</tr>
<tr>
<td>Tier 1 salary--rating</td>
<td>normal</td>
<td>$ 3,500</td>
<td>$ 500</td>
<td>(\text{MAX}(0, \text{NORMINV}(\text{RAND}(), \text{AD191}, \text{AD192})))</td>
</tr>
<tr>
<td>Tier 2 salary--officer</td>
<td>normal</td>
<td>$ 3,500</td>
<td>$ 500</td>
<td>(\text{MAX}(\text{AE189}, \text{NORMINV}(\text{RAND}(), \text{AE191}, \text{AE192})))</td>
</tr>
<tr>
<td>Tier 2 salary--rating</td>
<td>normal</td>
<td>$ 1,400</td>
<td>$ 300</td>
<td>(\text{MAX}(\text{AF189}, \text{NORMINV}(\text{RAND}(), \text{AF191}, \text{AF192})))</td>
</tr>
<tr>
<td>Annual officer days ISPS</td>
<td>Derived</td>
<td></td>
<td></td>
<td>(\text{AK194} \cdot \text{L194}) + (\text{AM194} \cdot \text{R194}))</td>
</tr>
<tr>
<td>Annual rating days on ISPS</td>
<td>Derived</td>
<td></td>
<td></td>
<td>(\text{AL194} \cdot \text{L194}) + (\text{AN194} \cdot \text{R194}))</td>
</tr>
<tr>
<td>Annual officer days on piracy tasks</td>
<td>Derived</td>
<td></td>
<td></td>
<td>(\text{AO194} \cdot \text{U194}) + (\text{AQ194} \cdot \text{W194}))</td>
</tr>
<tr>
<td>Annual rating days on piracy tasks</td>
<td>Derived</td>
<td></td>
<td></td>
<td>(\text{AP194} \cdot \text{U194}) + (\text{AR194} \cdot \text{W194}))</td>
</tr>
<tr>
<td>per port stop officer days ISPS</td>
<td>normal</td>
<td>0.0417</td>
<td>0.0208</td>
<td>(\text{MAX}(\text{AK198}, \text{NORMINV}(\text{RAND}(), \text{AK191}, \text{AK192})))</td>
</tr>
<tr>
<td>per port stop rating days ISPS</td>
<td>normal</td>
<td>0.0417</td>
<td>0.0208</td>
<td>(\text{MAX}(\text{AL189}, \text{NORMINV}(\text{RAND}(), \text{AL191}, \text{AL192})))</td>
</tr>
<tr>
<td>per port day officer days ISPS</td>
<td>normal</td>
<td>0.0208</td>
<td>0.0104</td>
<td>(\text{MAX}(\text{AM189}, \text{NORMINV}(\text{RAND}(), \text{AM191}, \text{AM192})))</td>
</tr>
<tr>
<td>per port day rating days ISPS</td>
<td>normal</td>
<td>1.0000</td>
<td>0.5000</td>
<td>(\text{MAX}(\text{AN189}, \text{NORMINV}(\text{RAND}(), \text{AN191}, \text{AN192})))</td>
</tr>
<tr>
<td>per piracy transit officer days</td>
<td>normal</td>
<td>0.0833</td>
<td>0.0417</td>
<td>(\text{MAX}(\text{AO189}, \text{NORMINV}(\text{RAND}(), \text{AO191}, \text{AO192})))</td>
</tr>
<tr>
<td>per piracy transit rating days</td>
<td>normal</td>
<td>1.3333</td>
<td>0.5000</td>
<td>(\text{MAX}(\text{AP189}, \text{NORMINV}(\text{RAND}(), \text{AP191}, \text{AP192})))</td>
</tr>
<tr>
<td>per risky transit day officer days</td>
<td>normal</td>
<td>0.0833</td>
<td>0.0417</td>
<td>(\text{MAX}(\text{AQ189}, \text{NORMINV}(\text{RAND}(), \text{AQ191}, \text{AQ192})))</td>
</tr>
<tr>
<td>per risky transit day rating days</td>
<td>normal</td>
<td>1.0000</td>
<td>0.5000</td>
<td>(\text{MAX}(\text{AR189}, \text{NORMINV}(\text{RAND}(), \text{AR191}, \text{AR192})))</td>
</tr>
<tr>
<td>Daily salary of officer day on EU vessel</td>
<td>Derived</td>
<td></td>
<td></td>
<td>(\text{((AA194} \cdot \text{AC194}))/30 + (1-\text{AA194}) \cdot \text{AE194})/30)</td>
</tr>
</tbody>
</table>
### Variable Distribution Expected Standard Dev. FORMULA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Distribution</th>
<th>Expected</th>
<th>Standard Dev.</th>
<th>FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily salary of rating day on EU vessel</td>
<td>Derived</td>
<td></td>
<td></td>
<td>$=\frac{((AB194\times AD194)/30 + (1/AB194)\times AF194)}{30}$</td>
</tr>
</tbody>
</table>

**Sources**: As detailed in Section 4.2, our sources for estimates include the following: interviews with stakeholders and experts; our derivation of port stay statistics from 4 years of AIS transponder data; official statistics on fleet sizes; Sulpice (2011); Mitroussi (2008); FST/ECSA (1998) Joint Study on “Improving the Employment Opportunities for EU Seafarers”; USDOT (2011); Corbett and Koehler (2004); Eagar (2011); Osler (2008); http://www.suezcanal.gov; van der Meijsden (2008); ISF (2006); OECD (2003); International Transport Workers' Federation’s Grade B benchmark wage.

**Note**: formulas are given to show functions used—a spreadsheet version is available for those wishing to trace cell references.

**Figure 47 - Derivation of key values in model**
8. Security, manning, workloads – the way forward

8.1 Explaining the stability of (under) manning levels

As described earlier, there was considerable anticipation and concern about the workload and manning implications of ISPS in the year leading up to its implementation, and passionate subjective reports of the increased workload in the years following. More recently, the growing prevalence of piracy has possibly added an additional set of tasks to the workload on vessels exposed to this.

Despite this, with the single important but obscure exception (Loginovsky, 2005) discussed in Section 4.1.1 our extensive research has not uncovered any principled study of the security task/workload/manning equation, nor have we been able to find any reliable indication of manning increases in response to the increased workloads reported on broadly yet anecdotally.

Our field interviewing and the modeling described in Section 4.2 show that security-related tasks, and especially ISPS, entail a small but not insignificant addition to crew workloads, which is absorbed by existing crew. As seafarers we interviewed continually reminded us, security is not the first set of additional tasks to be added, nor will it be the last. It is important, therefore, to extend beyond the particular details of security-related tasks and their workload and manning impacts, as discussed in some detail in previous sections, and consider the broader underpinnings of the broader maritime system that made the absorption of added workloads by existing crew rather than by augmentation of manning such an “obvious” and unremarkable choice, despite the considerable concern expressed before and during the implementation of ISPS, as discussed in section 5.1. By understanding the resistance to manning increases we will be in a better position to consider which interventions might intervene in assuring that manning levels are sustainably able to meet changing onboard tasks without compromising ship performance, safety, and security, on the one hand, or undermining the wellbeing of seafarers and the standing of their profession on the other. Section 8.1.1 describes some of the more proximal economic contexts, section 8.1.2 the broader political-economic ones, and section 8.1.3 describes some of the reasons why the maritime system is less amenable to regulation.
8.1.1 Economic rationale for the absorption of new workloads by existing crews

When expressed as 3 weekly hours per rating or $40 million a year for the entire EU-flagged fleet, this as if valuation of the security-related workload seems to be quite moderate (and the direct financial consequences are even lower, in light of the widespread absorption of ISPS tasks by existing crews). But there are several critical points to remember as we try to understand the real implications of these figures.

- The $40 million cost model calculation is a “notional” or imputed value based on the “as if” assumption that those performing the additional security-task workload are actually paid for the additional hours worked. However, we know from many interviews and articles in the literature that most shipowners have not increased crew size and it is unclear to what extent they have increased compensation rates (in salary rates or, more likely, additional overtime) for existing crew members following ISPS. Rather, in most cases the existing crew members have just absorbed the additional tasks, often with negative effects on rest time, or deferred other tasks. With this reality, the cost model’s imputed cost estimate overstates the actual direct financial consequences.

- There may, however, be indirect financial consequences over time, such as those arising from (1) the deferral of normal maintenance tasks, (2) increased fatigue of crew members leading to lessened efficiency and even accidents, and (3) the longer term costs that may result as the lifespan of a maritime career shortens under unsustainable workloads, with a loss of expertise and institutional memory, and the raised transaction costs to the maritime community as a whole due to more rapid turnover of seafarers, especially senior officers. Our interviews revealed quite explicit and strongly held opinions regarding all 3 of these indirect costs.

- Even relating to the imputed figure of $40 million, the indicative monetary costs are this low because they reference a salary rate reflecting the fact that much of the EU-flagged fleet can now tap into a global labour market for the (lower paid) ratings who perform most of this work. (In fact, increasingly deck officers, too, are from non-EU nationalities.) Indeed, the hours on security tasks add up with almost 400,000 port calls a year, but, even so, they are cheap hours. The imputed costs would be much higher if European seafarers filled most of the ratings positions on EU flagged vessels.

- These crew costs are dwarfed by the overall costs of maritime business. While crew costs are typically the main share of ship operating costs, they are only a

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32 As described in that section, the cost estimate results in this section and in Section 2.2 reflect updated parameters on SSO workloads and Security Levels 2 and 3, only recently available from the web-based survey of 300+ seafarers.
small part of the overall costs, which include capital costs and variable (voyage) costs. To put this into perspective: the additional 792,000 24-hour days expended by crews of the entire EU fleet on security tasks comes to about $40 million a year, compared to the $0.5-1.0 million annual depreciation for each of most of the vessels in this fleet. So even on a ship with an “expensive” crew, the total daily wages of the entire crew would not reach the daily cost of the loan service on the vessel (Alderton and Winchester, 2002), and if the average daily wage of each of the ten ratings on a cargo shop is $30, then their combined daily salaries would barely cover the ton of bunker oil their ship burns each hour.  

- Despite the fact that crew costs are only a small fraction of the overall costs of maritime transport, they are, together with maintenance and repairs, one of the very few factors that ship owners can act directly to reduce (Stopford, 2009; Polo, 2012). Other costs - of fuel, port fees and cargo handling, the costs of capital, etc. - are all dictated by external forces and longer term trends. Thus, while comparatively small, crew costs are the category most amenable and rapidly responsive to ship owner intervention.

- Because the added workloads seem to have been largely absorbed by the crew rather than by additional manning, and these crew members are already stretched thin, the few extra weekly hours for each rating doing watches or the officer serving as a SSO are consequential additions for both ship owners and crew. Where 56% of officers and 40% of ratings report working between 12-15 hours a day, and almost all the remainder working more than 8 (Smith et al, 2003), these few hours added on average are quite precious; especially since they are not evenly spread over the year but occur in short intense durations, and mostly in port when other workload demands are also at a peak for most crew. Thus any addition, such as security tasks, will have a disproportionately large negative effect on crew quality of life and ship safety.

- On the shipowner side, too, the extent to which the absorption of workload by existing crew spares ship owners/operators an increase in manning, its value to them is considerably larger than simply the daily wage value of the hours. Behind the wage of a single seafarer is the rotation of the person who replaces him after the contract, victuals and supplies, overheads of crew selection and management, etc., amounting to another 16% to the crew cost alone (Stopford, 2009). In addition, a less visible but important cost of officers and Tier 1 crew is due to their more generous leave arrangements and work on a permanent rather than per contract basis. The more a vessel is crewed by nationals with

33 Calculation based on rule-of-thumb levels of fuel consumption (a ton of bunker an hour) at a conservatively low $300 a ton, and the daily salary of ten ratings on $30 a day.
higher leave demands, the greater the ratio of the size of the “shadow” crew complement needed to crew a vessel. At the very upper end, a European Master on a 7-week/7 week arrangement means that the company is paying for 2 (actually 2.1) officers to man this one crew position (Stopford, 2009). At the lower end of the scale this ratio will drop to 1.1 or 1.2 on vessels with Asian officers and crew (Branch, 2007). But in any event, there is to some extent some additional partial crew member and entailed cost behind every manning position—one more reason to get the most work out of an existing position rather than add another.

Manning levels are what economists call a “lumpy input,” that is one that cannot be increased smoothly, but in jumps of some larger unit (in this case, of an added crew position). Thus, small marginal increases in workload cannot be translated directly into marginal increases in crew. The smaller the crew the more pronounced this lumpiness. The first generation container vessel of the late 1960s of 740 TEUs was employing ten licenced officers and 24 ratings, so that adding one rating was a modest increment of 4%. Such an arrangement could have accommodated the 4% additional workload due to security tasks with precisely a single rating. In 1992, a fourth generation container vessel of 4400 TEUs was crewed with only seven multipurpose officers and seven qualified ratings. In this case an additional crew member would be three times what was necessary to absorb a marginal 4% increase in workload—and absorption of the additional work by existing crew that much more compelling.

Thus, we see a situation where the structure of the maritime system is such that manning levels are pegged at fixed quanta of crew positions, which are rather “sticky,” that is resistant to an addition of a manning position in response to marginal increments in workload, such as ISPS- and piracy-related tasks. With a sequence of marginal additions to workload, each individual one being absorbed, in turn, by existing crew, we can expect considerable “overshoot” of sensible working conditions before a new position is added.

In addition to these more local vessel or company level dynamics that resist manning additions, there are also broader political-economic and institutional reasons why

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34 This, of course, is an important part of the impetus to flag out or introduce international registers in European countries.

35 Manning levels for 1968 and 1992 taken from Haralambides (2006) Shipping Policy of the EU. The largest container ship currently, the CMA CGM Marco Polo, just over 16,000 TEU, has a crew of 24 (ALB, 2012).
added workload is less likely to be absorbed by companies in the form of increases in manning, and more likely to be absorbed by crew (and especially ratings from developing countries), who are a considerably weaker link in the global maritime value chain. These are discussed in the following section.

8.1.2 Broader political-economic contexts\(^{36}\)

Despite numerous changes in the maritime system over time in response to technical, economic, political, and regulatory shifts and shocks, what seems to have remained constant over recent decades is the continued increase in crew workloads to the point these they edge uncomfortably close to the limits of human capacity. Thus, during their absence from home under contracts that for non-European crew members can often run in excess of 8 continuous months, seafarers derive much, and, sometimes most of their salary from overtime. With a baseline of exceptionally long hours punctuated by especially demanding peaks during port stays, crew exhaustion is a pervasive, chronic, and well-known accompaniment of the contemporary maritime life. (Our own survey found 90% of respondents agreeing with a statement that fatigue is a common and worrying aspect of maritime life.) While many of our younger interviewees and actors within the maritime industry take such conditions for granted, older interviewees could remember and mourned the loss of an era some 2-3 decades ago before this intensification of labour. As discussed in Section 6, our web survey demonstrates distinct differences in attitudes to these issues between seafarers who were at sea prior to 2004 compared to those who were not - differences unrelated to overall greater time at sea per se.

How is it that a civilian workforce has come to have regular operating conditions that seem more akin to a sustained emergency than to a job? What are the structures that maintain it? Is it unique to maritime work settings, and, if so, why? And, given the apparent robustness over time of current low manning levels and overworked crews, and the apparent resilience of the structures that undergird this, can we anticipate any sources of fundamental realignment?

It seems that the longstanding extraterritorial legal, institutional, and spatial positioning of the maritime workplace within a competitive maritime market leverages a powerful coupling of the robust demand for cheap labour and the near infinite supply of it at a global level. The necessarily extraterritorial nature of maritime work makes

\(^{36}\) This section draws heavily on discussion with Prof. Michael Bloor. I am grateful for his permission to include this material.
this conjunction possible, desirable, and robust. Indeed, seafaring work represents, perhaps, the earliest, purest, and most archetypal of transnational workplaces (Sampson & Bloor, 2007). Transnational maritime employment and the legal and institutional structures supporting these predate the emergence of organised labour and its faltering steps to transnationalise its reach. And, unlike the difficulties and costs of erecting and maintaining artificially remote locations of a foreign manufacturing facility, for example, solely in order to achieve the benefits of extraterritoriality, ships are intrinsically extraterritorial by virtue of their operation.

The extraterritorial maritime workplace essentially allows Third World labourers to work in Developed country “plants” in a way that is less prone to regulation (enforced by inspection) than a land-based facility located in a developed country or a developing one. Both sides enjoy the arrangement. On the side of the developing country seafarer, though their salaries are significantly below those commanded by seafarers from developed economies of the traditional seafaring nations, they are usually considerably above those available in developing countries. The opportunity to earn something approaching first world wages amidst a sea of third world poverty assures a ready supply of workers ready to work extraordinarily long hours (and able to do so, since they are extricated from competing family or non-work contexts). Though work is intense, so are the rewards in comparison to those available onshore at home, and there will always be individuals and nationalities ready to take the place of those that hesitate to take the terms offered. On the employer end, such positions are strongly attractive to companies who can obtain extraordinary per-person productivity at bargain prices compared to local wages. In a competitive maritime market, no company can afford to be undercut by offering higher wages or taking larger crews than their competition.

To put things in numerical perspective, a recent study comparing US flagged vessels, which are required to have an entirely American crew and adhere to US labour laws, with vessels flagged under flags of convenience, with their typical Asian crews (USDOT, 2011). The average daily crew costs on a non-US flag are $2,590, compared to $13,655 for the equivalent vessel under a US flag—a fivefold ratio. Thus there are considerable benefits to tapping a global labour pool. At the same time, however, our interviews with the Filipino or Indian seafarers who comprise this apparently “exploited” labour pool tell us that they typically earn four to five times more than their counterparts back at home. Labour markets and workplace arrangements anchored in this kind of 25-fold discrepancy in labour costs is likely to be tremendously resilient, and, indeed, it is. It is also likely to tend toward an equilibrium point set uncomfortably close to the limits of human capacity for work. This explains why crew are perhaps the most pliable (yet, ultimately, willing) link in the entire cost-cutting maritime value chain.
This structural dynamic and the more local economic factors described earlier help understand why security-related workloads are absorbed by existing crews, rather than translated into manning increases. While not universal, chronic fatigue and overwork have become a familiar, indeed, inevitable accompaniment of crew life. This is a price that many seafarers, especially non-European crew, are willing to bear because of the relatively lucrative incomes to be made, and the competition from other pools of labour eager for these opportunities. Thus, the logic of the maritime system has created positions requiring exceptionally high levels of sustained work intensity, but it has become less possible for any particular individual to sustain such efforts in one of these positions. Thus, a crew position is less a profession for a single person over a working life, but a slot through which many different workers cycle. Less a career, as it once was, and more a period of exertion endured by young men from developing countries, in order to save enough from some years of wages at levels approximating developed country levels, which will set them up for the non-maritime remainder of their lives.

Unless one considers these far broader political-economic structures, attempts to regulate manning and workloads might be less effective, or even counter productive. Or, in the phrasing of the blog of an Indian seafarer (Sha No Varunaha, 2011), regulation would simply try to restrain an effect rather than consider its root causes:

A simple equation can illustrate the problem:

Commercially driven lowering of manning; training levels + higher demands of turnaround times and efficient operations = taking short cuts in operations (deviating from the ordinary practice of seamen) finally leading to incidents.

The think tanks identified the right hand side of the equation, but failed to see that it will always be the case as long as the factors on the left hand side are not nullified. Simply forcing a process of over check-listing tasks is an ostrich syndrome solution to the problem. It is not physically possible to achieve good and safe operations with the same resources available at hand, when there is an increase in the commercial demands which leads to a reduction in manning.

Now, the seaman had to not only work under higher pressures to satisfy the industry’s commercial demands, but he was further burdened by the legislative pressures of recordkeeping and checklist based operations.

This overburdening of the seafarer has lead to many a case of filling up checklists after the operations are complete. I can, in many cases, empathise with this attitude. You don’t expect a seaman to start filling a 4 page “Navigation in congested/ restricted waters” checklist for navigation in high traffic areas when he sees vessels crisscrossing him at high speeds in all directions. I’d rather that he navigates the vessel safely using the ordinary practice of seamen instead of colliding the vessel and polluting our seas because he was filling a checklist when instead, he should have been keeping a lookout.
The solution to this core cause can only be found in the left hand side of the above equation. But commercial pressures, faster turnarounds and reduced manning are the norms of the day. They are here to stay, because shipping, like any other industry is a profit driven one. In the cut-throat world of smallest margins making the biggest differences of who stays in the game and who is out, even safety cannot come in the way of commercial gain. This is a very insensitive statement, one would say and I would most agree. But it is, nevertheless factual.

8.1.3 Difficulties in regulating extraterritorial labour conditions

The situation we have described is one in which the constituent stakeholders each act in ways that are beneficial and rational from their vantage point, but reflect a logic that can be detrimental to the longer term wellbeing of the maritime system as a whole. Individuals are willing to take the bargain of under-manned vessels, enduring harsh conditions for exceptional rewards, and companies surely benefit from the cheaper labour as well. The irrationality of this system emerge, as we have described, when they incur large engine repair costs tomorrow by saving small crewing costs today, and demands of seafaring life become such that the European maritime industry cannot find local candidates for land-based jobs who have the necessary experience at sea.

Why, then, have state regulation or organised labour resistance not been able to restrain this system from equilibrating at harmful levels of overwork despite the consistent complaints and warnings described in earlier sections? If we examine other instances of regulation in the maritime system we see that restraint of transnational practices would seem to require one or more actors that are (1) strong, (2) motivated, and (3) capable of exerting pressure extra-territorially. Thus far, these three conditions have emerged with respect to maritime labour only in a halting and partial way.

The labour organizations representing seafarers in developing countries who are undercut by this situation are effectively neutralised by the extraterritoriality of the maritime workplace. The developed country states themselves are in an ambivalent situation: their workers are being displaced, and they are fearful of losing their traditional maritime expertise, but their shipping companies and economies benefit considerably from available highly flexible pools of cheap labour. Labour organizations and states in developing countries are also ambivalent. Work conditions are extremely demanding, yet appear desirable to individuals willing to endure them for a few heroic years in order to set themselves up financially for life. National governments, and, most impressively the Philippines, which provides over 33% of the maritime workforce globally, gain substantial foreign exchange from their labour, and some have worked to formalise and capture as much as possible of these rewards, rather than regulate the conditions in which they were obtained.
A host of supranational bodies exist to regulate and operate the global maritime economy. Indeed, strong motivated extraterritorial actors have emerged that have set and effectively enforcing standards regulating the hardware or environmental side of maritime operations, but this has not happened to the same extent when it comes to regulating maritime labour conditions.

8.2 Recommendations for regulatory interventions and future research

Our mandate was primarily to assess, rather than redress the impacts and consequences of security tasks on workloads and manning and the dynamics underlying these. Indeed, as the previous section (8.1) has highlighted, solutions for many of the problems we describe can only be achieved through the kind of fundamental and challenging political efforts that go well beyond the scope of the kind of policy recommendations that can be forwarded in a research report. At the same time, however, our work does point to some distinct mid-range interventions with the potential to facilitate improvement, especially within the EU, including several that can benefit from the kind of added value that researchers can provide. Beginning with the relatively benign domain close to the heart of researchers - data access and coordination - we offer the following ways in which workload and manning levels could be better known and the situation improved.

8.2.1 Advance data fusion for the human element of the maritime system

In Section 4.2 of this report we discuss some of the data sources (and, very often, the absence thereof) needed in order to assess some very basic aspects of the workload/manning equation: how many vessels are there in each class, how do these travel, what is the size and composition of the crew that mans them, who does what work, and how much, and what are they paid?

For fleet sizes the numbers are there, but often with different lower capacity cutoffs (the 500-1000 GT discrepancy causes many difficulties), vessel type categories, and a confusion regarding the inclusion of vessels flagged under European second (open) registries. As for travel patterns, while AIS data is readily available to track almost any EU-flagged vessel in real time on a continuous basis, collated information on the fleet is either privately held and extremely expensive or publicly held and, thus, “confidential.” Such data, as we have demonstrated in our study, could offer very robust portraits of the itineraries that shape maritime labour in the most fundamental ways. We have demonstrated the value of this data for estimating the number and duration of port stops, as key variables in shaping security-related workloads, but there are other
important analyses could be performed were the data more reliably available. For example: what is the frequency of port stops and how have these changed with the growth in short sea shipping? How have port dwell times declined over time? What about transit through piracy areas? And in all cases, this kind of information can be broken down by ports, vessels, and, through IMO-number linkage to the Lloyd’s database, with other data such as flag and nationality. As discussed below, such data could be a platform allowing powerful evidence-based interventions on behalf of regulating workloads and rest conditions.

Regarding the size and composition of crews, the situation is, if anything, worse. Almost any serious consideration of maritime labour begins with a pained complaint about the unreliability and/or absence of the most basic data (McLaughlin, 2012). Glen and Marlow (2009) declare that “There is a general lack of reliable information on seafarer numbers: full stop. A cursory look at manning and training conference presentations posted online reveals that, even recently, the industry practitioners quote the same, single source of estimated seafarer supply and demand, namely the BIMCO/ISF 2005 Update.” They continue to describe a comparison of these commonly used numbers with the results from an ILO questionnaire that received responses from 38 states, which makes for “. . . chilling reading. For example, China is estimated to have 340,000 seafarers compared to 82,017; Korea, 65,038 compared to 16,488; Malaysia, 61,830 compared to 12,671. The total for the respondents was 997,803 against BIMCO’s 455,583.” Another researcher (Sulpice 2011), some of whose recent figures we drew on in our modeling, prefaced his work with a frank account of the impossibility of achieving his initial goals due to lack of data.

As we described earlier, there is a good comparative study on the determination of manning as part of the 6th Framework Maritime Transport Coordination Platform (MTCP, 2007), but even this offers a comparison for only 3 sample vessels types, and has a high non-response rate. Data on actually existing manning levels is very sparse. The Maritime Administration of the U.S. Department of Transport conducted a substantial and comprehensive reviews of the nationalities and size of the crews of foreign-flag cargo vessels calling at ports in the United State in 2006, and a similar study was published in 2006 by Seafarers International Research Centre (SIRC) at Cardiff University, drawing on crew lists collected from almost 4,000 vessels, collected in March of 2003. We attempted to obtain this raw 2003 data for our own statistical

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37 The report concludes: “Taking into account these findings and conclusions it is recommended to consider a major research project to analyse in depth the situation aimed at the harmonization of the minimum level of manning for merchant ships and the proposition of new EU legislation on the subject complementing the existing Council Directive 1999/63/EC on working time of seafarers.” (p. 60)
The Impact of Security Tasks on Crew Workloads and Manning Levels of EU - flagged vessels

reanalysis, and possible comparison with the 2006 USDOT data, so as to allow us to ascertain whether there were differences in manning levels that might be due to the mid 2004 enforcement of ISPS, but despite good will on both sides, the data agreements of SIRC did not allow this kind of access.

Since the submission of crew lists by any vessel entering port is mandatory, the collection and collation of detailed manning data should be relatively straightforward. Indeed, in this same period the European Maritime Safety Agency EMSA was engaged in preparing a database of crew lists. As reported in the STCW Information System Workshop held in Lisbon (June 8, 2007) this database -

“... will hold information collected from crew lists. From this data it will be possible to build a sample of seafarers serving on board EU ships and EU seafarers serving on non-EU flagged ships. The crew lists will be collected from port and canal authorities, employers and maritime administrations. The presentation outlined the database characteristics, database structure, use of fields extracted from crew lists, data sourcing, outputs and dissemination of information. The database will be centrally managed from EMSA and only aggregate statistics, not identifying seafarers or shipowners, will be disseminated through the periodic reports. This database will provide information on crewing patterns and manning levels of EU flagged ships and non-EU flagged ships where EU seafarers are employed”

In late May of 2012 we approached EMSA regarding this collection of crew lists and its possible use in our current research on behalf of the DG-MOVE study of workloads and manning. After EMSA confirmed the nature and contact agency for the study we were told that “the information requested is either not in EMSA’s possession or confidential in nature.”

When it comes to crew cost data, we encounter another challenge. “In writing professional and scientific papers in the domain of maritime shipping, authors often have difficulty when speaking about ship costs, since they represent data that shipowners consider their greatest business secret (Pocuca, 2006)”. With enough work, one can adopt a top-up approach to crew costs from salary information for various crew positions, triangulating, as we did, data from interviews with seafarers, from Manning agencies, and from the organizations that provide standard wage, and then coordinating this data with average crew sizes and compositions.

For more systematic studies of a large representative sample of crew and other operating expenses, and especially of how these change over time, a more top-down approach is needed, and here things are currently more difficult and/or expensive. For example, for $1000 one may purchase the annual OPCOST report, which allows shipowners to benchmark their costs against industry averages derived from the Moore
Stephens accountancy records for over 1000 actual vessels. Were such data available for research use as a time series, for example, it could yield a variety of insights into crewing levels and costs, and how these have changed over time. Specifically, in our case one could statistically control for other price changes and attempt to isolate where operating expenses registered an ISPS “signal” in 2004, whether as a one-time spike or a sustained state change in response to the demands of this new legislation. We approached a researcher who has conducted some elegant regression analysis using such operating expense time series straddling the 2004 period which is available to his employer, a large German maritime insurance company. Here too, despite goodwill, data access for research purposes was not possible in a manner timely enough for the purposes of our research.

Other piecemeal avenues to obtain information regarding the costs of regulation are destined to disappointment. For example, Osnin’s (2005) study of the financial implications of the ISPS code in Malaysia considered the setup costs to port operators and shipping companies through a survey of all port authorities and shipping companies operating in Malaysia. Despite the streamlined questionnaire design and follow-up telephone calls, only 28 replies were received from the 259 shipping companies who received the questionnaire: an 11% response rate whose potential for bias negated the possibility of inference from sample to population.

Public agencies have the power to leverage such cost data for the public good, and reassure companies that are required to submit their finances to government agencies that these can be aggregated without compromising their commercial interests. For example, here again, the USDOT produced a very substantial collection and analysis of operating cost data for their own and foreign vessels, published in 2011 on the basis of data up to 2010. This was geared at evaluating how operating costs—and crewing costs in particular affected the competitiveness of US flagged versus foreign ships.

The patchiness and fragmentation of data (reflecting, perhaps, the aforementioned fragmentation of governance and interests in the maritime sector) is especially frustrating since, as is evident from the above paragraphs, much of the data is already there, but simply not integrated. Crewing lists are collected in every port, ship ownership details and Manning certificates by registries, expense data by insurers and banks, employment data by national bureaus, and so forth, but this is nor accessible not adequately integrated. One can reconstruct a better portrait of some aspects of the size and compositions of the crews on Dutch crews over the course of the 17’th through 19’th century (Van Lottum and Lucassen, 2007) than one can of contemporary crews not because the Dutch East India and other merchant companies or the Dutch Navy had better record-keeping and computer systems than now, but because
researchers have better access to this data than they do to equivalent contemporary commercial or official datasets.

For this reason, our first recommendation is that data fusion efforts for the human element of the maritime system be emphasized and budgeted with vigor comparable to the data fusion efforts now underway for the system’s physical elements.

8.2.2 Use available technical tools to identify potential workload problems

“It is no secret that rest hour records and operational checklists are the most falsified documents on any ship today.”

-- Ship master

“You’re asking me about workloads: do you want the rules or the truth?”

-- Interviewee, Antwerp, 2013.

These unfortunately typical comments underscore the rationale for our next recommendations, that regulation of working conditions be based not only on the indicators of rest and work hours collected in inspections using formal records that can too readily be falsified, but also, increasingly, on first principles and common-sense models of workload and fatigue management, and an increased focus on fatigue itself as an end point.

Work hour records are beyond the reach of auditing, and are readily and regularly falsified (or, in the more polite euphemism used by one of our interviewees, “adjusted”) downward to the maximum levels that would be allowable under safe rest regulations. It is common knowledge that these the logged hours represent the hours that will be paid for not the time worked: base pay and “guaranteed overtime” are contractually set to come out at exactly the maximum possible under minimum rest requirements. As crew we interviewed openly (and sometimes humorously) admitted, after reassuring themselves that we were not ITF or other inspectors, these recorded hours are sometimes patently absurd, especially in the face of the continual punctuation of watches by port stops and other contingencies. There is a collusion between crew, officers, and ship-owners to maintain this gap between reality and records.

"I personally feel that STCW rest hour norms are being followed only on paper to satisfy oil major, ism, portstate inspectors. I have talked about this issue to lot of seafareres serving on different ranks, in different companies. The general scenario on most of the ships is that usually it’s a nominated officer who is in charge of filling up the rest hour reports of all personnel working onboard and it is thereby the duty of this officer to “fabricate” a report which satisfies the STCW/ILO norms." [spelling as in original source]

Yet inspectors have little recourse in the face of this kind of charade, as evidenced in the following excerpt from Michael Bloor’s field-notes on port state enforcement.

10/6/03 ... inspect the [name omitted], a heavy loader, 2000 gwt, built 1979, Croatian-flagged, classed and crewed (13), loading a mixed general cargo [...] The watches were posted on the bridge and the master took one of the three watches. Since the hours of rest listed the captain as having 16 hours of rest almost every day, this meant that the captain was resting almost all the time that he was not taking a watch, which was clearly preposterous. I pointed this out to [PSCO] on the way home. He agreed that the hours of rest were clearly falsified, but had no solution to suggest.

To augment the sometimes limited traction possible using such records, we suggest the coupled use of available datasets and technical tools that can identify potential trouble spots—places where security duties will be large, and likely to be added to already stressed and fatigued crews.

The scheme to be detailed below is as follows. We have seen that the number, frequency, and duration of port calls and transits through piracy-threatened areas give rise to the heaviest and most consequential additions to workloads in both human and imputed economic cost terms. And we have seen that port calls and piracy transits can now be monitored for each and every vessel in the entire EU commercial fleet using AIS transponder data (as well as future technologies). Regulatory agencies at the national level can obtain the minimum manning level statement filed for any given vessel, and inquire whether actual crews (which should conform to the crew lists vessels file at each port) exceed these minimal levels. In principle, therefore, vessels with travel patterns likely to produce exceptionally heavy security (and other) workloads, can be queried on their manning levels, and, if necessary, asked to demonstrate how the given crew manage the workloads corresponding to their objectively verifiable historical record of movement, on the one hand, and the rest hour requirements, on the other.

Building on this, modern maritime workload simulators, which are able to project the number and nature of rest hour violations that would result given a given combination
of port stops and crew, and modern maritime fatigue simulators, which can model the buildup of fatigue over time and under various watch systems, would provide some important objective benchmarking in such discussions. In this way, the burden of proof would be shifted to those operating vessels of potential concern, and enforcement less narrowly dependent on inspections that are partial and paper records that can be less than reliable. In the sections that follow, each of these tools is described in greater detail.

8.2.3 **Identification of potential workload excesses in port stops: proof of concept**

The graph of Figure 48 shows the kind of analysis that can be done to systematically identify vessels of particular concern. It represents the average number and average duration of all port stops made over four years by the 395 EU-flagged general cargo vessels tracked in the AIS dataset we used. Each dot represents a single vessel, and the green contour contains 50% of all vessels (marked in green), and the brown contour contains 75% of them. Two groups of the 25% of vessels lying outside of this brown contour might present exceptional workload challenges: one with very frequent and brief port calls, and the other with fairly extended port calls of moderate frequency.

More specifically:

- The red dashed lines demarcate the vessels with more/less than 100 port calls on average a year, and the more/less than 2 days average port stay. Sixteen vessels (marked in red), or 4% of the total vessels, average more than 100 port calls a year with a port stay of less than 2 days on average. This group of vessels is likely to be prone to extreme workloads because of frequent and rapid cargo handling at the same time that ISPS tasks are needed.

- The second group of vessels indicated in blue make between 10 and 40 port calls annually, staying for over 4 days. Here there may be workload demands due to added continuous gangway watches while in port for a relatively extended period.
Figure 48 - Identifying niches of concern with AIS data

This example is intended to demonstrate the ability to “zero in” on potential workload hotspots. For example, we have the flag for each vessel, and patterns emerge already at that level. In the cargo dataset depicted in Figure 48, all but one of the Finnish vessels in the entire sample are in the “red” group of frequent rapid turnaround, and, in fact, constitute half of this group. Almost all the “blue” vessels of long port stays are Maltese or Dutch flagged.

And, further, beyond the four-year averages shown in the figure, the original dataset contains the name of port and exact time of arrival and departure for each vessel over this period, so that the patterns of port stays can be more finely examined. There are sequences and timings of departure and arrival that to an experienced observer would seem to demand a combination of watches, navigation, and cargo handling that cannot
be supported at usual crewing levels without violating rest hours, no matter what the work hour record says. . . .

And, since each vessel in the original dataset is uniquely identified by IMO number, it should be possible to obtain the safe manning level filed for vessels observed to have excessively demanding itineraries. And it is a technically trivial matter to assess whether current travel patterns continue worrying historical ones, since various on-line AIS-based vessel trackers allow anyone with an internet connection and IMO number to easily follow the ships current movements continually in real time.

8.2.4 Workload modeling

We suggest exploration of the kind of workload modeling that is common in navy vessels and other demanding work settings. The call for these to be used more broadly in the maritime realm, and especially in the face of increased security threats, was made very early on (DiDonato, 2004), but has not received anywhere near the kind of implementation that these technologies deserve. Consider a case in point, which is a remarkable EU effort to simulate workload and manning requirements, which offers great potential and could be developed further. This is the model commissioned in the middle of the last decade by the Danish Maritime Authority (DMA) from the Danish Company FORCE and the Danish Technical University. They were tasked to create a simulator of ship tasks and their allocation to crew over time on typical voyages and vessel types in order to rationalise and assist in a decision support tool for manning level determination. The model took a team of 5-6 people 2 years to build--about 5000 man hours. In March we held an extended work meeting with the Project Team Leader in their Maritime offices in order to better understand this model, how security-related tasks might be entered into it, and what we might learn about the security/workload/manning issue through it.

The FORCE model was derived from pilot studies, which evolved into a conceptual model, into which data from experienced people was fed, and then it was elaborated/validated on two ships, one a larger tanker, and another a smaller freight ship. The heart of the model is a function table with each task (about 70 or so) as a row, and columns for various aspects of each: for each crew member the priority of them doing it (ranked from 0 to 100), as a way of signaling who should ideally do it; the task’s duration; when it must be done by; what happens when it is interrupted; whether it is done in parallel to any other tasks; and in which voyage phase it is done (port, transition to sea--i.e. departure, at sea, etc.). Tasks occupy 6 minute increment (tenths of an hour) currently, though they can be broken down to whatever level of resolution is needed. (For short haul ships, where the vessel might call at several ports
a day, this would be needed). The durations and start times have a minimum, maximum, and most likely level (decline is with a triangular function).

Next a "scenario" is drawn up, with the timing at and between ports of call, which establishes the cycles of the different phases, on a trip. The model is run, and one can specify how many trials are to be executed - a kind of Monte Carlo method with random variation included. The model allocates crew to the tasks that emerge in the scenario using the parameters and constraints of the function table - which crew can do this, which crew have had sufficient rest, how long they will be occupied with the task, etc. The program does not optimise allocation--the client (DMA) wanted an interactive tool, where the users would enter and iterate various values. As shown in Figure 49 (Source: FORCE), the model will output the allocation of tasks, the load on each crew member, as well as various indicators of interest.

![Detailed crew resource utilisation](image)

**Figure 49 - FORCE crew resource utilization simulation for master, chief, and first officer**

Of interest for our purposes, is that this example of the crew utilization on one of the test cases for the simulation of a 900 hour trip (over a month), demonstrates a (typical) pattern in which the Master exceeds the mandated 14 hour per day workload 9 times, sometimes within a short duration. Here the burden of proof is shifted to the shipowner or captain to show how the ongoing tasks of a typical voyage can be accomplished at the given manning level. Such graphs can be produced with any of the crew members overlaid. And, since the software has several rest rules programmed into it (ten hours of rest a day; that 6 hours constitute a single unit; that rest be at least 72 hours a week, etc.) the average daily number of violations for each crew member can be flagged. Thus, in the display of Figure 50 below, we can see the average number of violations (and the breakdown of the kind of violation) for each crew member.
The model allows one to pinpoint when and for whom the workload stress exceeds allowed levels and to begin to reallocate tasks or to play with various trade-offs between routes, task durations, and manning levels. For example, the model can easily show that if you want to load/unload in a given period, and make calls at ports within a short amount of time, this may be impossible (i.e. demand violations of rest hour standards) with the stated number of crew.

Now let us take the possibilities of such technologies one step further. We can readily draw on AIS port stay data to reconstruct actual voyage itineraries for any given vessel in the EU fleet, and test whether its actual manning level could have allowed it to avoid consistent violations. Or we might derive average data for certain classes of vessel and route, and use this model to help assure that the relevant vessels are adequately manned.  

Figure 50 - Rest rules violations per crew-member

In May of 2012 we obtained the agreement of FORCE Technology for future collaboration on inserting security tasks into an existing model of crew workload and schedule. We received the materials necessary from FORCE in order to conduct collection of security task data in a format that can be entered readily into FORCE simulator. Key task characteristics are the following: the tasks priority, number of crew needed, who can/should perform, the timing relative to voyage and
8.2.5 Fatigue simulation

Let us take these possibilities one last step, and consider the recently completed HORIZON project, which conducted fine grained studies of fatigue levels in controlled conditions on simulated voyages. Of particular interest was the build-up of fatigue over time under different watch arrangements (especially 6-6 versus 4-8), and the former was found to be clearly less sustainable after a number of days without incurring marked levels of fatigue. The project resulted in a fatigue planning tool. Both the FORCE simulator and the HORIZON fatigue prediction tool were developed with public funding and intended to be available for use by the broader maritime community, and AIS tracking information is, for better or worse, broadly available in the public domain. Thus, the maritime community is not too far off from being able to access these components and link them into a versatile and remarkably powerful toolkit that would place questions of workloads and manning levels onto a more empirically and logically solid, auditable, and objective footing than it is today. One could show that a particular or typical vessel’s operation must necessarily compromise its crew’s wellbeing, and, more constructively, allow the ship owner, captain, and crew to explore various what-if scenarios for reducing the problem (more crew, alternative watch-keeping arrangements, less frequent port calls, or, even, increased manning).

In short, by drawing on existing but under-utilised data and tools, AIS records of past and current ship movements can be used as an input into workload and fatigue simulators, and, together, these can serve as powerful decision-support tool. This would allow an additional and objective input into the tasks of identifying and regulating sites of chronic workload stresses and allow more realistic analysis and exploration of the options for avoiding rest violations and excess fatigue. These tools would allow conjoint exploration and discussion of various options for remedy, so that manning increases could be considered and monitored within the overall context of watch-keeping arrangements and typical the itineraries of the vessel. This technical support for a more unified approach would dovetail well with the more conceptual shift suggested in our next recommendation.

other tasks (with probability distribution), interrupts, duration (with probability distribution), whether also on weekends, etc.

40 Advances have also been made in developing physiological indicators of fatigue that could be explored as a way of broadening the regulation of workloads in demanding setting, though, obviously this kind of surveillance is more fraught with technical and ethical questions.
8.2.6 **Draw on “human systems integration” approaches and best practices**

In the previous recommendations, our emphasis was on the data and simulations tools that could provide more objective and well-rounded inputs into the surveillance and regulation of workloads and manning levels. Underlying these is an opportunity for a deeper kind of shift in approach to the maritime workplace. Currently safety, security, work, rest, and other aspects are regulated by different and poorly coupled sets of regulation, while key driving factors such as watch-keeping systems and ship itineraries are left to the discretion of companies, captains, and the vagaries of chartering opportunities. Yet all of these factors form a unified whole, into which a new set of tasks, such as those relating to fatigue, are inserted. Our recommendation **is for the EU to encourage movement toward a more unified approach to understanding and regulating the ship system as a whole.** For example, these could draw on work-hour and rest hour thinking (see Bucks, 1996) that takes all of these factors into account, and on best practices and approaches that have been developed in other contexts for optimising crew resources and workload scheduling in order to increase performance and reduce fatigue. These approaches would help tackle the security duty/workload issue within a broader systemic context.

In particular, the merchant marine community can consider the analytic approach to workload and manning level analysis that has been steadily moving forward in other crew-based workplaces. In the naval context, where performance supersedes commercial considerations, there is a longer history of development of a “human systems integration” (DiDonato et al, 2004) that could inform debates and practices within the merchant marine community as well. Similarly, the maritime community could consider the situation and efforts in crew-based workplaces in air, rail, and land transport (Pollard, Sussman & Stearns, 1990), and the advances made there to improve the planning of crew resources and reduction of workload excesses. One aspect of this that has already received considerable attention is the reform of the watch system. For example, the six on/six off arrangement, which tends to be employed in ports in order to allow the extra ISPS gangway watch alongside cargo and other activities, is flawed in several ways. Often, “off duty” time not on watch is used for other work tasks, and worsen a situation where frequent port stops disrupt rest, with crew that should be ending a watch directly begin duties associated with port approach.
8.2.7 Consider legal and economic mechanisms for rationalising manning

The persistent and consistent pressures for manning augmentation made over years by crew and their advocates, which we have described above, are not likely to subside soon. Nor are the structural forces that militate against such increases in manning. At the same time, there are some emerging shifts in the maritime landscape that may dislodge this deadlock. Some of these might be straightforward (and, probably, resisted) efforts to increase manning in the most affected vessel and voyage types, and establish red lines under which manning levels cannot drop. These can both be identified using some of the tools described above, and a targeted and rationalised choice of the subset of vessels most need of reform might produce less resistance than more sweeping or formalistic regulation.

As we have described in Section 0, the “lumpy” quanta of a manning unit presents considerable pressures for the absorption of marginal workload additions by existing crews, especially when these are due to tasks that occur in peaks. Specifically, adding a crew position in order to avoid the workload “crunch” of cargo loading and additional ISPS watches, which would remain underutilised for much of the time when the vessel is underway, is a strong deterrent. But there is an important and high-leverage way of avoiding the “lumpiness” of labour inputs—it is possible to smoothly increase crew by less than a full crew position, and to do so in a way targeting the key bottlenecks for crew time. This is the measures that have long been suggested by crew, and which our research would endorse, namely the outsourcing of cargo and gangway watches to port-side labour, and of paperwork to shore-side staff. The former might seem inconceivable in the current landscape of cost-cutting and making do, but we must remember several things. The first is that this will allow an addition of manpower that is proportional to the deficit in manning, or any new increments in workload, and one that is applied at exactly the right place at the right time, as opposed to the cruder and potentially more wasteful response of an entire new manning position. Second, in longer historical perspective, such outsourcing would come in the wake of a prolonged process of eroded manning levels and “in-sourcing” that has taken place over decades. For example, many companies employed non seafaring personnel on board (laundry men, stewards to serve food in the officer’s mess), the last of which were phased out in the mid nineties. Third, despite greater legal and jurisdictional complexities, a considerable burden of security-related workload has already occurred in the non-port context: the use of private security guards in areas of piracy risk has been embraced by ship owners and crew, and at considerable cost (Chalk, 2009; Chapsos, 2013; Harrelson, 41 In fact, these have been made cogently for two decades now: see Grabowski (1993).
2010; Richard, 2010; Spearin, 2010; Weiss, 2007), and is currently employed by something like one third of transits through waters with a piracy risk.

Given these factors, perhaps such measures might not be as inconceivable as it may seem at first, and is certainly worth fighting for. Or, in the more eloquent words of a long time crew member:

“In today’s world of specialization I am one of the few Masters with a wide variety of command experience - VLCC’s, Reefers, General Cargo, Containers (both large and feeders) and Bulk Carriers. I have also headed my company’s country operations - focusing on HR, albeit for a brief period of seven months. There is one aspect that is common to every variety of ship - the short port stays coupled with excessive work load whilst in port. Things become worse if the port is in the middle of a piracy prone area, or an area of high traffic density. My solution, though it might sound a bit novel is worth thinking about. Consider employing Port Crews - who will look after the entire port operations while the Ship crews get their rest. Doubtless this idea will come with its own set of problems. Two I can think of immediately would be unfamiliarity with the vessel and responsibility for the consequences of any errors. But one must realize that in this day and age of specialization, it is indeed possible to train people who are specialized in the loading and discharging of a particular cargo. In days gone by, ships used to have about 100% additional crew, and used to stay in port at least 300% longer. Everybody has benefited with the economic advantages of quicker turn around and smaller crews. Surely it is time to give something back! “(Nautical Institute Fatigue Report Web, 2006).

Finally, we may be seeing the harbingers of new kinds of legal challenges related to working conditions that could disrupt the maritime labour landscape in quite far-reaching ways. A case in point was that of William C. Skye v. Maersk Lines, last summer. Skye, an American Chief Mate, sued under the Jones Act for damage to his heart resulting from overwork after having worked as chief mate (second in command) on the Sealand Pride, with 16 hours workdays for 4 years (70 days on 70 days off). He performed two 4 hour watches plus his additional duties. Maersk had knowingly budgeted the duties such that it required this length of shift continuously. Despite Maersk’s claims that he arranged his own duties and had not delegated properly, and that Maersk had no operational control over the vessel during part of the period in question, he was awarded $590,000.

Commenting on this case, Nautilus senior national secretary Allan Graveson remarked:

"We have said consistently that the problem of seafarer fatigue will be dealt with through the courts rather than by the regulators and this judgement reinforces the strength of our arguments.... Coupled with he way in which the Project Horizon research has increased knowledge of the immediate safety risks of excessive hours, there are now compelling reasons why shipping companies should take proactive
safety management measures to mitigate the effects of long and irregular working periods on watchkeepers—rather than relying on socio/economic regulatory measures that fail to consider the long term health of personnel, safety of the ship, and protection of the marine environment.” Nautilus (2012)

Maersk is appealing, of course, and it is unclear whether this case will become a resounding precedent or a forgotten dead end. In another recent legal development, a legal challenge was made to the UK law that exempts the maritime workplace from legislation that more generally disallows discriminatory differential salaries based on the basis of nationality. At a minimum, these kind of challenges could increase the pressure for improving working conditions in more gradual and less combative ways. For this reason, we suggest that the EU be attentive to such legal challenges to blatant instances of under-manning, and also be attentive to legal challenges with extra-territorial reach that could reduce the wage differentials that make globalised Manning so appealing, and stabilise a system of chronic maritime under-manning.

8.3 Security, workloads and manning – the way forward

Our research set out to “to assess the possible impact, including financial consequences, of security duties including the measures for self protection and the prevention of piracy and armed robbery against ships, on the workload of all categories of ship crew and the interaction of security levels with manning level of ships.” These security tasks are embedded in the broader contexts shaping maritime workloads and manning levels, and constitute one more marginal addition to decade-long trends that have lead to a system that has stabilised at an equilibrium point that seems to generate widespread and chronic under-manning and, thus, overwork and fatigue. Despite this complexity, it has been possible to produce several results -

- We generated a robust empirically-based initial estimate of the overall extent and cost (in salary terms) of the hours spent on these new tasks on EU-flagged vessels of all categories. Because of the sheer preponderance of port-stops, the main contributor to this workload addition at a fleet-wide level appears to be ISPS requirements in port. Our model is constructed in an open-ended and probabilistic manner, so that others can refine and adapt

42 “The European Commission informed the UK government that it had received a complaint in relation to s9 of the Act permitting wage differentiation on the basis of nationality. Further concerns were raised regarding s8 and its application to nationals of EU (then EC) and EEA states, as the Commission viewed the section as ‘unjustifiably indirectly discriminatory’ and contrary to European law, in particular, Council Regulation (EEC) No 1612/68 on freedom of movement for workers within the Community” (Lavelle, 2010).
these estimates in light of changes in parameters or improvements in data quality over time.

- We show that manning levels have not been increased to any noticeable degree in response to security workload increases, and the curious bifurcation of viewpoints on this. Maritime authorities and shipowners/operators are convinced, with reason, that existing crews are able to, and, indeed, have absorbed this small marginal addition to workloads. And the seafarers closest to the realities of the maritime workplace remain adamant that these new tasks add to already intolerably high levels of work, and that manning augmentation is long overdue.

- We discuss why the maritime system is configured in a way that, indeed, makes it almost inevitable that small incremental workload additions, such as new security tasks, be absorbed by existing crew. And we describe the inherent difficulties in regulating workplace conditions in the deeply extra-territorial and globalised maritime context. These logics have “locked in” manning levels that undermine crew wellbeing and may harm vessel safety and performance in the long term, and these persist despite wide-spread and persistent complaints about the situation and its effects.

- We indicate, in qualitative terms, the kind of cross-cutting, subtle, and less readily quantifiable impacts of security workloads. They increase a degree of overwork that has created a workplace that increasingly encourages seafarers to approach it as an exhausting multi-year sprint rather than a sustainable profession; and has undermined the cultivation of longer term values, such as ship maintenance, crew quality of life, safety, and, ironically, a deeper culture of security-consciousness rather than checklist compliance.

- We indicate the sites and situations particularly vulnerable to the impacts of security tasks. Security tasks in themselves need not be excessively onerous or costly, but when they fall on a crew already stretched thin, and at times of peak workloads from other sources, their impacts are multiplied. We find the impacts of security tasks weigh most heavily on the categories of ships and seafarers that are already known to suffer from fatigue: vessels with smaller crews, those making frequent and short port stops, etc. We demonstrate how regulators can use available AIS data to readily pinpoint vessels and vessel categories of particular concern with any degree of resolution needed.

- Finally, we offer a set of recommendations and tools that might help regulators dislodge the “stuck” systemic dynamics shaping maritime workplaces. We suggest that the data and tools and approaches all exist to approach the manning/workload question in new and more productive ways. These would address not simply the proximal question of whether and how manning levels could accommodate security-related tasks, but the broader and longstanding issues behind them: creating ship working conditions that support the long term interests of all maritime stakeholders, rather than a downwards spiral of competition that creates ones that are barely tolerable. We have outlined how these tools and data might serve as a resource for overcoming a tendency for the regulatory treatment of work, rest, and the tasks needed to assure compliance with safety, security, environmental, and other regulations, to become overly fragmented. These tools can help consider the workplace and workloads as a whole, and identify vessels who’s manning levels and itinerary seem likely to systematically produce excesses. Rather than relying on inspectors
to find slip-ups in work and rest hour logs that are easily falsified, or expecting vulnerable crew to expose the companies that pay their salary, one could engage in constructive dialog to ascertain how a ship is able to manage its available crew resources in a way that allows it to cover its itinerary of port arrivals and departures while respecting rest hour arrangements, security duties, as well as the ongoing workload related to port stops.

Our assessment attempted to combine aggregate and quantitative information with site-specific and detailed qualitative information to provide a portrait of the workload and manning impacts of security tasks that is both comprehensive and fleet-wide yet reflects the varied contexts and categories within this fleet. More important than a sealed product, which must necessarily generalise and examine in detail only a small subset of prevailing situations, we attempted to demonstrate the feasibility of an approach that allow regulators to dynamically improve aggregate estimates as needed and to zero in to any degree of detail required. The Monte-Carlo time and cost model described in 17 can be updated as needed in response to updated or improved parameters, while AIS data (see section 4.3.4) can be used to identify potential workload hotspots. Section 8.2.2 offers a “proof-of-concept,” demonstrating one way in which data already available to the EU can be used to identify classes of vessels (indeed, particular vessels) that might merit closer examination of manning level adequacy (in this case, the particular 8% of EU-flagged cargo vessels whose port calls indicate the possibility of excessive workloads).

We point, also, to other fronts (such as the outsourcing of cargo-handling and security tasks in ports) that could bring rapid and high-leverage improvements in the fit between manning and workloads, as well as some of the broader structural reforms of the maritime political-economy that would lessen the dynamics that currently encourage a “race to the bottom” with respect to crew working conditions. Our immediate question of the impacts of additional security-related tasks is only an entry point into these larger challenges.
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