Volume XXIV 2021
ISSUE no.1
MBNA Publishing House Constanta 2021

Scientific Bulletin of Naval Academy

SBNA PAPER • OPEN ACCESS

Management tools for implementation and monitoring of requirements for enforcement of reducing sulphur oxides on ships: Latvia and Lithuania cases

To cite this article: Anastasia INOZEMCEVA, Vilma LOCAITIENĖ, Vytautas DUBRA and Taner ALBAYRAK, Scientific Bulletin of Naval Academy, Vol. XXIV 2021, pg.225-239.

Submitted: 31.03.2021
Revised: 15.06.2021
Accepted: 22.07.2021

Available online at www.anmb.ro

ISSN: 2392-8956; ISSN-L: 1454-864X

doi: 10.21279/1454-864X-21-I1-026

Management tools for implementation and monitoring of requirements for enforcement of reducing sulphur oxides on ships: Latvia and Lithuania cases

Anastasia Inozemceva[1], Vilma Locaitienė[1], dr. Vytautas Dubra[2], assoc. prof. dr. Capt. Taner Albayrak[3]

Lithuanian Maritime Academy[1], Port economy and management department, Klaipeda, Lithuania, a.inozemceva@lajm.lt, v.locaitiene@lajm.lt,
Lithuanian Maritime Academy[2], Navigation Department, Klaipeda, Lithuania, v.dubra@lajm.lt
Piri Reis University[3], Faculty of Economics and Administrative Sciences, Department of Maritime Business Management, Tuzla İstanbul, Turkey, talbayrak@pirireis.edu.tr

Abstract. The main type of bunker oil for ships is heavy fuel oil, derived as a residue from crude oil distillation. Crude oil contains sulphur which, following combustion in the engine, ends up in ship emissions. Sulphur oxides (SO_x) are known to be harmful to human health, causing respiratory symptoms and lung diseases. Limiting SO_x emissions from ships will improve air quality and protect the environment. From 1 January 2020, the limit for sulphur in fuel oil used on board ships operating outside designated emission control areas is reduced to 0,50% m/m. However, there are varying degrees of readiness among port and flag states for implementation and monitoring of requirements for enforcement of reducing Sulphur oxides on ships. In this paper are described management tools of states for implementing the inspection on Sulphur in ships fuel, analysed the states institutions activities for the enforcement of reducing Sulphur oxides on ships, and indicated the possibilities of increasing effectiveness of the management tools in Latvia and Lithuania.

KEYWORDS: Port state control, Sulphur inspection, Sulphur Directive, port management tools

1. Introduction

Environmental regulations are drawn up to protect public health and the environment from pollution by industry and development. It is very important for the maritime industry to follow the law and to achieving the environmental sustainability. States play the key role in ensuring the sustainable management of port and control of the ships to meet the international standards. Environmental regulations are drawn up to generate solutions to particular environmental problems in order to protect the surroundings and human lives. In this day and age, there is a strong interest in global shipping industry to limit emissions from ships such as Carbon dioxide (CO_2), Sulphur oxides (SO_x), ozone-depleting substances (ODS), particulate matters (PM), volatile organic compounds (VOC) and Nitrogen oxides (NO_x) [1, 7, 9]. Ship emissions are an important source of air pollution, including Sulphur oxide emissions from fuel oil combustion. Ships are emitting into the atmosphere 5–7 10^9 kg/year of nitrogen

oxides (NO_x), 4.7–6.5 10^9 kg/year of Sulphur dioxide (SO_2), and 1.2–1.6 10^9 kg/year of particulate matter (PM) [2, 9].

In order to regulate hazards caused by ship emissions, the International Maritime Organization (IMO) broadened the MARPOL 73/78 International Convention for the Prevention of Pollution from ships by introducing Annex VI, which stands for air pollution prevention from ships. The latest amendments to Annex VI were adopted in 2018 and entered into force in January 2020. The European Union accordingly issues their legal acts as Directives based on the International MARPOL Convention. In addition, the IMO insists on establishing of emission control areas (ECAs) to control ship emissions, where there are more stringent controls on ship emissions. At present, the Baltic Sea, the North Sea, the North American Area, the United States Caribbean Sea and the South Korean ports are designated as ECAs [3, 6], where the sulphur content in marine fuels has been reduced to 0.10%, already in 2015. From 1 January, 2020, the maximum sulphur content of marine oil is reduced to 0.5% globally outside specific designated emission control areas.

The scheme (see Figure 1) represents the evolution of the global Sulphur restrictions.

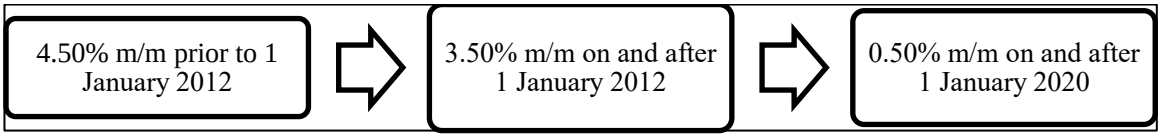

Figure 1. The Sulphur content of any fuel oil used on board ships on a global scale [5]

Maritime transport has a direct impact on air quality in many coastal cities. Ships traditionally use fuel oil for propulsion, which can have a sulphur content of up to 3.50%. By comparison, the sulphur content of fuels used in lorries or cars must not exceed 0.001%. About seventy percent of the emissions from ships occur along the coasts and therefore contribute to the degradation of air quality in both coastal areas and port cities [7, 9]. Sulphur oxides are harmful to the human respiratory system and make breathing difficult [1]. 2012 the Sulphur Directive, which was revised in 2016, reduced SO_x emissions by setting maximum sulphur content for the marine fuels and incorporated new standards set by the International Maritime Organization into EU law, both within and outside regional protected areas. There are varying degrees of readiness among ports and flag states for implementation and monitoring of requirements for enforcement of reducing Sulphur oxides on ships. This led to study of the readiness and condition of Lithuania and Latvia for the implementation these requirements.

Many studies in this field include the impact of marine fuels on air quality in port cities [1, 2, 7, 9]. Due to manoeuvring, fuelling, and hoteling (supply, crew change operations, etc.) phases, air pollution in the port areas can be quite high. In addition to quantifying emissions from shipping, research has provided clear evidence to assess the impact of control on improving air quality [8, 13, 14]. However, there is a lack of research analysing the experience of States in implementing the requirements of the Sulphur Directive, the activities of the Port Authorities, the port services work, and Port State Control. The research applied D. Özçayir (2009), C.C. Yuan (2020) insights on how to improve the Port State Control activities [11, 13], based on M. Burns (2015) interpretation of port management was identified the role and contributions of key actors' in controlling port management, including the emissions from ships [3, 14]. Y. Zhang et al. (2018) research's model was used to identify management tools that could be used by the governments [14].

The novelty of the research is revealed by the combination of port management tools, what could be used by Governments of Lithuania and Latvia, and Port Authorities to improve and make more efficient the implementation and monitoring of requirements for enforcement of reducing the Sulphur oxides on ships.

The purpose of the research – to indicate the possibilities of the effectiveness of management tools for requirements of lower Sulphur limits on ships in Latvia and Lithuania.

Methods such as scientific literature analysis, a chronometric analysis of the Sulphur Inspection in a ship, data interpretation, comparative analysis and synthesis were used.

2. Data and methods

In this paper, Lithuanian and Latvian ports were chosen to be analysed. Both countries are EU countries, with ports located in the SECA region at the Baltic Sea. In addition, the ports of Klaipeda and Riga are the main competitors in the region. The volumes of cargo handled in these ports have similar trends (see Figure 2)

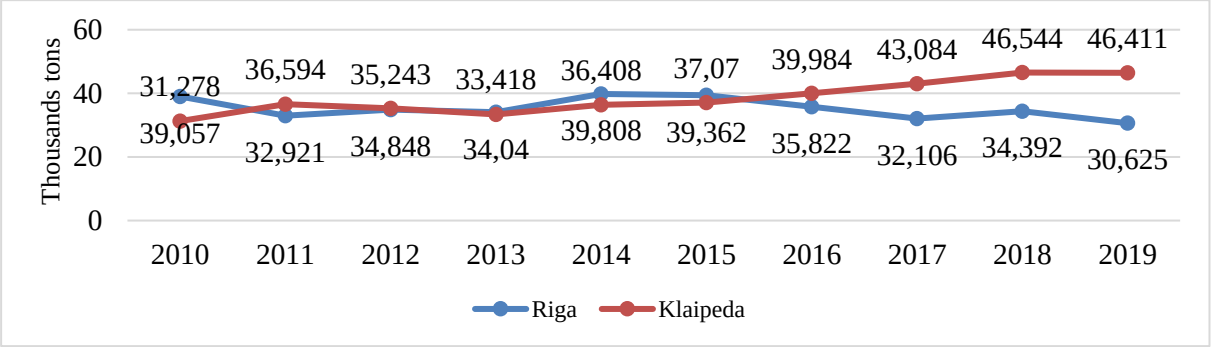

Figure 2. Volume of cargo handled in Klaipeda port and Riga port.

However, the management of these ports is different. Latvia uses the mixed model of national and municipal government level collaboration of port governance, where the owner or shareholder consists of government and municipality. The board ports in Latvia shall be formed by the relevant local government council, consisting of not more than 10 members, representatives from the local government, the commercial companies operating in the port, and Ministries. Yet the only seaport of Lithuania, the port of Klaipeda, uses the model of national port governance with different institutional frameworks.

Port State control in Latvian ports is performed by the Maritime Safety Inspectorate of the State joint stock company - the Maritime Administration of Latvia. More precisely its division called the Maritime Safety Inspectorate. The Sulphur inspection is performed by so-called “environmental inspectors”. The environmental inspectors work on behalf of the State Environmental Service (SES) of Latvia -the institution controlling the compliance with the environmental laws and regulations in Latvia under supervision of the Ministry of Environmental Protection and Regional Development of the Republic of Latvia.

In Lithuania the institution performing the Port State control is the Lithuanian Transport Safety Administration (LTSA). It is the national safety agency of railway, road, civil aviation and water transports. Regarding the Sulphur inspection – three state institutions are involved in the process. The LTSA inspectors (no special position as “environmental inspector” exist, the Sulphur inspection is performed by regular PSC inspectors) choose the ship for inspection, check the documents and perform a visual inspection. If the above is not in compliance with the requirements established by legal acts, the LTSA immediately forwards this information to the Lithuanian Marine Environmental Protection Inspectorate of Environmental Protection Department under the Ministry of Environment (AAD) and the State Consumer Rights Protection Service (the Service). Sampling of marine fuels to determine the sulphur content belongs to the competence of the Department of Environmental Protection (AAD). Inspection of samples is under the competence of the State Consumer Rights Protection Service (the Service). These differences in the organization of the process made it possible to analyse the management tools applied and their effectiveness though comparative analysis.

Data and evidence in this paper are collected from a database THETIS-EU, a series of reports of the Marine Environmental Protection Inspectorate of Environmental Protection Department under the Ministry of Environment of Lithuania, the State Environmental Service’s of Latvia, legislative documents [4, 5, 6] and regulatory statements. The source of knowledge in this paper also includes the experiences from practitioners who are involved in the whole process of the Sulphur Inspection.

A chronometric analysis of the Sulphur Inspection on ships in Klaipeda and Riga ports was conducted through participatory monitoring. It was attended by one of the authors of the paper.

3. Management tools identification

To better formulate the process, which is regulated by the state government, the authors used the model "Interactions among major players using Advocacy Coalition Framework", developed by Y. Zhang at el. [14]. During the analysis of scientific articles [1, 2, 7, 9, 14], rules of procedures [4, 5, 6] and Sulphur inspections documents, this model has been complemented in the context of the Sulphur Directive. The authors used this model to summarize the beliefs, problem perceptions and resources, which have the government and the industry, that may influence government decisions formulation regarding tools for implementation and monitoring of requirements for enforcement of reducing sulphur oxides on ships (Figure 3).

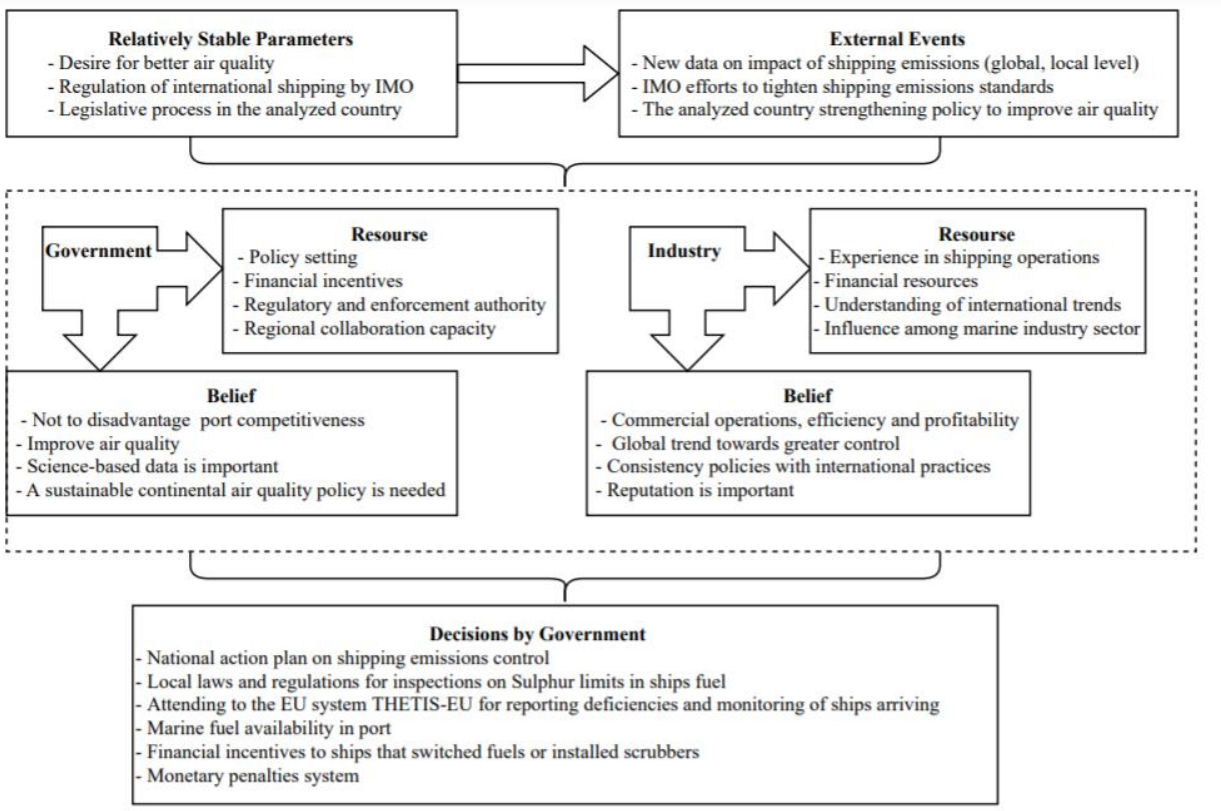

Figure 3. Interactions among government and industry in finding the decisions to reduce emissions from shipping

Tighter international regulation of shipping emissions has also been instrumental in encouraging global shipping actors "Industry" to engage in dialogue once they have recognized the interest of government officials [14]. In addition, the government's drive for better air quality has created a political impetus for regional cooperation to regulate shipping emissions, which has eased concerns about port competitiveness and facilitated the policy-making process (see Figure 3) [14]. To properly implement the requirements of the Sulphur Directive must establish these decisions and management tools (see Table 2).

Table 2. Relation between the decisions by government and management tools.

Decisions by Government	Management Tools
1. National action plan on shipping emissions control	1. Sulphur inspection in ships fuel, sampling taking management process;
2. Local laws and regulations for inspections on Sulphur limits in ships fuel	

	2. Usage of remote measuring equipment
3. Attending to the global system for reporting deficiencies and monitoring of ships arriving	3. EU system THETIS-EU
4. Marine fuel availability in port	4. Compliant fuel availability in ports
5. Financial incentives to ships that switched fuels or installed scrubbers	5. State support program (scheme) to compensate for purchased scrubbers
6. Monetary penalties system	6. Procedure for imposing fines, amount of fines

Accordingly, to implementation of these decisions, five management tools are analysed in this research: (1) inspection on Sulphur in ships fuel, (2) compliant fuel availability in ports, (3) usage of remote measuring equipment (sniffers), (4) monetary penalties and (5) European Union system THETIS-EU for reporting deficiencies and monitoring of ships arriving at port. Mentioned management tools are described theoretical and how they are implemented in Latvia and Lithuania.

3.1. Requirements for inspection on Sulphur in ships fuel

The inspection on Sulphur is a part of Port State Control (PSC) and is intended to ascertain the compliance with the Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the Sulphur content of certain liquid fuels and to identify non-compliances. It consists of inspection of ships' logbooks and bunker delivery notes of at least 10% of the total number of ships calling in the Member State per year. Moreover, sampling and analysis of fuel on Sulphur content of at least 40% from these yearly 10% inspected ships in Member States fully bordering Sulphur Emissions Control Areas. The Sulphur inspection consists of the three main phases (Figure 3):

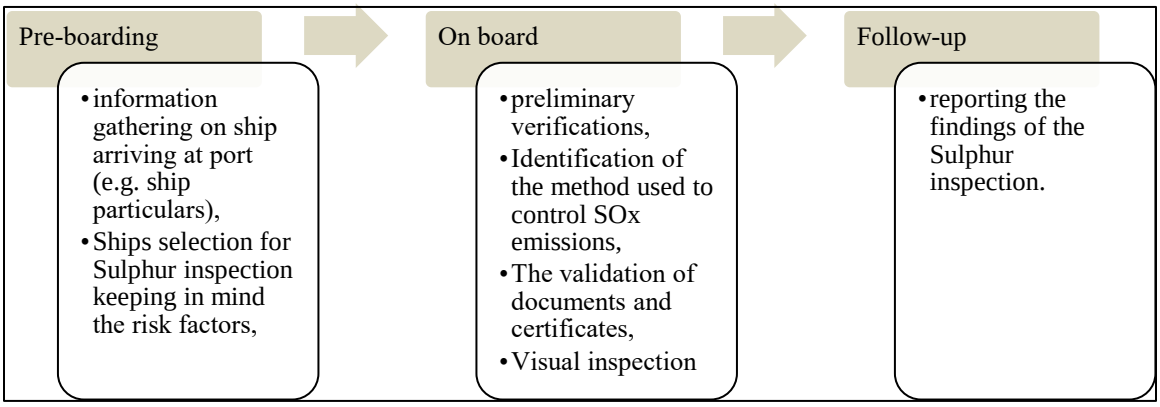

Figure 2. The phases of the Sulphur inspection with actions listed [5]

The PSC main objective is to reduce non-compliant vessels shipping in the waters under the jurisdiction of State and to reduce number of ship accidents [5]. The PSC still remains the most effective control system in the modern world. However, the port state control cannot be applied effectively in all parts of the world due to the differences in funds and lack of trained personnel [13].

3.2. European Union system THETIS-EU for reporting deficiencies and monitoring of ships arriving at port

EMSA (the European Maritime Safety Agency) implemented and hosted the information system "THETIS-EU" (the Hybrid European Application and Inspection System), who used to inspect ships and report inspection results. It informs national PSC authorities which ships are due for an inspection

[5]. Data on ships' particulars, certificates, port calls and reports of previous inspections carried out within the Paris MoU region are provided by the inspection database as well.

All port State control officers (PSCOs) shall inspect the ship's previous inspection report and, if so, how the company and / or the ship has resolved all settings related to its safety management system to assess the company's performance before boarding the ship. During the PSC inspections, the PSCO may assess a deficiency that is identified as a failure, serious failure, or ineffectiveness in the implementation of the ISM Code. If there are unclear deficiencies in the ISM related to the previous inspection and internal audit records cannot be provided after the failure has been identified, the PSCO may detain the ship.

This tool, the European Union system THETIS-EU platform, is used by Port States of 28 EU countries and by Canada, Iceland, Norway and Russian Federation (countries, which signed the Paris Memorandum of Understanding on Port State Control. The information on the results of compliance validations performed by Member States is recorded and exchanged in the system. Thus, the follow-up phase of the Sulphur inspection represents reporting the findings of the Sulphur inspection that have to be added in the system [6, 8].

The system contains in itself all necessary information about the ship and inspections:

1. Ship particulars (incl. Emission abatement methods),
2. Remote sensing measurements (Reporting Member State, date of observation, sulphur content, the place of measurement),
3. Fuel tanks names an their capacity,
4. Combustion machinery and its power,
5. Active and archived alerts,
6. The company responsible for a Vessel's compliance with the ISM Code under paragraph 1.1.2 of the ISM Code,
7. Statutory certificates and their issuing and expiry dates,
8. Bunkering history before inspections,
9. Fuel sampling history,
10. PortCall history,
11. Inspection history,
12. Information on incidents,
13. Observations,
14. Inspector's name and Organization,
15. Outcome of the inspection (compliant/non-compliant, penalty applied or not).

3.3. Compliant fuel availability in ports

In order to comply with the Directive, the Member States of the EU are motivated and encouraged to offer the qualitative and compliant fuel in their ports. As a significant number of ships are not been fitted with exhaust gas cleaning systems that enables the vessels to consume high sulphur fuels in compliance with the Directive, there is increased demand for low sulphur fuel, and prices have risen accordingly. In addition, the concerns have been raised about the quality of some low sulphur fuel blends that can lead to the vessel engine's misfunctioning (e.g. blockage of engine filters and pipes) or increasing the the rate of wear of engine components. The types of bunkers used by ships are provided in the Table 2.

Table 2. The types of products used for ship combustion.

No.	Name	Abbreviation	Sulphur content by mass - % m/m
1.	Marine Gas Oil	MGO	<0,50%
2.	Marine Gas Oil	MGO	<0,10%
3.	Low Sulphur Fuel Oil	LSFO	<0,50%
4.	Ultra Low Sulphur Fuel Oil	ULSFO	<0,10%
5.	High Sulphur Fuel Oil	HSFO	>0,50%

6.	Liquefied Natural Gas	LNG	0%
7.	Biofuels	-	0%
8.	Synthetic and paraffinic fuels	-	0%
9.	Compressed natural gas	CNG	0%
10.	Liquefied petroleum gas	LPG	0%
11.	Ethyl/Methyl alcohols	-	0%
12.	Electricity	-	0%
13.	Hydrogen	H_2	0%

The ideal scenario is when a port can satisfy any ship with the compatible good quality bunkering fuel needed at the reasonable price. Certainly, the States are ought to monitor and control the prices of bunkers because of the commercial interest of suppliers.

If the required bunkering fuel cannot be obtained in the port, the Fuel Oil Non-Availability Report (FONAR) must be completed and submitted to the Flag State and the competent authority of the port of destination. A copy of the FONAR should be kept on board for inspection for at least 36 months. FONAR is an evidence-based paper which allows vessels not to delay or deviate from the intended voyage. The report lists all the details of the voyage and efforts made by the ship operator to get the compliant fuel. The higher cost of compliant fuel is not considered as a valid reason for claiming non-availability. FONAR helps the port states to make the decision if the vessel is allowed to use non-compliant fuel in their ports with/without penalties applied. If the port state is completely satisfied with the efforts made by ship operators as described in the FONAR, the ship may be allowed to use non-compliant fuel without any penalty to the vessel. If not, the port state may allow use with the penalty to the vessel which would depend upon the seriousness of the non-compliance [10].

3.4. The usage of remote measuring equipment

In this day and age, the only legal way to state that the vessel is using the non-compliant fuel and to impose a fine is to present the results of the sample analysis taken on board the ship as said in the Directive. It means that only ISO approved laboratories are trustworthy and other information gained by different methods is considered complimentary to the emssion monitoring activities. However, the two methods such as a portable on board kit for analyzing the fuel samples and the remote sensing equipment (sniffer) measurements are broadly used in real life. The methods serve as a basis for a more detailed inspection. In other words, it calls the ship into question. It was consider this method necessary to be mentioned in relation to management tools of States for monitoring of requirements for enforcement of reducing Sulphur oxides on ships.

Sniffers are gas sensors that are put on the Remotely Piloted Aircraft Systems (RPAS) to measure the amount of SOx by flying into the ship's exhaust gas plume. The sniffers not only register the Sulphur content, but also record the maritime scene by photographic evidence using electro-optical cameras and identify vessels and determine their position using AIS transponder. The RPAS Data Centre is linked to THETIS-EU, a European database used by authorities around Europe responsible for ship inspections. If the emissions measurement taken by the drone reveals a breach in the concentration limit, a subsequent ship inspection may be triggered at the next port of call [5, 6].

Currently, the sniffers are given to the EU Member States in limited quantities upon request for a trial. The deployment is for a minimum of two months. The flight control is managed by qualified pilots from the service provider. The Member State must provide and appropriate take-off/landing are, onsite facilities and support in obtaining the RPAS permit to fly from the national aviation authority [6, 12].

It should be highlighted that the RPAS is multi-purpose in nature and can be used for a range of activities. These include the monitoring and detection of marine pollution including oil spills and litter, vessels and people in distress, as well as the general identification and tracking of vessels of all sizes and their activities including identifying potentially illegal activities (i.e. illegal fishing, drug trafficking, illegal migration, etc.)" [12].

At the moment it is known about at least two sniffers deployed in the EU territorial waters. The first one operates in a specific area north of the Great Belt in Denmark from 1st July to 31st October 2020. The second one is deployed in France's SECA in the part of the North Sea for a period of three months starting on 23rd of September 2020 [5,6,12].

3.5. Monetary penalties

The last but not least management tool that was determined is imposing fines for non-compliance with the Directive. The maximum financial penalties imposed in European countries for violations inside ECA zones in 2015 are presented in the Figure 4.

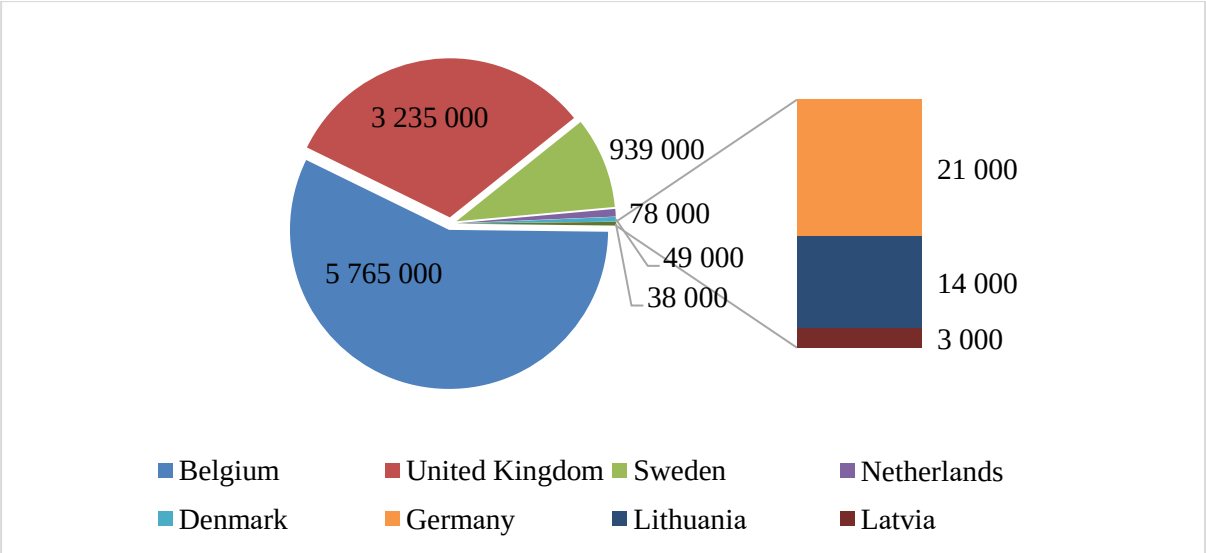

Figure 4. Penalties for non-compliance to SO_x regulations in European countries within SECAs in 2015 (in Eur)

The most fines for non-compliance to SO_x were issued by Belgium (5,75MM Eur), Germany – 3,235MM Eur., while Lithuania – only 14K Eur, Latvia – 3K Eur (Figure 4).

The Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the Sulphur content of certain liquid fuels does not determine the amount of the penalties, but states the following:

- is also necessary for Member States to establish a system of effective, proportionate and dissuasive penalties for non-compliance with the provisions of this Directive.
- Effective, proportionate and dissuasive penalties are important for the implementation of this Directive. Member States should include in those penalties fines calculated in such a way as to ensure that the fines at least deprive those responsible of the economic benefits derived from their infringement and that those fines gradually increase for repeated infringements. Member States should notify the provisions on penalties to the Commission.
- Member States shall determine the penalties applicable to breaches of the national provisions adopted pursuant to this Directive" [8].

4. Analysis of the activities of Latvia and Lithuania for enforcement of reducing Sulphur oxides on ships

As Latvia and Lithuania are located in SECA, the more stringent rules regarding Sulphur content came into force back in January 2015. Therefore, the data starting from that day was obtained through the State Environmental Service of Latvia and the Lithuanian Marine Environmental Protection Inspectorate of Environmental Protection Department under the Ministry of Environment. As the data from the year 2020 is available from January to October, the 2015-2019 data was intended to be chosen

for these months respectively. However, the authors could obtain the detailed monthly information only from Latvian side. Thus, data on Sulphur inspections in Lithuania are given for a period of one year for 2015-2019 and for a period of January-October for 2020.

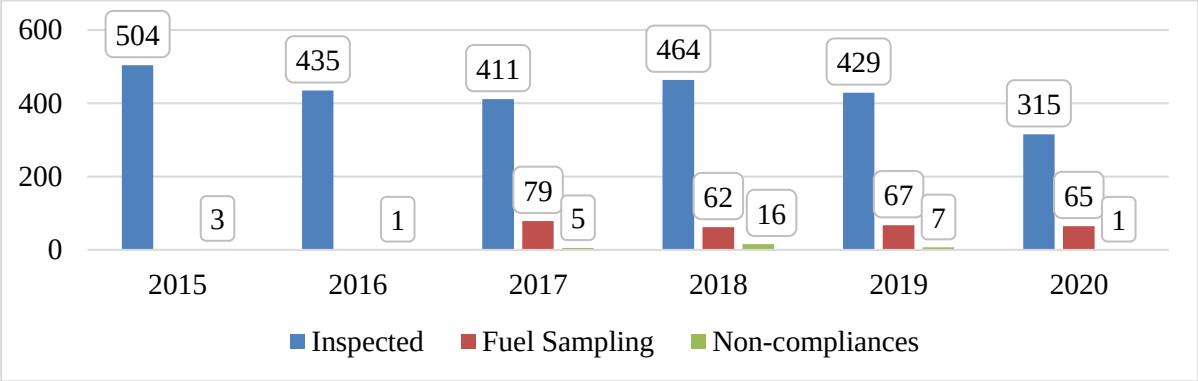

Figure 5. Sulphur inspections statistics from 2015 to 2020 in Latvian ports

The average number of inspections performed in Latvia for the period January-October is 426 with maximum in 2015 and minimum in 2020 (see Figure 5). The average number of fuel samples collected onboard is 17,2% from all inspected ships for the period January-October 2017-2020 with maximum in 2020 (equals 20,6%) and minimum in 2018 (equals 13,3%). The 17,2% is considered as a good performance of the State because the mandatory number of fuel samples taken from ships fuel stated in the Directive is 10%. Therefore, it means that Latvia exceeds the plan by at least 7,2% in average each year. The rise in the percentage of the inspected ships in 2020 may be caused by the new regulations on Sulphur content in marine fuels that entered into force in January 2020. The average number of ships with non-compliances (in documents and in marine fuel) detected for the period 2015-2020 is 1,65% from all inspected ships, which can also be considered as a good indicator for the environment in ports and their surroundings. Even though the non-compliances cannot be predicted, the number of non-compliant ships entering the Latvian ports is descending, dropping to 1 in 2020, making a big step towards achieving sustainability in ports.

It is important to mention that the COVID-19 crisis affected the ports activities in 2020 due to the official lockdown proclaimed by the government of Latvia. Port State Control inspections were suspended for one month. The data regarding the number of inspected ships and fuel samples collected by months is displayed on the picture below (see Figure 6).

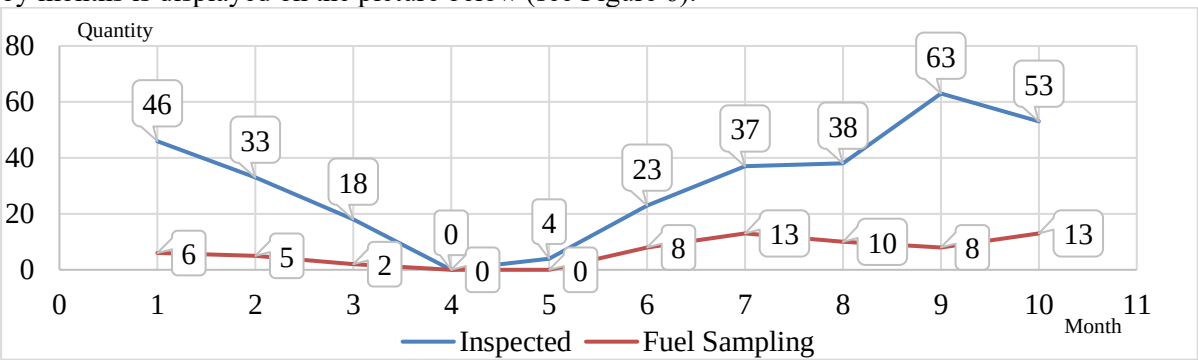

Figure 6. Sulphur inspections January-October 2020 in Latvian ports

The pandemic caused by COVID-19 has impacted the inspection rate drastically as in April there were no ships inspected at all (see Figure 6). The number of inspections recovered quite fast as the restrictions declared by the Latvian government were softened in June.

Lithuanian Transport Safety Administrations inspectors performed in average 135 Sulphur inspections a year in the period of 2015-2020 with maximum in 2019 and minimum in 2015 (Figure 7).

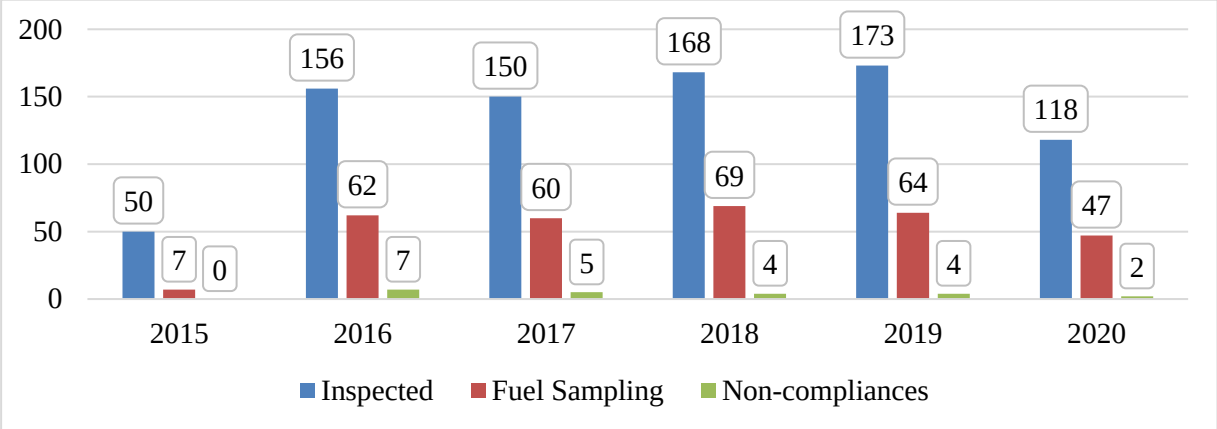

Figure 7. Sulphur inspections statistics from 2015 to 2020 in the Port of Klaipeda

The average number of fuel samples collected onboard for the period of 2015-2020 respectively is 35% from the number of total inspected ships with maximum in 2018 (equals 41%) and minimum in 2015 (equals 14%) (see Figure 7). The 35% is an impressive performance of the State because the mandatory number of fuel samples taken from ships fuel stated in the Directive is 10%. Therefore, it means that Lithuania exceeds the plan by 25% in average each year.

The average number of ships with non-compliances detected in port of Klaipeda for the period 2015-2020 is 2,4% from all inspected ships, which can be considered as a good indicator for the port environment and its surroundings as the number is single-valued.

As in Latvia, the number of non-compliant ships entering the port is descending, dropping to 2 in 2020. However, it should be noted that the number of non-compliant ships fluctuates between numbers 4 and 7 depending on the year with no extreme points meaning that the deleterious environmental impact is pretty much steady.

There are total ten ports in Latvia (Mersrags, Salacgriva, Engure, Pavilosta, Skulte, Lielupe, Riga, Ventspils, Liepaja, Roja) but in only five of them Sulphur inspection is performed (in Riga, Ventspils, Liepaja, Skulte, Salacgriva). The extended data as the distribution by ports was given to the author only for the period of January-October of 2020. On the Figure 8 below the distribution of the Sulphur inspections by ports is illustrated.

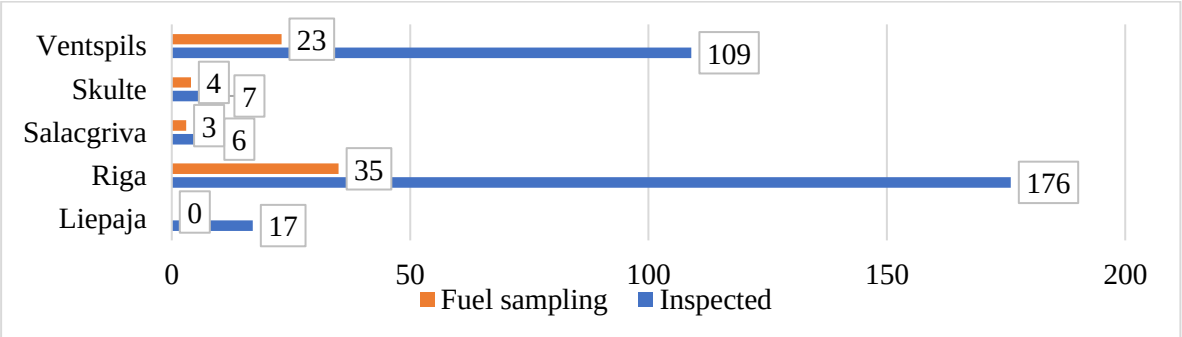

Figure 8. The distribution of the Sulphur inspections in Latvia's port during January-October of 2020

The vast majority of inspections is performed in ports in Riga and Ventspils (see Figure 8), taking up respectively 55,9% and 34,6% of the total inspected ships. Thus, making the ports of Riga and Ventspils the two most productive ports amongst other in terms of Sulphur inspection rate.

Port State control in Latvian ports is performed by the Maritime Safety Inspectorate of the State joint stock company - the Maritime Administration of Latvia. More precisely its division called the Maritime Safety Inspectorate. The Port State control is established in order to prevent the shipping traffic which does not conform to the international standards and to increase the compliance of ships with the requirements of International Maritime Organisation, the European Union and regulatory enactments of the Republic of Latvia in respect of maritime safety, the marine environment protection and seafarers' living and working conditions. The Sulphur inspection is performed by so-called "environmental inspectors", which are not employed in the Maritime Administration of Latvia as other regular Port State inspectors. The environmental inspectors work on behalf of the State Environmental Service (SES) of Latvia -the institution controlling the compliance with the environmental laws and regulations in Latvia under supervision of the Ministry of Environmental Protection and Regional Development of the Republic of Latvia. The goal of the SES is to ensure the compliance of implementation of legislation framework in the area of the environment and natural resources protection, and control on radiation and nuclear safety. The SES has eight Regional Environmental Boards and Marine Environmental Board. The Marine Control Unit, which is responsible for controlling the compliance with Sulphur Directive, is functioning under the Fishery Control Department. The laboratories performing the analysis of the fuel samples for inspection purposes are private, the names are unknown.

In Lithuania the institution performing the Port State control is the Lithuanian Transport Safety Administration (the LTSA). It is the national safety agency of railway, road, civil aviation and water transports. Its goal is to achieve high quality, secure and environmentally aware transport system within Lithuania. Regarding the Sulphur inspection – three state institutions are involved in the process:

- The LTSA inspectors
- Lithuanian Marine Environmental Protection Inspectorate of Environmental Protection Department under the Ministry of Environment (the AAD)
- State Consumer Rights Protection Service (the Service)

The LTSA inspectors (no special position as "environmental inspector" exist, the Sulphur inspection is performed by regular PSC inspectors) choose the ship for inspection, check the documents and perform a visual inspection. If the above is not in compliance with the requirements established by legal acts, the LTSA immediately forwards this information to the AAD and the Service. Sampling of marine fuels to determine the sulfur content belongs to the competence of the AAD. Inspection of samples is under the competence of the Service. The fuel samples are analysed in the Lab ("Naftos Produktų Bandymų Laboratorija"), who is located in the city Šauliai, situated 70 km from Klaipeda port.

During this research was determined the time consumption on each part of the Sulphur inspection management process in the ports of Latvia and Lithuania respectively. This information was obtained from the SES of Latvia and the AAD in Lithuania (Figure 9).

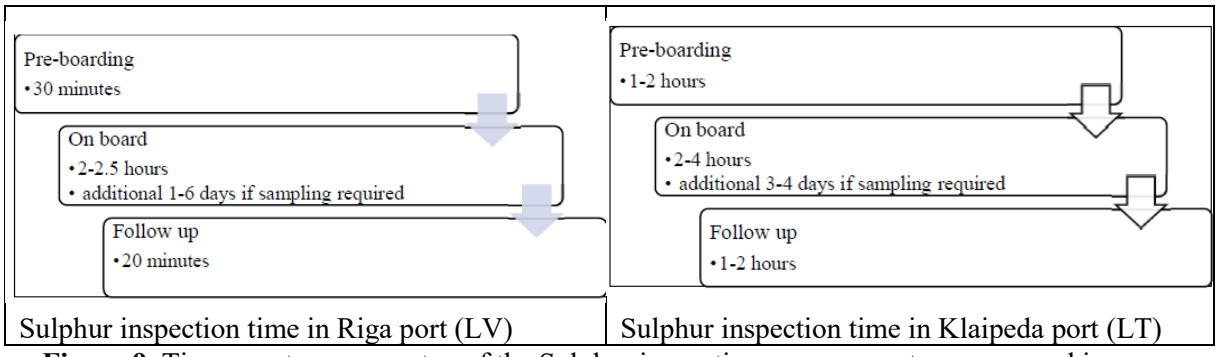

Figure 9. Time spent on every step of the Sulphur inspection management process on ships

The minimum time spent on the complete Sulphur inspection in Latvia is 2 hours 50 minutes (if sampling is done – 1 day 2 hours and 50 minutes), the maximum time is 3 hours 20 minutes (if sampling is done – up to 6 days 3 hours and 20 minutes). It should be noted that the figures are given if one

inspector is on duty. Usually two environmental inspectors perform the Sulphur inspection, thus the total time may be reduced.

The smallest amount of time consumed on the management of Sulphur inspection on ships in Lithuania is 4 hours (if sampling is done – 3 days and 4 hours), the maximum time for Sulphur inspection recorded – 8 hours (if sampling is dome – up to 4 days and 8 hours).

Certainly, these time frames are very approximate because they are affected by different circumstances that are not predictable and are also not preventable, such as:

- Orderliness in the storage of ship documents;
- The crew change just before the inspection (it is more time consuming to collect the
- necessary documents);
- How responsive and knowledgeable in English the crew is;
- Ship size and design;
- Whether the inspectors are on board that vessel for the first time, or have already been (if they have already been, then the time for carrying out the visual inspection is less).

During this research was contacted all Latvian ports authorities in order to gather information about the fuel availability in their ports. Apparently, small ports as Mersrags, Salacgriva, Engure, Pavilosta, Skulte, Lielupe, Roja do not have the bunkering companies in the ports. Therefore, they are forced to bring required marine fuels from the big ports (Liepaja, Riga, Ventspils) using trucks.

In the Table 3 below the information regarding marine fuel availability in the big ports of Latvia and port of Klaipeda is accumulated.

Table 3. Marine fuel availability in the ports of Liepaja, Riga, Ventspils and Klaipeda

Name	Abbreviation	Sulphur content by mass - % m/m	Liepaja	Riga	Ventspils	Klaipeda
Marine Gas Oil	MGO	<0,50%				
Marine Gas Oil	MGO	<0,10%	✓	✓	✓	✓
Low Sulphur Fuel Oil	LSFO	<0,50%	✓	✓	✓	✓
Ultra Low Sulphur Fuel Oil	ULSFO	<0,10%	✓	✓	✓	✓
High Sulphur Fuel Oil	HSFO	>0,50%	✓	✓	✓	✓
Liquefied Natural Gas	LNG	0%				✓
Biofuels	-	0%				✓

According to the regulations adopted by the Ministry of Energy of the Republic of Lithuania, the Ministry of Environment of the Republic of Lithuania and the Ministry of Transport and Communications of the Republic of Lithuania it shall be prohibited to place on the market in the Republic of Lithuania marine fuel with a Sulphur content exceeding 1.5 % by mass and marine gas oils with a Sulphur content exceeding 0.1% by mass (Ministry of Energy of the Republic of Lithuania et al, 2014). The list of marine fuel suppliers and the fuels available on the website of the Lithuanian Transport Safety Administration.

According to the obtained information from the Latvian ports (Table 3), there are only four types of marine fuel out of thirteen possible are available. This is very far from the ideal scenario as not even 50% of fuel diversity is available for ship operators. Therefore, the ports of Latvia can be considered as low-competitive compared to the other major European ports. Latvian bunkering companies explain this situation's ground as poor financial support from the government to build the new bunkering terminals (e.g. LNG). Also, the demand for the other nine types of fuel is almost insignificant meaning that the terminals might not be cost-efficient.

On the other hand, the information available on the Lithuanian Transport Safety Administration website shows that there are six out of thirteen types of marine fuels in Port of Klaipeda (Table 2). Actually, the LNG fuel is not offered for sale to the ships except one plying in the waters of Port of Klaipeda under the Lithuanian flag. The LNG is delivered to this ship by trucks. Therefore, it can be considered that only five out of six marine fuels are obtainable for the ship operators. Thus, still offering

bigger diversity of the marine fuels comparing to the Latvian ports offer on the fuel market, as companies in Klaipeda port additionally sell biofuels to the ship operators. Yet, there is a huge room for improvement in this field for both countries.

The statistics regarding Fuel Oil Non-Availability Reports in the Latvian ports and the port of Klaipeda is positively impressive. There were no cases of registering the FONAR reports in the port of Klaipeda since 2015. The last cases in Latvia were registered in January of 2015 when the regulations concerning 0,1% Sulphur content in marine fuels in SECAs entered in force. The reasons for issuing the FONARs were the following:

- 05.01.2015 in Port of Liepaja due to the bad weather the bunkering company was unable to deliver the fuel to the ship;
- 06.01.2015 in Port of Ventspils the marine fuel with 0,1% Sulphur content was unavailable;
- 09.01.2015 in Port of Riga MGO was unavailable for delivery to the ship.

The penalty system in the maritime sector in Latvia is defined in the "Maritime Administration and Marine Safety Law" issued by the Saeima. According to the sixty fifth section in the ninth Division of the law, firstly, if there are no mandatory documents on board, or if these documents are not approved, registered, completed or not stored in accordance with the requirements established by regulatory enactments, a fine shall be imposed on a legal entity - from fifty to eight hundred and sixty units of fine. Secondly, for the operation of a ship without the mandatory certificates a fine shall be imposed on a legal person-from one hundred and twenty to two thousand eight hundred units of the fine. Thirdly, if ship's hull, mechanisms or equipment do not meet the requirements established by regulatory enactments, a fine shall be imposed on a legal person-from one hundred and twenty to two thousand eight hundred units of the fine. One unit of fine is EUR 5. The minimum and maximum of penalties amounts are presented on the graph below (see Figure 10).

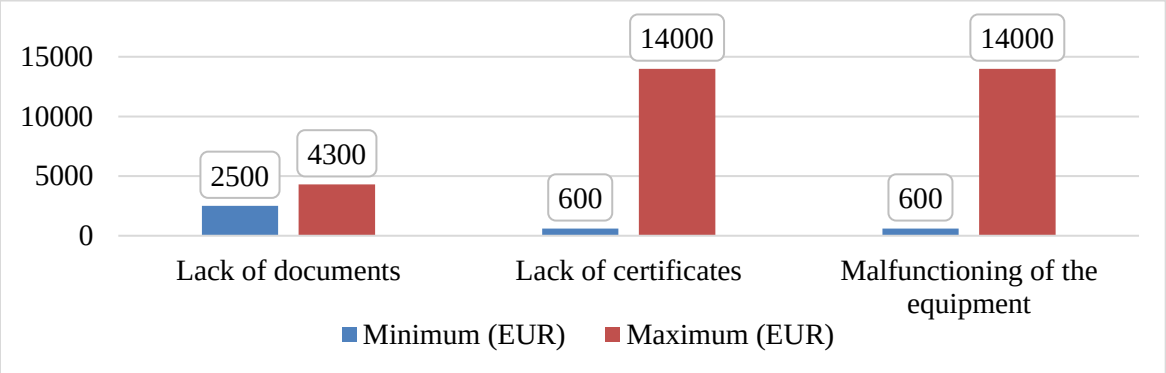

Figure 10. The minimum and maximum penalties imposed on legal person in Latvian ports after incompliances found during Sulphur inspection

The biggest penalty imposed (14K Eur) in the ports of Latvia in the last five years was in October 2018 when the ship consumed 62 tonnes of non-compliant fuel in the SECA (see Figure 10). The smallest penalty was imposed in November 2017 when the inspector found discrepancies in the fuel changeover documentation. The average amount of fine issued regarding the exceeding the Sulphur content limits in the samples taken on board was 2200 EUR. Overall, in the last five years more fines where imposed for the non-compliances detected after the fuel sampling than for the non-compliances found in the ship documents.

On the other hand, the Lithuanian Transport Safety Administration has not imposed any fines while the ship was in the Port of Klaipeda. It means that all cases of non-compliances in marine fuels after receiving the analysis results from the laboratory were communicated to foreign flag states for further investigations. The penalties in Lithuania are drawn in the National Environmental Law Act. The penalties are harmonized with EU, reaching the amount of 220K Eur, depending on violation and vessel installed power.

There isn't the consensus on what the EU sanctions system should look like. According to the representatives of the Latvian SES, the speed of sentencing in Latvia is more efficient compared to others, as administrative fines are imposed and their amount is relatively small compared to other EU countries where sentences are imposed by courts. In this case, the process can take a long time and ultimately no penalty can be imposed. Meanwhile, in the opinion of Lithuanian representatives, a unified system of penalties would help in cases when ships leave the port until the results of fuel analysis are received and discrepancies are identified.

5. Conclusions

Port State control in Latvian ports is performed by the Maritime Safety Inspectorate. The PSC is established in order to prevent the shipping traffic which does not conform to the international standards and to increase the compliance of ships with the requirements of IMO, EU etc. The Sulphur inspection is performed by the environmental inspectors who work on behalf of the State Environmental Service (SES) of Latvia. The Marine Control Unit of SES is responsible for controlling the compliance with Sulphur Directive.

In Lithuania the institution performing the Port State control is the Lithuanian Transport Safety Administration (LTSA). Regarding the Sulphur inspection – three state institutions are involved in the process. Sulphur inspection is performed by regular PSC inspectors.

The average time spent on the complete Sulphur inspection in Latvia is 3 hours therefore in Lithuania average time spent on same inspection is two times longer (6 hours). Certainly, these time frames are very approximate because they are affected by different circumstances that are not predictable and are also not preventable. Usually, two environmental inspectors perform the Sulphur inspection, thus the total time may be reduced.

The activities of the State Environmental Service of Latvia in establishing the compliance with the Sulphur Directive are considered to be executed on appropriate level as the rate of fuel samples collection during inspections is higher than required, the average percentage of ships entering national ports is less than 2%, and the time spent on inspection and imposition of fines may be limited to one day. Certainly, Latvia expresses a great concern in ensuring the compliance with the Directive and better environmental conditions for ports and their surroundings.

Lithuanian Transport Safety Administration's activities for enforcement of reducing sulphur oxides on ships are found to be managed on reasonable degree as the rate of fuel sample collection on board is higher, in average, by ¼ of inspected ships, the percentage of non-compliant ships entering the port of Klaipeda is a single-valued number, inspectors use remote-sensing equipment during inspections, and the choice of the marine fuel is vaster (compared to Latvia in particular). Thus, meaning Lithuania's commitment to the effective management of the Sulphur Directive and all the ensuing measures.

By analysing the five management tools of states for enforcement of the Sulphur directive in Latvia and Lithuania, it is established that all five management tools' effectiveness can be increased in both states. There is a room for improvement in the Sulphur inspection time (especially related to the fuel sample logistics processes), human factor reduction, offered fuel diversity, systems of penalties, introducing of the remote sensing equipment (on drones), implementing portable analysing kits, and financing the emission abatement methods installation on the national ships.

6. Acknowledgement

The article is prepared in the frame at the project "Strategic partnership for supporting Blue Growth by enhancing Maritime Higher Education maritime cooperation framework on marine pollution and environment protection field" (BLUE4SEAS).

The authors also want to thank the Marine Environmental Protection Inspectorate of Environmental Protection Department under the Ministry of Environment of Lithuania, the State Environmental Services of Latvia for providing data used in this research.

7. References

[1] Aksoyoglu, S., Baltensperger, U., and Prévôt, A. S. H., (2016). Contribution of ship emissions to the concentration and deposition of air pollutants in Europe, *Atmos. Chem. Phys*., 16, 1895–1906, https://doi.org/10.5194/acp-16-1895-2016

[2] Buhaug, Ø., Corbett, J.J., Endresen, Ø., Eyring, V., Faber, J., Hanayama, S., et al., (2009). Second IMO GHG Study 2009. International Maritime Organization, London, UK, p. 129

[3] Burns, M. (2015). Port management and operations. Routledge

[4] European Maritime Safety Agency. (2020). *Emission Abatement Methods*. http://www.emsa.europa.eu/main/air-pollution/emission-abatement-methods.html

[5] European Maritime Safety Agency. (2019). *Sulphur Inspection Guidance*. http://emsa.europa.eu/about/items.html?cid=2&id=2407

[6] European Maritime Agency. (2020). *Ship Emissions Monitoring*. The Maritime Challenge. https://www.maritimecyprus.com/wp-content/uploads/2017/09/emsa_rpas-ship-emission-monitoring-1.pdf

[7] Gobbi, G.P., Liberti, L., D. & Barnaba, F. (2020). Impact of port emissions on EU-regulated and non-regulated air quality indicators: The case of Civitavecchia (Italy). *Science of the Total Environment*, 719. https://doi.org/10.1016/j.scitotenv.2019.134984

[8] International Transport Forum. (2016). *Reducing Sulphur Emissions from Ships: The Impact of International Regulation*. https://www.itf-oecd.org/reducing-sulphur-emissions-ships-impact-international-regulation

[9] Ledoux, F., Roche, C., Cazier, F., Beaugard, Ch. & Courcot, D. (2018). Influence of ship emissions on NOx, SO2, O3 and PM concentrations in a North-Sea harbor in France. *Journal of Environmental Sciences*, JES-01487. doi.org/10.1016/j.jes.2018.03.030

[10] Maritime knowledge. (2020). Do you know why FONAR is needed from 2020 and onwards?

[11] Özçayir, D. (2009). The Use Of Port State Control In Maritime Industry And The Application Of The Paris MOU. Ocean & Coastal L.J. https://digitalcommons.mainelaw.maine.edu/oclj/vol14/iss2/4/

[12] SAFETY4SEA. (2020). New aerial drone sniffing sulphur emissions from ships in Denmark. SAFETY4SEA. https://safety4sea.com/new-aerial-drone-sniffing-sulphur-emissions-from-ships-in-denmark/

[13] Yuan, C.C. (2020). Important Factors Influencing the Implementation of Independent Port State Control Regimes. *Journal of Marine Science and Engineering,* 8(9), 641. https://doi.org/10.3390/jmse8090641

[14] Zhang, Y., Loh, Ch., Louie, P., Liu, H. & Lau, A. (2018). The roles of scientific research and stakeholder engagement for evidence-based policy formulation on shipping emissions control in Hong Kong. Journal of Environmental Management, 223, 49-56 https://doi.org/10.1016/j.jenvman.2018.06.008