Optimizing fuel consumption for a sustainable future

MV Seabourn Ovation - Fuel economy of sea voyages 2019

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Abstract

The cruise ship leisure industry attracts thousands of customers every year. Furthermore, the increased interest, popularity, and public awareness of environmental sustainability have brought up significant responsibilities to cruising. The consumption of fuel and related exhaust gas emissions has become a relevant subject, impacting the customer's decision-making soon. Consequently, it is significant to improve and diminish energy consumption.

The thesis examines the reduction of fuel consumption by improving itinerary planning and base it on the vessel's optimal speed. To achieve the objective, actual voyages are explored to demonstrate the fuel economy of route profiles. The study also raises a debate on a topic where future route planning could be changed based on the results of the ship's optimal speed. The primary data analysis was based on data collected from the author's work on the Seabourn Ovation in 2018 and 2019 and historical AIS data. The additional information resulted from the author's observation of the participants and through the action research.

In conclusion, for a better fuel economy to follow the average required speed as closely as practically possible, This would give nearly 10% fuel saving for the propulsion consumption at sea without additional investment. Present voyage reporting has shown to be inaccurate and needs improvement. Additionally, the voyage reporting content should be revised to serve the ship's most economical operation better. There is a great potential for emission reduction and fuel saving by taking economical speed into consideration in itinerary planning. Reducing one knot of annual itinerary speed would save fuel nearly 1000MT annually or 20% of the fuel used for sea passages.

Language: English Key words: Cruise Ships, Fuel saving, Itinerary planning

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Glossary

AAQS	Advanced Air Quality System
A/C	Air conditioning compressor motors
AIS	Automatic identification system
ANN	Artificial Neural network
CO_2	Carbon Dioxide
$DeSO_X$	Flue gas desulfurization of sulfur oxides
DSS	Decision Support System
ECA	Emission Control Area
ECDIS	Electronic Chart Display and Information System
EEDI	Energy Efficiency Design Index
EGCS	Exhaust gas cleaning system
FWD	Forward
GHG	Greenhouse Gas
HFO	Heavy fuel oil
HVAC	Heating, ventilation and air conditioning
IAMCS	Integrated Alarm Monitoring and Control System
IMO	International Maritime Organization
ISO	International Organization for Standardization
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil
MCR	Maximum continuous rating
MEPC	Marine Environment Protection Committee
MFD	Multi-functional displays
MGO	Marine gas oil
PAC	Process Application Controllers
PM	Particulate Matter
SEEMP	Ship Energy Efficiency Management Plan
SFOC	Specific fuel oil consumption

SOG	Speed over the ground
SOLAS	The International Convention for the Safety of Life at Sea
SRtP	Safe Return to Port
STBD	Starboard
STW	Speed through water
SECA	Sulphur Emission Control Area
3D	Three-Dimensional

1 Introduction

Global warming and awareness of the need to reduce carbon emissions add pressure for the companies to improve the operational methods to achieve a sustainable future. In the cruise ship businesses, there is a need to develop new ways to reduce fuel consumption and greenhouse gas production (GHG) onboard the vessels. Additionally, companies need to contemplate their internal and external surroundings, open up for new tendencies, and understand the needs to collaborate within a sustainable future. Over my 30 years of experience in different cruise lines and shipbuilding, commissioning, operation, and power plant and marine applications, I feel motivated to get a coherent understanding of this demand and propose a solution for this disputed point. I feel triggered to research how to reduce fuel consumption and exhaust gas emissions and, consequently, meet the changing and dynamic environment's demands.

Cruising as a holiday choice has grown in popularity in recent decades thanks to increased choice opportunities. Cruises are available for all ages and all types of holiday experiences around the world. By the end of 2018, it has reached the 28.5 million passengers with an economic input of $150 billion globally. (Cruise Lines International Association, 2020) The 38 major cruise line operators with 277 ships in service and dozens of ships under construction represent over 95% of the industry’s capacity. (Cruise Lines International Association 2019)

This popularity and public awareness of environmental sustainability have brought responsibility to the cruise industry. International Maritime Organization (IMO) adopted the International Convention for the Prevention of Pollution from Ships. This widely known MARPOL Convention addresses pollution from the ship by oil, noxious liquid substances, sewage, garbage, or air pollution. (IMO 2018) The cruise line operators have acknowledged the MARPOL Convention and the importance of recycling and minimizing airborne emissions and overboard discharges. The ships have state of the art recycling centers, and overboard discharges are controlled and minimized with the latest technology. Also, shipping companies provide theoretical and practical training to the ship's crew.

The cruising industry commits to following the IMO strategy to reduce carbon compound emissions by at least 40% by 2030 and reduce total annual greenhouse gases (GHG) 50% by 2050 compared to the baseline year of 2008. (IMO 2018) To reach the targets set by IMO, the cruising and shipping industry as a whole is making a substantial investment in developing energy-efficient technologies and switching to cleaner fuels for reducing emissions and environmental impact.

Several cruise ships use LNG instead of HFO, while most ships are equipped with EGCS or have switched over to MGO to minimize particulate matter (PM) and Sulphur emissions. Shipping companies have already introduced many energy-efficient measures, such as minimizing hotel energy load by improving the ventilation economy and reducing the power demand of lighting by using the latest technology or optimizing speed and trim of ship for certain voyages. Many cargo ships have widely adopted slow steaming, by reducing the shipping speed to cut fuel consumption. Large container ships that used to sail over 22-25 knots are now traveling less than 18 knots to cut fuel consumption and CO_2 emissions. (Psaraftis, Kontovas 2014) In the cruise industry, the slow steaming in fuel consumption optimization, considering the most economical load on the engines and optimal speed of the hull, has received less attention.

This research examines the ship's optimal speed while operating at the most favorable load on the propulsion system. The focus is on optimizing the voyage itinerary rather than modifying existing systems and investing in new technologies. Seaborn Cruise Line's newest vessel MV Seabourn Ovation is used as a case study in this thesis.

The chosen cruise line is an ultra-luxury operator that owns five ships sailing worldwide from Northern America to Antarctica and Europe to Asia. Also, a new expedition ship is under construction. Seabourn Cruise Line is part of Carnival Corporation & plc, the world's largest leisure travel company, with a combined fleet of over 100 cruise ships and visiting over 700 ports over the world. (Carnival Corporation & plc 2020)

1.1 Research objectives and questions

The research objectives are to evaluate possible fuel consumption reduction by improving itinerary planning and base it on the vessel's optimal speed. To achieve this, real itineraries are explored to demonstrate current route profiles and determine the cruise's fuel economy curves. According to the author's pre-research results, this has not been considered effectively in the past and, thus, it might present a great saving opportunity without additional system and equipment modification or investment costs. This improved fuel economy would help the operating line reach the CO_2 emission reduction targets set by the IMO. Also, it would improve the profitably of the owner by reducing the fuel costs, which represent up to 10% of the cruise ship's operating expenses. (Véronneau, Roy 2012)

Moreover, it is essential to clarify the difference between voyage speed research where the itinerary, arrival and departure times are fixed, and the other part of research where the itinerary could be modified based on results of a ship's optimal speed. The main research topic is fuel economy optimizing by using itinerary planning.

The following research questions are specified:

1. Could slow steaming improve fuel economy?
2. Is there an impact on fuel economy if the cruise schedule's speed is not followed?
3. How can the collection of historical AIS (Automatic Identification System) data benefit fuel economy?
4. How have the ship's design speed and actual ship's specific fuel consumption been taken to account in itinerary planning?

1.2 Thesis Structure

The introduction of the research is presented in the first chapter. It gives broad background information related to the thesis topic and provides the goal of the research and defined research questions. The second chapter introduces a literature review that targets providing the paramount theoretical framework regarding energy saving in the transportation industry. The third chapter describes the used methodology of research, while in the fourth chapter, the data collected from the vessel automation system and original design from the shipbuilder has been analyzed to determine vessel power and energy usage for specific speeds. The fifth chapter presents an analysis of voyage planning and reporting to compare actual ships AIS data. The sixth and final chapter summarizes the conclusions.

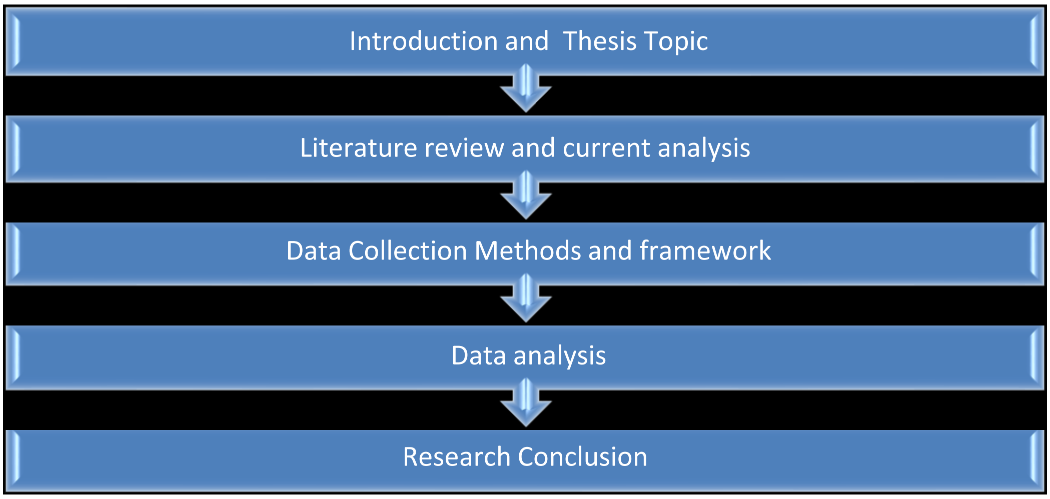


Figure 1- Thesis structure

2 Literature review

Awareness of the impact of air pollution on our environment has increased in recent years. In addition to economic benefits, this has increased the interest of shipowners in finding new ways to reduce ship fuel consumption. Thanks to these activities, literature, and dissertations related to fuel economy and air emissions are widely available.

2.1 Seabourn

Seabourn is a registered trademark of an ultra-luxury cruise line. Its headquarter is located in Seattle, WA, U.S.A. Seabourn is owned by Carnival Corporation & plc. (Seabourn Cruise Line Limited)

Seabourn is offering all-inclusive cruises with a fleet of five cruise ships built between 2009 to 2018. The all-suite ships are carrying 458 to 600 guests each and cruising around the globe. Two new expedition ships are under construction and are expected to enter service in 2021 and 2022. (Seabourn Cruise Line Limited)

2.2 Measures optimizing the operation of the ships to reduce air pollution in the maritime industry

Growing awareness of the negative impact of greenhouse gas emissions (GHG) on global warming has raised the need to find solutions to reduce emissions worldwide. The International Maritime Organization (IMO) has estimated in the Third IMO Greenhouse Gas Study 2014 that international shipping released 796 million tonnes of CO_2 in 2012, representing about 2.2% of the total global anthropogenic CO_2 emissions mentioned year. (Smith, 2015)

Johansson et al. (2017) have presented a comprehensive global shipping emission inventory and ships' global activities for 2015 by using AIS data for more than 300,000 ships. The Ship Traffic Emission Assessment Model (STEAM3) was used for evaluating the ship's emissions while a route generation algorithm was handling the gaps between the AIS data. They have compared results with values reported previously in the 3rd IMO greenhouse gas (GHG) study (Smith et al., 2015) concluding, that by analyzing the AIS data with Emission Assessment Model (STEAM3), the global shipping activities and emissions agree with the reported fuel statistics. Environmental factors such as wave and wind-resistance or sea current, which might increase the required propulsion power, were not considered in the study. However, when taken into account, combining these factors could increase the global annual fuel oil consumption estimated as much as 5% -15%. (Johansson, August 2017)

The Marine Environment Protection Committee (MEPC) of the IMO has been working with technical aspects of GHG emissions and, in 2011, introduced technical measures for the new ships and operating measures for existing ships to reduce GHG emissions. (IMO, 2020) The Energy Efficiency Design Index (EEDI) was introduced to improve the ship's energy efficiency, thus reducing CO_2 emissions from the design perspective, while Ship Energy Efficiency Management Plan (SEEMP) was established for improving energy-saving methods at the operative level. These regulations entered into force on January 1st, 2013. (IMO, 2020)

In 2018, the IMO introduced the following initial strategy on how to reduce GHG emissions from the ships. (IMO, Apr. 13, 2018)

- Carbon intensity of new ship to decline.

- To reduce CO_2 emissions per transport work of international shipping by at least 40% by 2030.

- GHG emissions of international shipping to peak and reduce as soon as possible.

The global shipping is mainly using distilled or residual fuel, known as bunker fuel, while still, a relatively limited number of ships are using liquid petroleum gas (LPG) or liquid natural gas (LNG) as an energy source for the main and auxiliary engines.

From each ton of residual or distilled fuel burned onboard, approximately 3 tons of CO_2 are released into to atmosphere (Phil Ballou, 2008). This relationship between used fuel and CO_2 emissions are described in Table 1. As the CO_2 emissions are directly proportional to fuel oil consumption, the best and most effective way to reduce emissions is the increasing efficiency of the ships and machinery. Besides, reduced fuel consumption reduces cost and increases the profitability of the business. (Phil Ballou, 2008)

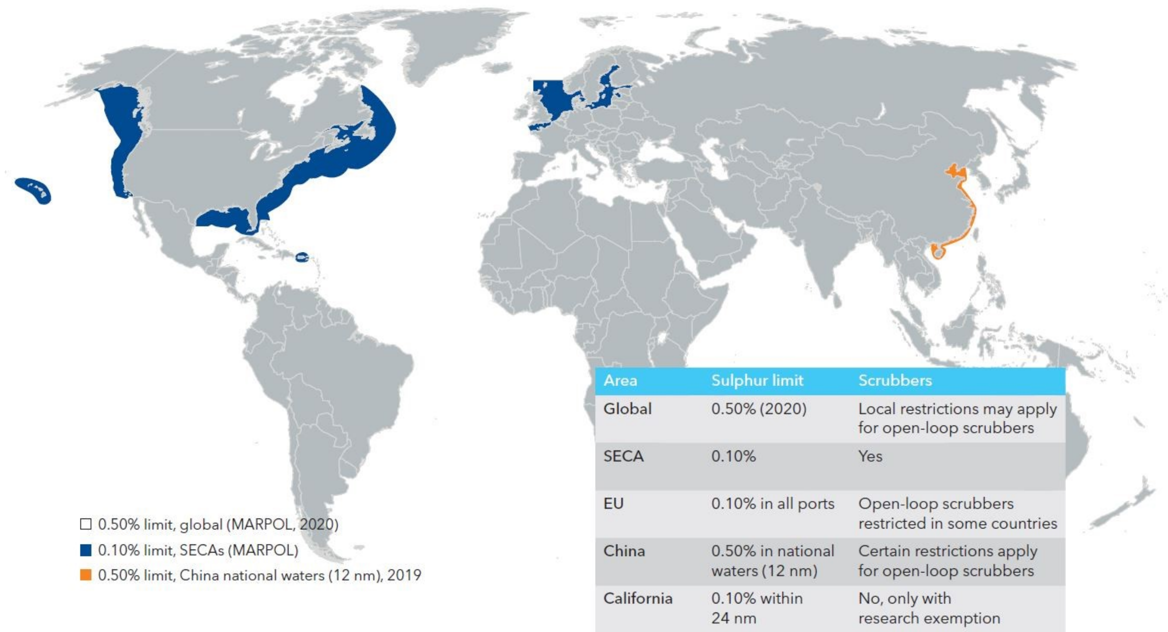
Table 1. Calculation of CO_2 emission in relation to fuel consumption (IMO, Oct. 28, 2016)

Type of Fuel	Reference	Lower calorific value (kJ/kg)	Fuel Carbon Content % by Mass	CO_2: Fuel ratio
Diesel/Gasoil	ISO 8217 Grades DMX through DMC	42,700	87.44%	3.206
Light Fuel Oil	ISO 8217 Grades RMA through RMD	41,200	85.94%	3.151
Heavy Fuel Oil	ISO 8217 Grades RME through RMK	40,200	84.93%	3.114
Liquid Petrol Gas (LPG)	Propane	46,300	81.82%	3.000
	Butane	45,700	82.64%	3.030
Liquid Natural Gas (LNG)		48,000	75.00%	2.750

Effective ways of reducing fuel oil consumption and associated GHG emissions by technical and operational measures have been studied in the 2000 IMO report. (IMO, 2000) The study included technical measures such as designing the new building ships, fuel improvements of the machinery, hull and propeller maintenance and operational measures such as fleet planning, trim optimizing, weather routing, and voyage and speed optimizing.

The study concluded that the most effective and imminent way to reduce fuel oil consumption and GHG emissions was to reduce the ship's speed. According to report, a 10% speed reduction would reduce 23% of CO_2 emissions and by reducing speed even more, to 20% would reduce the CO_2 emissions close to 50%.

As a continuing effort to reduce SO_x emissions, the new global 0.5% Sulphur gap has entered in force in January 2020. The stricter 0.1% Sulphur limit has already been in place for several years in Emission Control Areas (ECA) (Figure 2.) in the North Sea, the Baltic Sea, coastal areas of 200 nautical miles offshore of North America including Hawaii, St. Lawrence Waterway and the Great Lakes, and the USA Caribbean Sea area and 0.5% Sulphur limit in the coastal area of China. (IMO, 2020)



Area	Sulphur limit	Scrubbers
Global	0.50% (2020)	Local restrictions may apply for open-loop scrubbers
SECA	0.10%	Yes
EU	0.10% in all ports	Open-loop scrubbers restricted in some countries
China	0.50% in national waters (12 nm)	Certain restrictions apply for open-loop scrubbers
California	0.10% within 24 nm	No, only with research exemption

Figure 2. Regulatory overview of global fuel Sulphur limits (DNV GL, 2020)

Because the SO_x emissions are directly linked to the fuel burned, this gives several options for shipping companies and owners on how to achieve the required SO_x regulation.

According to DNV GL (DNV GL, 2020), the most comfortable option is switching over from high-Sulphur residual fuel oil to distillate fuel oil, Marine Gas Oil (MGO), or Marine Diesel Oil (MDO). This will significantly increase the fuel cost expenses and might require upgrading the existing fuel oil treatment and handling system onboard due to lower viscosity and flashpoints.

An alternative option is to use new compliant low-Sulphur fuel with a Sulphur content less than 0.5%. Based on the DNV (DNV GL, 2020) report, this is a cheaper option than distilled fuel usage, but it might increase the non-compatible fuel issues, which increase the importance of proper fuel treatment prior usage. Topali et al. (2019) pointed out that these two options will not require expensive significant modifications for the engines where the fuel is intended to be used and makes it an appealing option. (Dimitra Topali, April 2019)

Installing exhaust cleaning systems (SO_x scrubbers), which allow continuing using high Sulphur residual fuel (HSFO), requires significant capital investment. The engine itself will not require modification, but installing a scrubber tower with related piping, pumps with control, and monitoring systems can be challenging, especially in ships with limited space available. The system usage's increases fuel consumption on board by 2% - 3%, thus increasing GHG emissions. Depending on the system's operating principle, open-loop, closed-loop, or hybrid, it might require relatively high consumption of chemicals and sludge handling. (DNV GL, 2020)

Linstad et al. (2017) have studied that the continued use of high Sulphur fuel with scrubbers installed will be the most attractive option for larger ships with higher fuel oil consumption, while distilled fuel will be an attractive option for smaller ships. With higher speed, the fuel oil consumption and CO_2 emissions increase, but due to the high fuel price difference between high Sulphur fuel and compliant fuel, this will encourage utilizing scrubbers with high capital investment in order to benefit it most. (Lindstad, December 2017)

As an alternative fuel option to the new building vessels, LNG has become a more attractive option due to available technology and supporting infrastructure, such as refueling facilities. The LNG usage reduces of GHG by 10% to 20%, depending on the technology used. However, due to LNG systems' complexity of and differences in comparing fuel feeding systems in HFO fueled ships, retrofitting LNG to the existing ships is not the most attractive option. (DNV GL, 2020)

With distilled fuel or low Sulphur fuel as an option, the high fuel price would encourage speed reduction and slow steaming. According to a source (IMO, 2020), reducing the speed by 10% would reduce 23% of the CO_2 emissions. In contrast, the higher speed due to scrubbers' usage would increase the CO_2 emissions and push the GHG targets ever further away.

Concerning the compliance options available for reducing SOx emissions, Smith et al (2015) has highlighted in GHG 3 Executive summary that the carbon content of all types of fuels is invariable thus, CO_2 emissions are not affected by Sulphur content nor the type of engine used.

The specific fuel oil consumption (SFOC) is proportional to the engine load, as the engines are at the most fuel-efficient at about 75% to 85% load (equation 7. and figure 14.) and thus have a direct effect on CO_2 and NOx emissions. For this reason, the MARPOL Annex VI NO_x emission Tiers indirectly regulates the slow steaming of the ships. (Smith, 2015)

As noted by Topali et al. (2019), the level of compliance with the Sulphur gap is difficult to regulate and monitor, especially at high seas as the most of the enforcement methods are possible to carry out at port or nearby port and coastal water by conducting ship visit or airborne monitoring measurement.

Improving the situation, IMO at MECP 73 has banned the ships without scrubbers to carry non-compliant fuel. The so-called "carriage ban" policy was adopted on March 1st, 2020. The policy intended to help the port state control (PSC) identify the illegal usage of non-compliant fuel without proofing the fuel's actual usage. (Dimitra Topali, April 2019)

The selected method of complying with Sulphur cap 2020 will influence the transportation competition regarding the maritime market situation. Fuel-efficient vessels are expected to be more competitive due to lower fuel consumption, while vessels equipped with scrubbers have a clear advantage of using cheaper fuel, which compensates the operating cost difference due to higher fuel consumption. It has also been expected that the ships with exhaust gas cleaning systems installed will be able to secure premium charter rates as a result of the ability to use cheaper fuel. (DNV GL, 2020)

Raza et al. (2019) have studied the slow steaming as an option complying with Sulphur gap regulation in RoRo and RoPax segment in the Baltic sea. Due to high competition with alternative transportation modes, slow steaming has not been an option with most of the RoRo and RoPax operators. The increased fuel costs due to compliant fuel usage is partly transferred to the customers via an increased Bunker Adjustment Factor and partly handled by the ship operator/owner.

2.3 Energy saving development in global shipping

Ballou et al. (2008) have been studying different ship operating methods, including route optimizing, constant speed of the vessel, constant RPM of the propeller shaft, "sprint-and-loiter," and intelligent speed management. Ballou has noticed that one of the most common operation practices is so-called "sprint-and-loiter," where the ship is sailing at high speed and slows down for the final part of the ship voyage, ensuring arrival planned time. As per Ballou, this is likely to result in the most inefficient way of operating the ship in terms of fuel oil consumption.

In the past few years, numerous computerized voyages optimizing program providers have entered the market. These programs offer intelligent speed and route management that can significantly reduce the operating costs, fuel oil consumption, and related GHG emissions while maintaining the ship's original schedule. (Phil Ballou, 2008) The programs calculate the most optimal route based on weather information such as wind speed and direction, wave height and direction, current speed and direction while taking into account the trim of the ship and load and torque of the shaft line.

Chaal (2018) examine the use of voyage modeling in decision support systems (DSS) to find the most fuel-efficient way of operating the ship. The author is employing Artificial Neural networks (ANN) to find the most optimal parameters for the vessel's economical operation. The article confirms that optimizing the vessel's speed is the most effective method of reducing fuel consumption. At the same time, it can be challenging to utilize due to fixed schedules regarding port visits. Chaal highlighted trim optimizing as an alternative way of reducing fuel consumption efficiently with the existing ballast system. Chaal concluded that voyage modeling in decision support systems (DSS) has a lot of potential and could be modified and used widely in different types of merchant vessels.

Rehmatulla, Hosseinloo et al. (2015) have noticed that many energy-saving technologies for the shipping industry are available. However, the implementation of technology across the industry has not been studied. With operational measures, and technical solutions, energy consumption and ultimately CO_2 feasibly reduced. The authors surveyed the implementation of energy-efficient technologies over 270 shipping companies. The article concluded that bulbous bows, pre- and post-swirl devices, lowering the design speed, upgrading engines, and de-rating of the propulsion engine are the most adopted energy-saving methods.

Wang, Mao et al. (2019) have proposed using a three-dimensional Dijkstra’s optimizing algorithm to generate the most fuel-efficient voyage plan. The paper confirms that this model can generate an optimal route plan by minimizing the effect of harsh sea conditions such as wind, waves and current resistance. The authors estimate that the three-dimensional Dijkstra’s optimizing algorithm reduced fuel consumption at least 5% in an analyzed case study. According to the article, the Dijkstra algorithm is best optimized during long sea voyages due to limitations in the method such as shallow water, land crossing, and significant speed changes. As a result, this model may not bring the desired savings in coastal or heavily trafficked areas where speed or considerable course changes might occur.

Wang, Helong et al. (2020) have studied more complex voyage optimizing algorithms like the 3D Isochrone method, improved Isochrone method, and multi-objective approaches. Wang has noticed that the programs’ computation efforts have dramatically increased to perform voyage optimizing and leading to unacceptably long waiting time by program users onboard. Due to this reason, weather routing providers are mainly implementing two-dimensional optimization algorithms for a ship’s voyage planning. (Helong Wang, 2020)

Wang has pointed out that many uncertainties might result in more unsure voyage planning. The Metocean data forecast, which accuracy reduces dramatically after 3 to 5 days, together with unsure ship's performance parameters creating very complex voyage optimizing algorithms proposals. According to Wang, in certain situations the voyage optimizing program might generate an ideal route by deviating significantly from the shortest route (great circle) to avoid bad weather conditions several days ahead of the ship. However, due to large uncertainties related to the Metocean forecast and the ship's performance parameters entered to the calculations, the suggested optimal route might end up being longer and more expensive than the great circle route. For this reason, great circle speed optimizing might give better results in terms of fuel-saving.

Regarding uncertainties of ship's performance parameters, the most accurate way would be to use the ship's full-scale energy performance measurements at sea. However, unfortunately, such measurements are rarely available for such purposes. According to Wang, the case study with full-scale measurements when sailing in the North Atlantic east and westbound voyages shows the uncertainties associated with the voyage optimizing program, when using two different speed-power voyage models. Mentioned conjectures are correlated with metocean forecast, ship fuel oil consumption model and optimization methods. (Helong Wang, 2020) During discussed North Atlantic voyages, the fuel oil consumption along the optimized routes can vary 4 to 10% due to model uncertainties.

Wang states that today's trend to use slow steaming, often about 30 to 50% of maximum continuous rating (MCR), affects ship's voyage optimization and can ultimately give the best fuel saving results. However, the ship's engine and propeller performing most efficiently when running with design service speed. When slow steaming, the specific fuel oil consumption (SFOC) can be significantly higher than when running with service speed. This is not the case with multi-engine installations such as cruise ships with diesel-electric propulsion, where the ship's speed can be reduced significantly without compromising SFOC by reducing the number of running engines.

Simonsen et al. (2018) have estimated fuel consumption associated with cruise ships sailing Norwegian waters regarding GHG emissions. Simonsen et al claimed that cruise ships have some flexibility regarding speed and weather routing, which impact fuel oil consumption. They have also noticed that the hull and propulsion design and condition significantly contribute to emission reduction. The underwater hull's shape, low friction antifouling coatings, and propeller polishing can significantly reduce fuel oil consumption.

Nowadays, typical for cruise ships, diesel-electric propulsion can maintain a higher load of individual diesel generator sets than ships with separate main and auxiliary engines. For instance, during maneuvering when the bow and possible stern thrusters are running, the main engine load might be relatively low compared to the auxiliary engines' load. In diesel-electric installations, the electrical power for all loads, including propulsion and thrusters, is produced by diesel generator sets. Most of the modern cruise ships have the possibility to connect to shore power (cold ironing) and stop all diesel generators while alongside, reducing the ship's emission. However, not many ports have the facility yet to connect ships to shore power.

3 Methodology

In this chapter, the researcher explains how data was collected and analyzed. The researcher not only describes how data was acquired but also why they were collected. Furthermore, in this chapter, the author justifies the chosen methods to investigate the research topic.

3.1 Research Approach

The research's author has been working within the shipping industry for over 30 years. Consequently, primary data was based on the data collected throughout the author´s work onboard the vessel Seabourn Ovation during 2018 and 2019. As a consequence, the researcher acted as a participatory action researcher. (Lawson, 2015, pp. 1-34) As the author's impressions experienced through the research process and his career experience were crucial to determining the need for a deeper understanding of the measurements used in practice in the mentioned cruise line. Action Research strategy objective is to acquire practical knowledge by identifying issues. Additionally, the aim is to develop real solutions, plan, act, and improve organizational learning. (Saunders, Lewis, & Thornhill, 2007, pp. 282-285)

The quantitative analysis was a prerequisite to ensure the in-depth understanding of the research purpose, which is to provide a solution for the company´s fuel economy onboard the passenger cruise ships at Seabourn Cruise Line, by taking into consideration numerical values and systems. This research has been conducted by following a deductive approach, as the study is based on existing theories.

3.2 Data collection

The research methodology is determined according to the data gathered throughout the analyzed data from the Seabourn Ovation.

A bottom-up approach was used to collect and analyze vessel automation system data and original design data from the shipbuilder to determine vessel power and energy usage for specific speeds. Further, the voyage planning and reporting data of sea voyages from December 4th, 2018 till December 1st, 2019, were analyzed with material collected from AIS data. Finally, the analyzed technical parameters and measured data of the ship were processed together with the voyage data from reported data sources (Voyage planning and reporting) and measured data sources (AIS data) to answer to research questions. This approach is illustrated in figure 3.

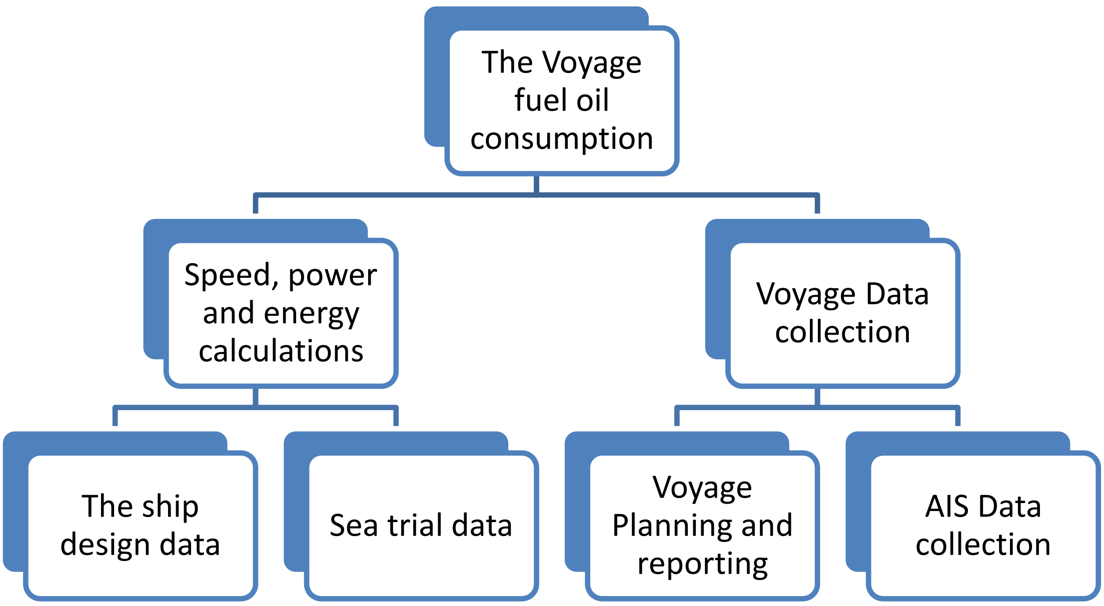


Figure 3. The bottom-up approach for voyage fuel oil consumption analyzing

4 Performance of the ship

The example ship is a typical, modern, purpose-built cruise ship. Environmental considerations and minimum fuel consumption have already been taken into account in the design phase of the ship. The hull of the ship has been designed at a lower service speed than its predecessors a decade earlier, and many energy pollution measures have been a reality since the ship was commissioned.

4.1 The ship designs

The MV Seabourn Ovation, hull number H 6258, was built by Fincantieri S.p.A, Sestri Ponente, Italy, for Seabourn according to ship specification agreed by the builder and buyer. The delivery of the vessel was on April 30, 2018.

The ship's service speed is 15kn with a 6,53m draught with 5650kW propulsion power while the maximum speed at 100% propulsion load would be 18.6kn. (Fincantieri S.p.A, 2015) The ship’s main particulars are illustrated in table 3. The vessel accomplishes the requirements of SOLAS Safe Return to Port with the following conditions as described in the table 2.

Table 2. Seabourn Ovation – The SRtP conditions

Ship’s speed	6 knots
SRtP range	1200 NM
Sea condition	Beaufort 8

Table 3. Design dimension of hull #6258, Seabourn Ovation (Fincantieri S.p.A, 2015)

Fincantieri H.6258 SHIP SPECIFICATION 5th June 2015

1.8 - MAIN PARTICULARS

1.8.1 - DESIGN DIMENSIONS

Gross tonnage, international	abt.	41,700	GRT
Length, overall	abt.	210.5	[m]
Length, between perpendiculars	abt.	177.1	[m]
Breadth, hull (mld.)		28	[m]
Breadth, maximum (deck 11 level - Bridge Wings)	abt.	34.8	[m]
Draught, design from Base Line (mean, moulded)		6.57	[m]
Draught, maximum from Base Line		6.80	[m]
Deadweight at 6.57 m draught		3,500	[tons]
Maximum Air draught, from Base Line	abt.	46.5	[m]
Height to bulkhead deck, deck 3 (mld.)		8.80	[m]
Height to deck 9 (mld.)		26.95	[m]
Height to boat deck, deck 5 amidship (mld)		15	[m]
Propelling continuous service output (S1)		2 x 6,000	[kW]
Installed diesel engine power (MCR)		23,040	[kW]
Service speed at draught of 6.53 m with electric motors developing 5,650 kW		15.0	[knots]
Trial speed at draught of 6.53 m with electric motors developing 12,000 kW (100%)		18.6	[knots]

The ship is equipped with a diesel-electric propulsion system with two fixed pitch, five-blade propellers. Four diesel generators each with maximum output of 5760kW drive alternators feeding the 6.6kV main electrical network. The table 4 below shows the specifications for power generation and propulsion equipment.

Table 4. The specification of ship's power generation and propulsion equipment

Main Diesel Generator sets	
Manufacturer:	Wärtsilä
Number of sets:	Four
Model:	12V32D, IMO Tier 2
Maximum power:	5760KW
Speed:	720rpm
Mean Effect Pressure:	24.9bar
Alternator	
Manufacturer:	VEM Sachsenwerk GMBH

Number of sets:	Four
Model:	DRKSX-1032-10WSA
Type:	3-phase synchronous
Voltage:	6600V, 3-phase, 60Hz
Capacity/rating:	5760kW, 6920kVA
Shafting and propellers	
Number of propeller shafts:	Two
Propellers:	Two fixed pitch and five blade propellers
Manufacturer:	Wärtsilä
Propulsion Motors	
Manufacturer:	VEM Sachsenwerk GMBH
Type:	DTMSZ 2555-16YS
Rated power:	6000kW
Voltage:	2*2850V
Stator current:	668A
Speed:	0-133 rpm

Diesel generators #1 and #2 are located on the forward engine room, and diesel generators #3 and #4 are located on the aft engine room. All engines can use either residual fuel (HFO) or distilled fuel (MGO, LFO). As well, all four engines are equipped with water-fuel emulsifiers that reduce the NO_x and PM emissions of the exhaust gases. Also, both engines in the aft engine room are equipped with an Advanced Air Quality System (AAQS) for reducing exhaust gas SO_x emissions. Both $DeSO_X$ towers are open loop, wet type units, and comply with all IMO requirements.

Since the 1st of January 2020, the global upper limit of fuel Sulphur content was reduced to 0.50%. The two aft engines can continue burning residual fuels available in global markets. In comparison, the other two engines located in the forward engine room are forced to use residual fuels less than 0.50% content of Sulphur. Alternatively, to meet the Global Sulphur Cap, the forward engines can use more expensive MGO/LFO with less than 0.50% content of Sulphur.

For improved redundancy, both engine rooms are equipped with independent fuel conditioning modules (See figure 4). These modules maintain sufficient pressure in the fuel oil system, controlling and maintaining paramount viscosity of different grade of fuel and measuring consumed fuel with flow meter.

The flow meters are Coriolis type flow meters, which measuring principle operates independently of physical fluid properties such as viscosity or density with an accuracy of 0.15% of mass or volume flow of liquid. (Endress + Hauser, 2013)

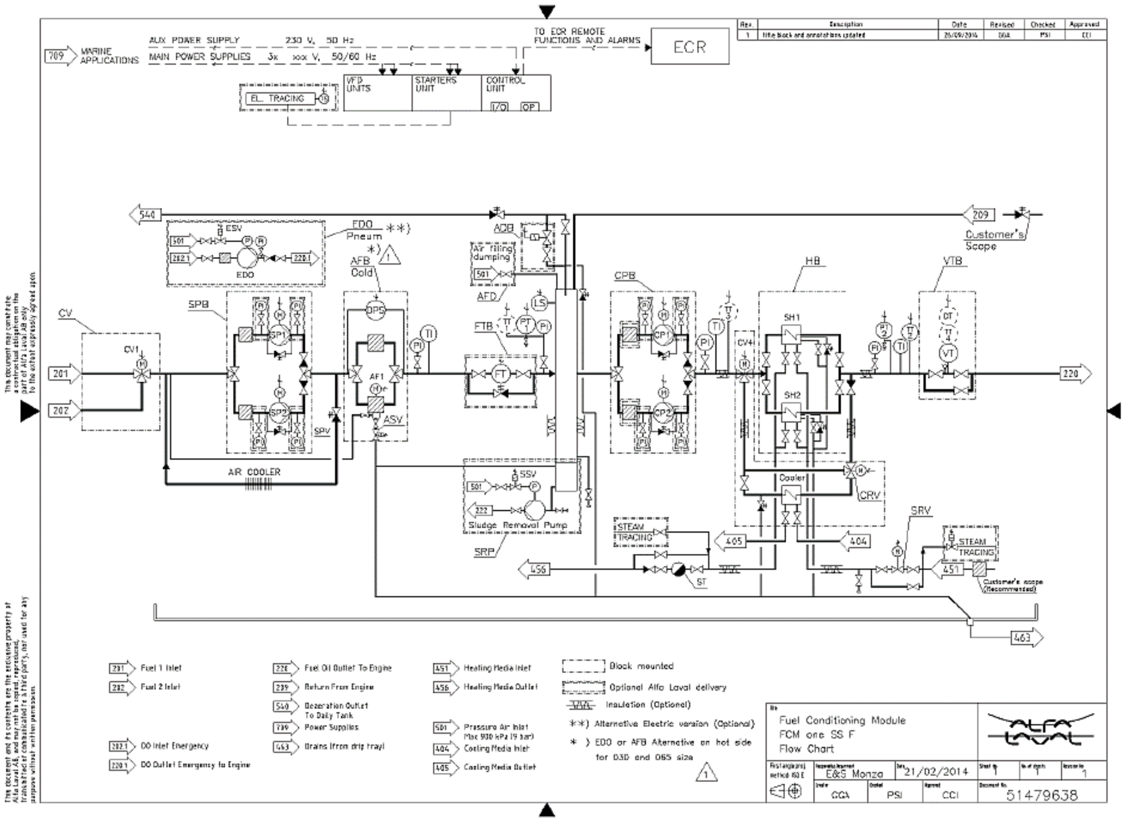


Figure 4. Fuel Conditioning Module (Laval, 2015)

The electrical power produced by four diesel generators is fed to the 6.6kV distribution system. Generators #1 and #2 supply power to the forward main 6.6kV switchboard while generators #3 and #4 supply power to the aft main 6.6kV switchboard.

In order to achieve greater system redundancy, Safe Return to Port (SRtP) SOLAS requirements for passenger vessels have been implemented. At Seabourn Ovation, some of these requirements have been implemented by feeding the high voltage consumers from different main 6.6kV switchboard as described in table 5 below.

Table 5. SRtP redundancy of high voltage consumers

Unit	Feeding
Propulsion motor, Port	AFT main 6.6kV switchboard XA/872B
Propulsion motor, STBD	FWD main 6.6kV switchboard XA/872A
Bow thruster #1	AFT main 6.6kV switchboard XA/872B
Bow thruster #2	FWD main 6.6kV switchboard XA/872A
Stern Thruster #3	AFT main 6.6kV switchboard XA/872B
Stern thruster #4	FWD main 6.6kV switchboard XA/872A
A/C #1	FWD main 6.6kV switchboard XA/872A
A/C #2	AFT main 6.6kV switchboard XA/872B
A/C #3	AFT main 6.6kV switchboard XA/872B
A/C #4	FWD main 6.6kV switchboard XA/872A

Under normal operating conditions, these two switchboards are connected to a common bus which will then feed all high voltage consumers like a propulsion system.

The main 6.6kV switchboards (Figure 5) are supplying power to the 690V engine room substations via transformers. The engine room substations are supplying power to engine room equipment and the galley, mooring, and accommodation substations and laundry 440V and 230V distribution panels.

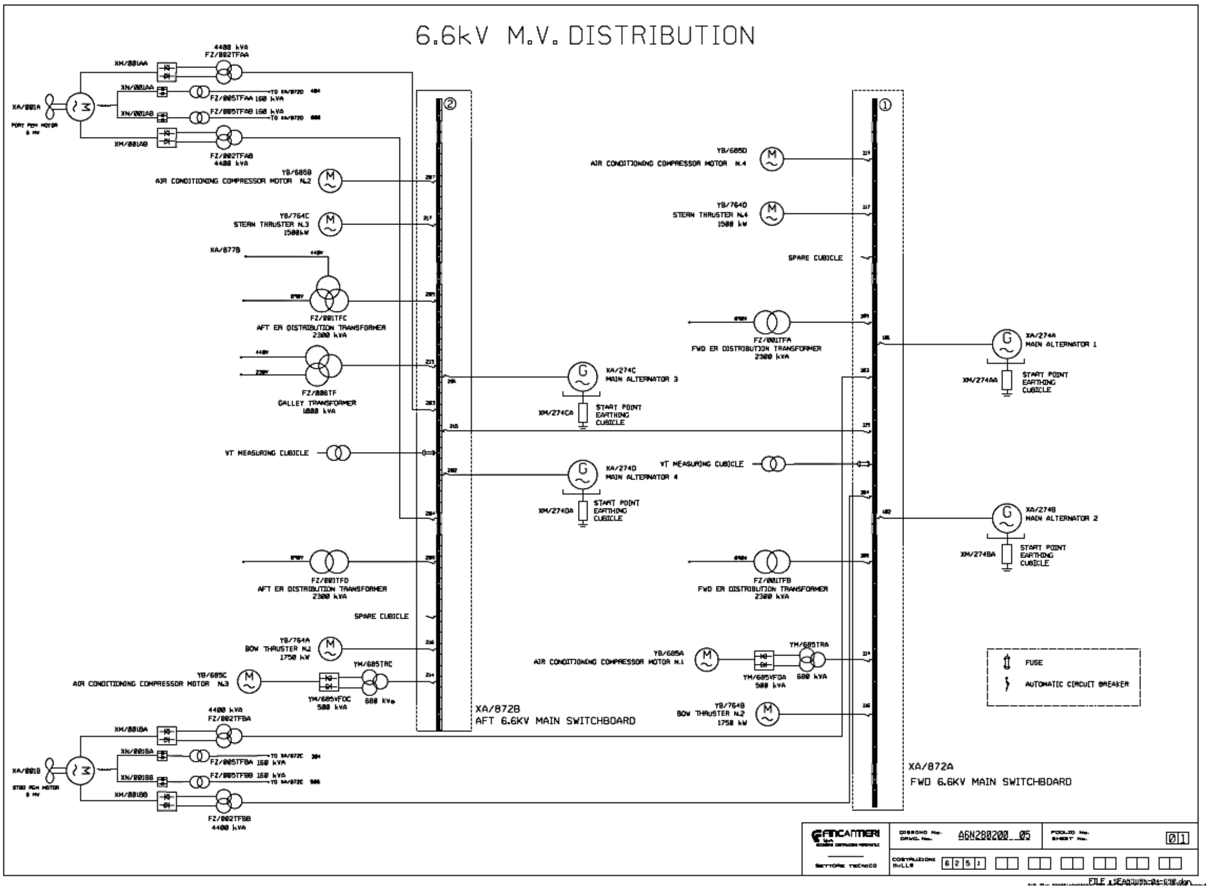


Figure 5. 6.6kV M.V Distribution (Fincantieri S.p.A, 2014)

The main propulsion system consists of two shaft lines with fixed pitch, five-blade propellers. The shaft lines are connected via thrust bearings, without reduction gear to the speed controlled, synchronous propulsion motor. The system is split into two identical systems with the port and starboard shaft lines.

Each propulsion shaft line consists independent systems described in table 6.:

Table 6. Systems of the individual propulsion shaft line

Unit	Number of units
Propulsion transformers fed from 6.6kV main switchboard	2
Synchro-converters supplied by a dedicated propulsion transformer	2
One 6.0MW brushless synchronous propulsion motor, with two 3-phase windings	1
Independent remote-control systems	2
Excitation transformers	2
Pre-magnetization transformers	2

4.2 Monitoring and collection of data

The Wartsila Valmatic Platinium Integrated Alarm Monitoring and Control System (Figure 6) IAMCS monitors and collects information of all machinery on board such as propulsion power, propulsion shaft speed, total consumed power, number of engines connected to the network, and engine load.

Figure 6. Wartsila Valmatic Platinium - Integrated Alarm Monitoring and Control System (IAMCS)

The system starts, stops, and regulate loads of the units automatically or manually depending on the operator's preference. For instance, it can synchronize the generators, control the breakers, and reduce or trip the load automatically when needed. (Wärtsilä, 2016) The system consists of Multi-functional displays (MFD) and operator stations from were all controlled and monitored values can be controlled, and operated. As well, the Process Application Controllers (PAC) of the system are connected together by using fiber-optic communication network. (Wärtsilä, 2016) The integrated alarm monitoring and control system (IAMCS) shows a graphic picture of all alarms and set points in the operator station. (Wärtsilä, 2016) And further, the electronic alarm list and event list are displayed and controlled from the operator station. These electronic lists are approved by classification society and the hard copy printed lists are no longer required.

The Neptune software platform collects data onboard and replicates it into the Neptune Data warehouse located in shore-side for analysis and real-time monitoring. The system is designed to collect and feed the data continuously from the ship. The NDC (Neptune Data Collector) is integrated with different data sources onboard. The shore-side data receiver collects information from the ship storing and processing. (Costa Crociere s.P.a., 2019)

The Neptune Collector illustrated in figure 7, collects information related to the safety and navigation of the ship, such as the safety level of route plans, the actual position and status of the ship (AIS), and weather and sea state conditions. (Costa Crociere s.P.a., 2019)

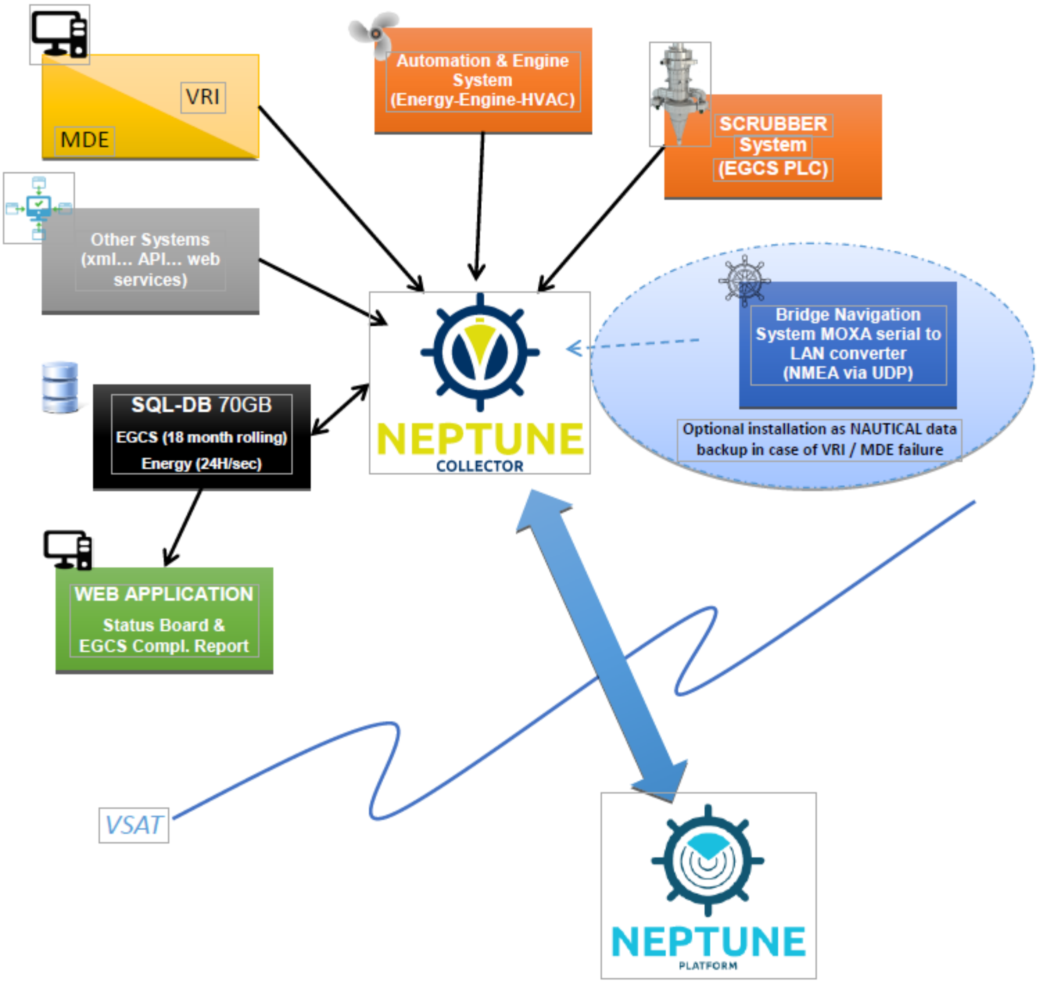


Figure 7. Neptune data flow layout (Costa Crociere s.P.a., 2019)

Also, essential information about energy consumption and efficiency of the hotel and power plant, are collected including automation and operational data from different sources such as:

- AAQS (Advanced Air Quality System) previously called Scrubber systems.
- Engine monitoring systems
- Energy efficiency, SFOC (Specific Fuel Oil Consumption) data
- HVAC (Heating, Ventilation, and Air Conditioning) systems

Data collected to Neptune Collector is then replicated to Neptune Data warehouse, where the data is being analyzed and stored.

The Neptune Data gives advantages to control efficacy, and business analysis to achieve energy-saving goals, low emissions and systems availability. (Costa Crociere s.P.a., 2019)

4.3 Calculating the ship's speed and fuel economy

The ship has been built as per ship specification agreed by the builder and buyer. The ship's purpose, operating environment, energy balances, service speed, and maximum speed has been agreed upon. The shipyard further assures the delivery of a certificate issued by the Classification Society, confirming the ship's Energy Efficiency Design Index (EEDI).

The contractual speed trial for calculating the Energy Efficient Design Index has followed an analytical method approved following ISO 15016 standard. (ISO, 2015) Figure 8 illustrates the speed test's dependence on the propulsion power at a mean draught of 6.49 m. However, the ISO standard is not specific in terms of variables, and the shipyard can choose a wind and wave resistance calculation method that is favourable to it. The shipyard can also take advantage of the wide acceptable ship draft tolerance to obtain positive speed test results. (Henk J.J. van den Boom, 2014) The shipyard's official speed –power curve created based on data collected during the sea trial with a draught of 6.49m is illustrated in figure 8.

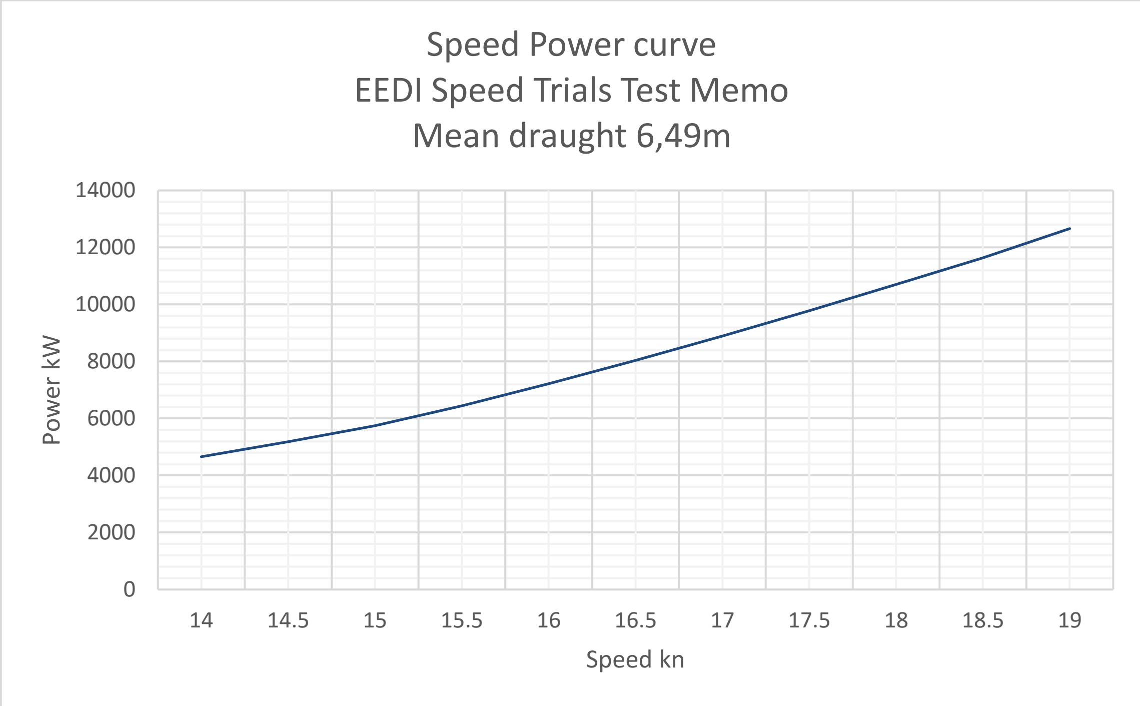


Figure 8. Speed-Power curve, EEDI Speed Trials Test Memo (Fincantieri S.p.A, 2018)

During the first year of the vessel's operation, the author collected numerous measurement data over a more comprehensive speed range than the minimal time and speed variation made during the speed test to create a more accurate speed-power curve. The average draft of 6.70 m is the average annual draft between the vessel's stern and bow while in operation. The more significant displacement of the ship during operation than in sea trial tests is the entire mass on board, such as stores, fuel and lubricants, freshwater, and ballast water, which were at the minimum level before the ship's delivery.

The ship's Integrated Alarm Monitoring and Control System (IAMCS) and the Electronic Chart Display and Information System (ECDIS) (Figure 9) have been utilized to collect information on the ship's performance. These measurements include propulsion power, propulsion shaft speed, and total consumed power, the number of engines running, consumed fuel oil, engine load ship speed through water (STW), and speed over the ground (SOG).

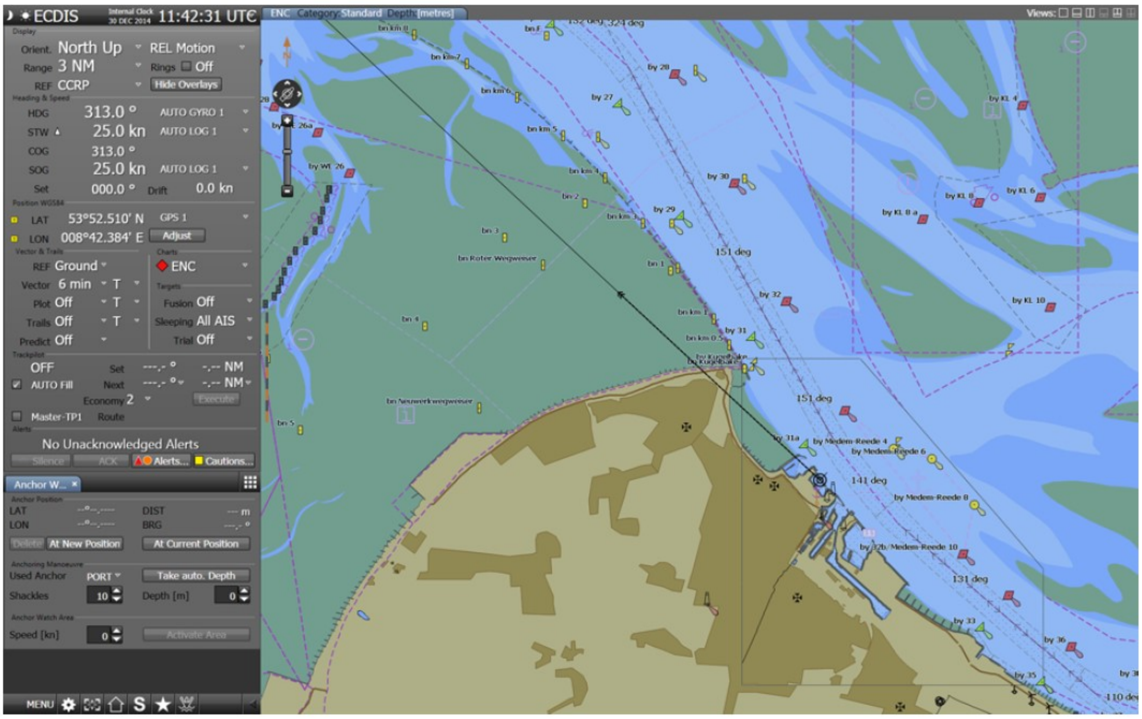


Figure 9. Overview of the Wartsila Navigation Platinum ECDIS Pilot 2.0

After analyzing the collected data, the following formulas were created by the author for the speed curves:

The speeds up to 8.8kn:

$$y = 172 * x^{0,8} \qquad (1)$$

The speeds from 8.9kn to 18.0kn:

$$y = (4{,}06 * x^3) - (8{,}2 * x^2) - (810 * x) + 5978{,}9 \qquad (2)$$

Where y is consumed power [kW] and x is the speed of the ship [kn].

With above mentioned information available, the corrected Power-Speed curve was created as illustrated in figure 12.

For comparison, with a 100% load equal to 12,000kW propulsion power, the ship reached approximately 17,9 knots in operation. During the sea trial, the speed at maximum load was 18,6 knots. The difference can be explained by higher hull resistance cause by more significant displacement during operation than in sea-trial.

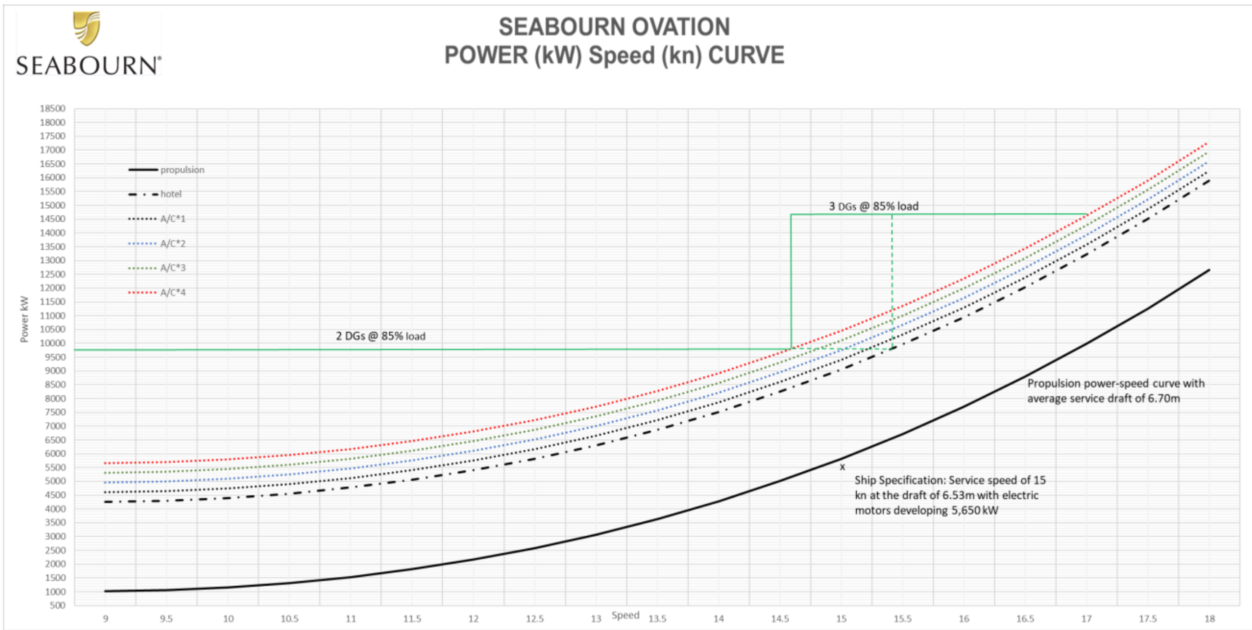


Figure 10. Corrected Speed –power curve based on operational experience

In figure 10, the original narrow speed range has been extended and starting now from 9,0 knots instead of 14,0 knots. All main power consumers, such as propulsion, hotel, and loads of all four A/C chiller compressors are shown with the individual power-speed curve. Also, diesel generators load limitations at 85% load are marked to the chart for a better understanding of power demand. This is typically the highest load where engines are operating while at sea. The higher load limitation would lead to unnecessary starting and stopping of stand-by engines due to power fluctuation caused by the movement of the sea.

The specific fuel oil consumption of diesel generators is calculated by using the following formula: (Wärtsilä, 2016)

$$Be = \frac{1000*\left(M - S*\frac{MLS}{3600}\right)}{P} * \frac{3600}{S} \Rightarrow \left[\frac{g}{kWh}\right] \qquad (3)$$

Be = Specific fuel oil consumption on board [g/kWh]

M = Measured fuel oil quantity [kg]

MLS = Flow of clean leak fuel [kg/h]

P = Power measured after generator

S = Time [s]

It is essential to mention that the calculated fuel oil consumption value is the actual fuel oil consumption value based on the measurement data collected onboard. The computed value is not an ISO 15550 corrected value where corrections such as lower fuel calorific value [MJ/kg] and machine efficiency or losses are taken into account. The curves' shape would remain the same for both non-ISO and ISO-corrected consumption values [g/kWh].

For the comparison, the ISO corrected fuel oil consumption can be calculated by using the following formula. (International Standard, 2002)

$$BISO = \frac{\alpha}{K} * \frac{LCVtest}{LCVISO} * Be - EDP => \left[\frac{g}{kWh}\right] \qquad (4)$$

BISO = Fuel oil consumption according to ISO [g/kWh]

LCV_{test} = Lower caloric value of the fuel during the test [MJ/kg]

LCV_{ISO} = Standard Lower caloric value of the fuel [42700 MJ/kg]

EPD = Engine driven pumps [g/kWh]

Where K and α are calculated by using following formulas:

$$K = \left(\frac{Px}{Pra}\right)^m * \left(\frac{Tra}{Tx}\right)^n * \left(\frac{Tcr}{Tcx}\right)^s \qquad (5)$$

$$\alpha = K - 0{,}7 * (1 - K) * \left(\frac{1}{\eta mec} - 1\right) \qquad (6)$$

K = Ratio of indicated power

α = Power adjustment factor

P_x =Barometric pressure during the test [hPa]

P_{ra} =Standard reference barometric pressure [1000 hPa]

m =0.7 exponent

T_{ra} = Reference air temperature [298.0K]

T_x =Air temperature during the test [K]

n =1.2 exponent

T_{cr} =Reference charge air coolant temperature [298.0K]

T_{cx} = Charge air coolant temperature during the test [K]

s =1.0 exponent

η_{mec} =Mechanical efficiency (0.8 as per engine manufacturer)

The specific fuel oil consumption of the engines is load dependent. By taking load variation to account, the instantaneous SFOC (figure 11) is calculated using equation 7 presented by Smith et al. (p. 110).

$$SFOC_{Load} = SFOC_{Baseline} * (0.455 * Load\ factor^2 - 0.71 * Load\ factor + 1.28) \quad (7)$$

$SFOC_{Load}$ = Instantaneous Specific Fuel Oil Consumption

$SFOC_{Baseline}$ = The lowest SFOC value

Load factor = Value from 0 to 1 based on engine load(s)

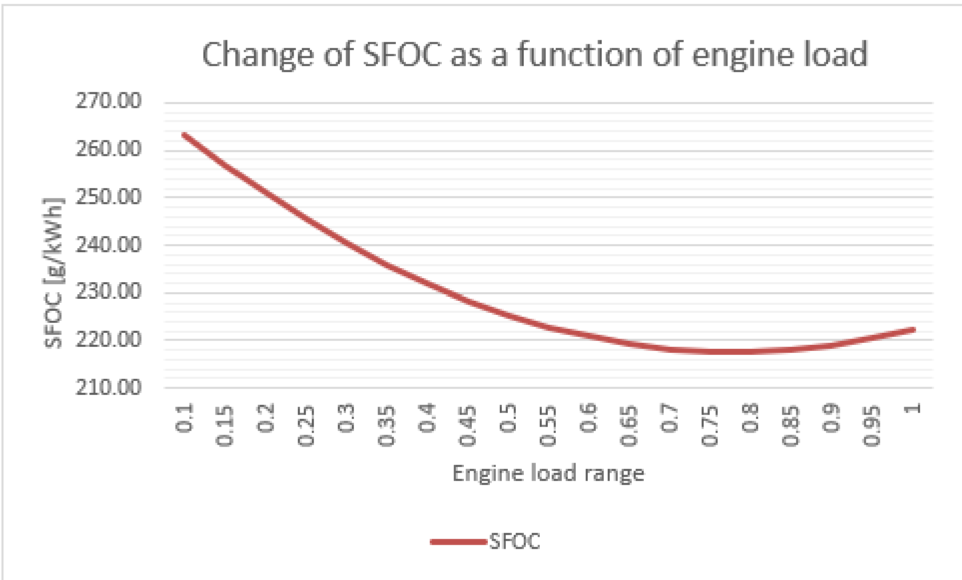


Figure 11. Impact of engine load to SFOC based on a baseline value of 217g/kWh (Smith, 2015)

The calculated value of SFOC $_{Baseline}$ onboard is 217 g/kWh, which is in-line with emission factors given by Entec (Table 7). (Entec UK Limited, 2002)

Table 7. Emission factors in g/kWh regarding engine/fuel type for Auxiliary Engines. (Entec UK Limited, 2002)

MSD = medium speed engine, HSD = high speed diesel, MGO = marine gas oil, MDO = marine diesel oil, RO = residual oil

AEs	NO_x	SO_2	CO_2	HC	PM	specific fuel consumption
Engine type / Fuel type / Size						
MSD / MGO	13.9	1.1	690	0.4	0.3	217
MSD / MDO	13.9	4.3	690	0.4	0.3	217
MSD / RO	14.7	12.3	722	0.4	0.8	227
HSD / MGO	10.9	1.1	690	0.4	0.3	217
HSD / MDO	10.9	4.3	690	0.4	0.3	217
HSD / RO	11.6	12.3	722	0.4	0.8	227

Using load-dependent specific fuel oil consumption values, the author has created the ship's fuel oil consumption curve (Figure 12.) for the propulsion. The curve illustrates the consumed fuel per distance [MT/Nm] versus the ship's speed [kn].

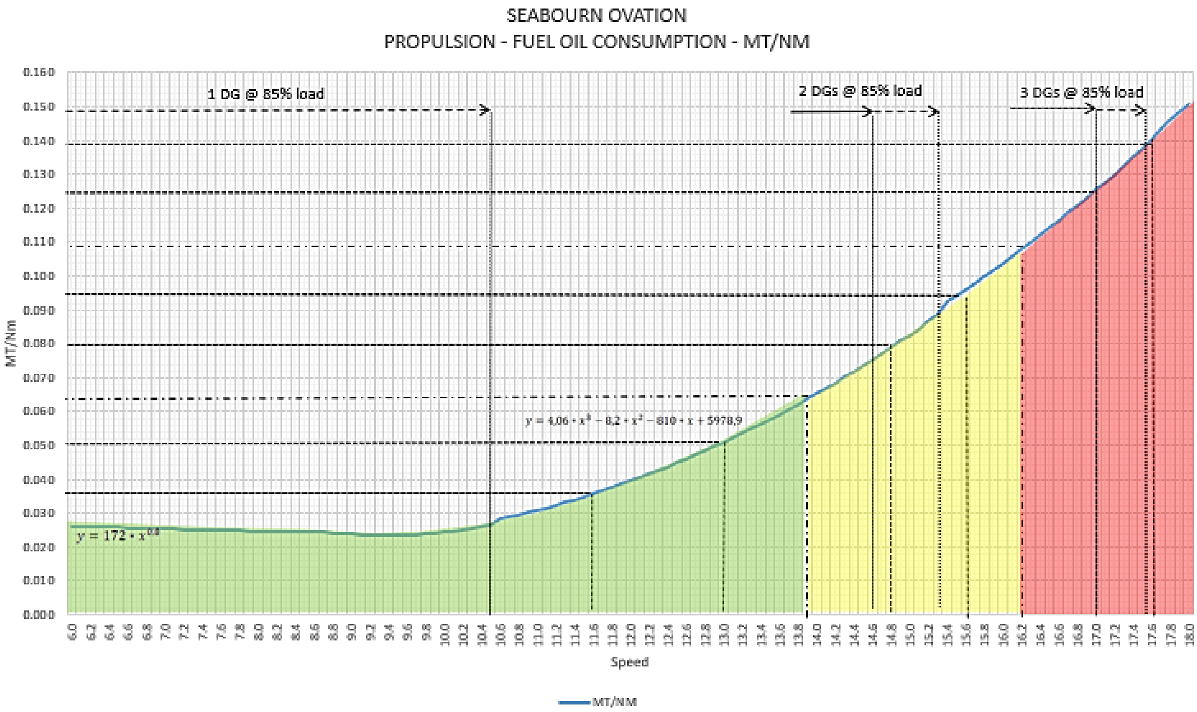


Figure 12. Ship's fuel oil consumption curve [MT/NM] versus speed [kn]

The ship's fuel oil consumption curve (Figure 12) is divided into three main sections, illustrated with different colors. From the most efficient (green) to the most un-economical (red) speed. It is important to note that boundary bets between color segments are not based on a specific calculation formula. The 15 knots design service speed is set in the middle of the yellow segment and from there the boundaries between green and red segments are set based on operational experience of the author. Furthermore, all main sections are divided into three subsections based on fuel efficiency. The author selected the divisions' location between the main sections for better visualization and it will not affect the research result.

As illustrated in figure 12, the economy of the sea mileages is the most economical up to the speed of ~10.5kn with low propulsion power demand. The other extreme is the speeds over 17.0kn -17.5kn when more than three diesel generators are needed for speed generation depending on hotel load demand (figure 12.). The operating window of most economical speed with one DG online is from minimum speed ~ 6.0 up to ~10.5kn depending on the hotel load level, as mentioned earlier. However, for safety reasons, the usage of one DG online is limited to an open and relatively calm sea with low marine traffic. When sailing in coastal waters in busy traffic lanes, more than one generator connected to the grid is required to ensure better operational reliability.

The fuel economy in terms of the number of engines connected to the grid is shown in the table. Fuel consumption increases momentarily each time a new engine connects to the grid. This is due to higher specific fuel consumption at lower engine load (figure 11.) when multiple engines share the grid load. When more engines are running, more auxiliary power is needed, which also increases fuel consumption slightly.

It is important to note that resistance due to weather conditions such as wave, wind, and current resistance is not considered in the diagrams. [Figures 10 and 12.].

5 Analyzing the sea voyages

The study aimed to analyze the consumed energy of the propulsion during sea voyages from the pilot station to the pilot station. The author has reviewed the cruises of 2019 by utilizing voyage reports produced on board after the voyage and analyzing the historical Automatic Identification System (AIS) data available by several commercial data providers. The itinerary of each cruise of the year was analyzed day by day. The researcher has compared fuel consumption results based on voyage reporting against AIS data. Also, the author has examined the accuracy of the voyage reporting thru the cruises of the year. The results of all cruises in 2019 are described in the appendices at the end of the research.

5.1 Voyage reporting

After each cruise, the ship's navigation officer generates a voyage report containing the necessary information about the completed cruise.

As shown in Table 8, the original reporting version was a simple Excel format model with separate columns for voyages, hours, and speeds throughout the voyage. The speed data in these reports are calculated based on the time and distance traveled at average speeds and not based on the cruise's actual profile. The information collected from these reports is called Voyage Report data.

Table 8. Voyage reporting onboard of Seabourn Ovation, Excel format.

VOYAGE REPORT FOR OVN190505

OP	PORT	DATE	TIME ZONE	ARRIVAL			DEPARTURE			SEA VOYAGE TO NEXT PORT			
				ARR. DIST	EOP	FWE	DEP.	FAOP	DEP. DIST	AT SEA		SPEED	TOTAL
										DIST	HOURS	KNOTS	DIST
D	Barcelona, Spain	05/05, Sun	2				17:10	18:04	6.5	164.4	12.50	13.2	179.4
D	Valencia, Spain	06/05, Mon	2	8.5	6:34	7:56	17:55	18:31	4.0	158.0	12.13	13.0	169.9
D	Cartagena (Murcia), Spain	07/05, Tue	2	7.9	6:39	8:00	16:54	17:24	8.9	192.4	12.92	14.9	210.2
D	Málaga (Granada), Spain	08/05, Wed	2	8.9	6:19	7:44	22:44	23:06	2.0	63.3	7.65	8.3	71.0
D	Gibraltar, Gibraltar	09/05, Thu	2	5.7	6:45	7:54	17:03	17:30	3.0	191.9	14.15	13.6	201.8
D	Casablanca, Morocco	10/05, Fri	0	6.9	5:39	6:58	21:13	21:51	4.2	158.2	10.58	14.9	170.4
D	Tangier, Morocco	11/05, Sat	0	8.0	8:26	9:39	20:56	21:26	2.0	70.2	6.93	10.1	81.3
D	Cádiz (Seville), Spain	12/05, Sun	2	9.1	6:22	7:52	22:58	23:33	3.5	416.3	32.10	13.0	426.6
C	At Sea (Atlantic Ocean)	13/05, Mon	1										
D	Leixões (Porto), Portugal	14/05, Tue	1	6.8	6:39	7:54	16:05	16:35	3.0	185.4	12.30	15.1	195.5
D	Lisbon, Portugal	15/05, Wed	1	7.1	4:53	6:26							
										Manoevring	17.15		106.0
										Sea Passage	121.27		1600.1
										TOTAL	**138.42**		**1706.1**

The previous version of the Voyage Report format was replaced by an electronic template in a Napa program (figure 13). (Napa Oy, Ltd, 2013) The deck and engine officers on duty complete the Voyage Report template with relevant information after every cruise leg. In addition to speed, distance, and time information, this report includes information about the type and amount of consumed fuel and lubricant oil and information about freshwater production, bunkering, and consumption. A separate cruise fuel reporting is not needed as the information is already included in the voyage reporting. The template has slots for energy consumed, but at the time of collecting information for the research, the data was not yet available. Same as in the previous reporting format, this report has calculated average speed only, and not the detailed actual speeds as per commited cruise profile.

Voyage Report

Ship:	Seabourn Ovation
Voyage:	SV190505
Description:	8-Day Barcelona - Lisbon
Begin Date:	May 5, 2019 06:39 +02:00
End Date:	May 15, 2019 06:26 +01:00
PAX:	578
Captain:	[illegible]
Chief Engineer:	[illegible]

Distance [NM]:	1699.3
Duration [h]:	240.8
Port hours [h]:	102.4
Maneuvering [h]:	17.2
Sea hours [h]:	121.3
Avg Speed [kn]:	12.3
Weighted Avg Speed [kn]:	7.06

Total Fuel On Board	Voyage Open	Voyage Close	Bunkered	Total Cons
HFO High > 1% [mt]	0.0		0.0	0.0
HFO Low <= 1% [mt]	416.9	337.9	200.0	279.0
MGO Normal [mt]	177.7	111.7	0.0	66.0
LO [Ltr]	34500	33800	0	700

FW Produced [m³]:	2160.0
FW Bunkered [m³]:	0.0
FW Consumed [m³]:	2160.0
FW specific [m³/day]:	215.3

Leg	Begin Time	End Time	Distance [NM]	Duration [h]	Avg Sea Spd [kn]	FO Consumption by Counter [mt]				Energy [MWh]				
						HFO	LSHFO	MGO	Total	Prod.	Propul.	Thruster	Hotel	AC
Barcelona - Valencia	May 5, 2019 06:39 +02:00	May 6, 2019 07:56 +02:00	179.4	25.3	13.15	0.0	24.8	15.0	39.8	0.0	0.0	0.0	0.0	0.0
Valencia - Cartagena	May 6, 2019 07:56 +02:00	May 7, 2019 08:00 +02:00	169.7	24.1	13.02	0.0	32.2	5.6	37.8	0.0	0.0	0.0	0.0	0.0
Cartagena - Malaga	May 7, 2019 08:00 +02:00	May 8, 2019 07:44 +02:00	203.8	23.7	14.90	0.0	31.4	6.6	38.0	0.0	0.0	0.0	0.0	0.0
Malaga - Gibraltar	May 8, 2019 07:44 +02:00	May 9, 2019 07:54 +02:00	70.9	24.2	8.28	0.0	9.0	21.7	30.7	0.0	0.0	0.0	0.0	0.0
Gibraltar - Casablanca	May 9, 2019 07:54 +02:00	May 10, 2019 06:58 UTC	201.6	25.1	13.56	0.0	29.1	11.3	40.4	0.0	0.0	0.0	0.0	0.0
Casablanca - Tangier	May 10, 2019 06:58 UTC	May 11, 2019 09:39 UTC	170.4	26.7	14.94	0.0	24.3	0.0	24.3	0.0	0.0	0.0	0.0	0.0
Tangier - Cádiz (Seville)	May 11, 2019 09:39 UTC	May 12, 2019 07:52 +02:00	81.4	20.2	10.13	0.0	34.5	0.0	34.5	0.0	0.0	0.0	0.0	0.0
Cádiz (Seville) - Leixxes (Porto)	May 12, 2019 07:52 +02:00	May 14, 2019 07:54 +01:00	426.7	49.0	12.97	0.0	37.0	5.5	42.5	0.0	0.0	0.0	0.0	0.0
Leixxes (Porto) - Lisbon	May 14, 2019 07:54 +01:00	May 15, 2019 06:26 +01:00	195.4	22.5	15.07	0.0	56.7	0.3	57.0	0.0	0.0	0.0	0.0	0.0
			1699.3	**240.8**		**0.0**	**279.0**	**66.0**	**345.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Remarks
05May19 - Barcelona - No AAQS allowed 08May19 - Malaga - PS alongside, no AAQS allowed 09May19 - Gibraltar - No AAQS allowed 15May19 - Lisbon - No AAQS allowed, all MGO within 12NM

2019-05-15 06:54

Digitally signed by [illegible] on **May 15, 2019 06:54 UTC**

Figure 13. Napa Electronic Voyage reporting (Napa Oy, Ltd, 2013)

5.2 Historical AIS data

The historical AIS data, what was needed for a better understanding of individual legs of all year cruises and creating a detailed cruise speed profile, was collected from 4 December 2018 to 1 December 2019 until the end. 2019 from Dubai, UAE - Dubai, UAE. The example of processed data is illustrated in table 9.

Table 9. Example of processed historical AIS data of Seabourn Ovation (VesselFinder Limited, 2019)

DATE TIME (UTC)	NAME	IMO	MMSI	CALLSIGN	LATITUDE	LONGITUDE	COURSE	SPEED	HEADING	AISTYPE	A	B	C	D	DRAUGHT	DESTINATION	ETA
12/4/2018 0:03	SEABOURN OVATION	9764958	311000585	C6CV5	25.36847	54.7002	101.2	14.8	511	60	35	176	18	18	6.9	QADOH>AEDXB	12/4/2020 2:00
12/4/2018 1:04	SEABOURN OVATION	9764958	311000585	C6CV5	25.31962	54.97335	104.7	11.7	511	60	35	176	18	18	6.9	QADOH>AEDXB	12/4/2020 2:00
12/4/2018 2:04	SEABOURN OVATION	9764958	311000585	C6CV5	25.2919	55.22655	87.6	9.5	511	60	35	176	18	18	6.9	QADOH>AEDXB	12/4/2020 2:00
12/4/2018 3:01	SEABOURN OVATION	9764958	311000585	C6CV5	25.27652	55.28522	99.9	0.1	511	60	35	176	18	18	6.9	QADOH>AEDXB	12/4/2020 2:00
12/4/2018 4:01	SEABOURN OVATION	9764958	311000585	C6CV5	25.27652	55.28522	353.5	0	511	60	35	176	18	18	6.9	QADOH>AEDXB	12/4/2020 2:00
12/4/2018 5:01	SEABOURN OVATION	9764958	311000585	C6CV5	25.27652	55.28522	332.2	0	511	60	35	176	18	18	6.9	QADOH>AEDXB	12/4/2020 2:00

The cruises of year 2019 consist of 30 individual voyages, from where the historical AIS was collected every hour thru the year. The information from Voyare reports and historical AIS Data were processed in an Excel chart voyage by voyage. The maneuvering and the time spent at port or anchorage were filtered out as this is irrelevant information for this study. The individual voyage route chart (figure 14), cruise speed profile (figure 15), and fuel economy profile (figures 16 and 17) were developed.

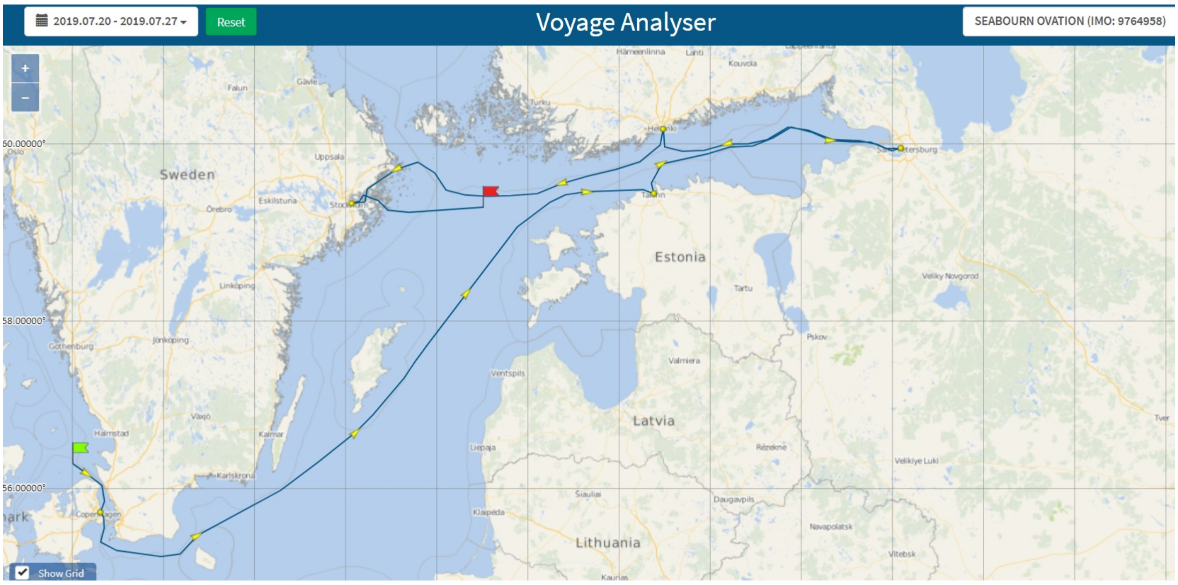


Figure 14. Example of analyzed voyage route based on historical AIS data. (VesselFinder Limited, 2019)

The developed cruise profile (Figure 15.) gives a visual image of the average and actual speeds thru the individual cruises. The average speed is illustrated in red bars, which is the Voyage report speed between the voyage's legs. The blue line represents the actual speed information collected from the historical AIS data. The blue line gaps are the maneuvering times and port of call stops, which are not considered into calculations. For example, the graph shows that on July 20th, 2019, the ship departed from Copenhagen at 18:00 LT. During the first 24 hours of the cruise, the ship's speed was approximately 17.5 knots instead of the 15.2 knots reported in the Voyage report. The evening before arrival in Tallinn, the speed was reduced to 13.5 knots to reach Tallinn as scheduled.

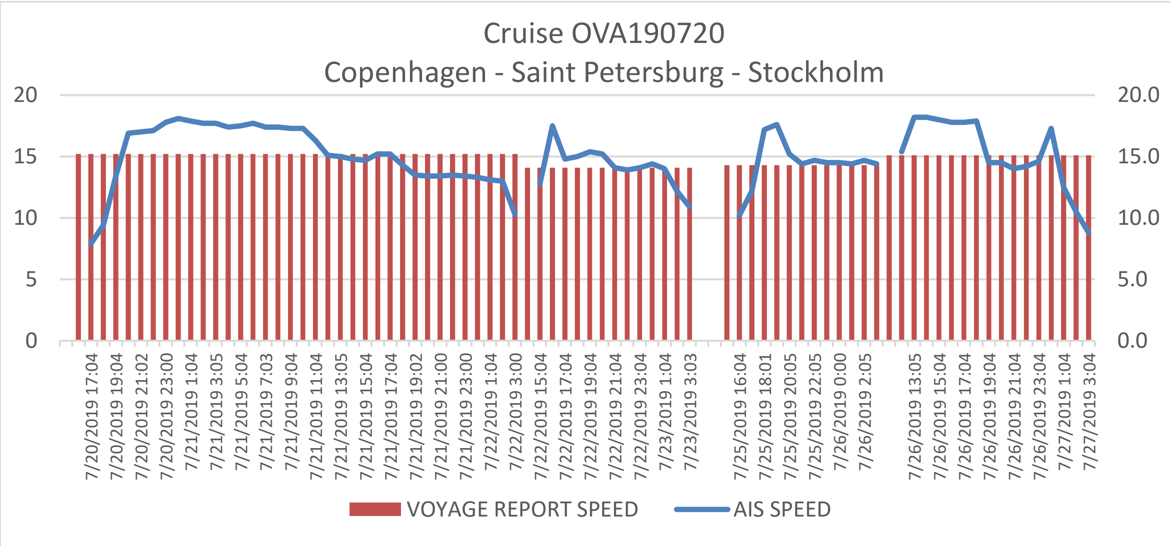


Figure 15. Example of developed cruise profile.

By processing information on voyage reports and historical AIS data, the economy of both reported and sailed speeds and distances were computed. The results were divided into three primary color groups; green, yellow, and red, and further down to three subgroups based on the economy of sailed distance expressed in Metric Tons of fuel per nautical mile (Table 10).

Table 10. Fuel economy versus speed

Cons. up to [MT/NM]	Speed range [kn]
0.035	6.0 – 11.5
0.05	11.6 – 12.9
0.065	13.0 – 13.9
0.08	14.0 – 14.8
0.095	14.9 – 15.5
0.11	15.6 – 16.3
0.125	16.4 – 17.0
0.14	17.1 – 17.6
0.155	17.7 ->

An example of the cruise's economy profile as per voyage report data is illustrated in figure 16, and the economy profile as historical AIS data shown in figure 17. The sailed mileages of the individual cruises are divided into the economy of sailed distances (MT/NM) based on the fuel consumption of individual ship speed, illustrated in the Ship's fuel oil consumption curve (figure 12.) and table 11.

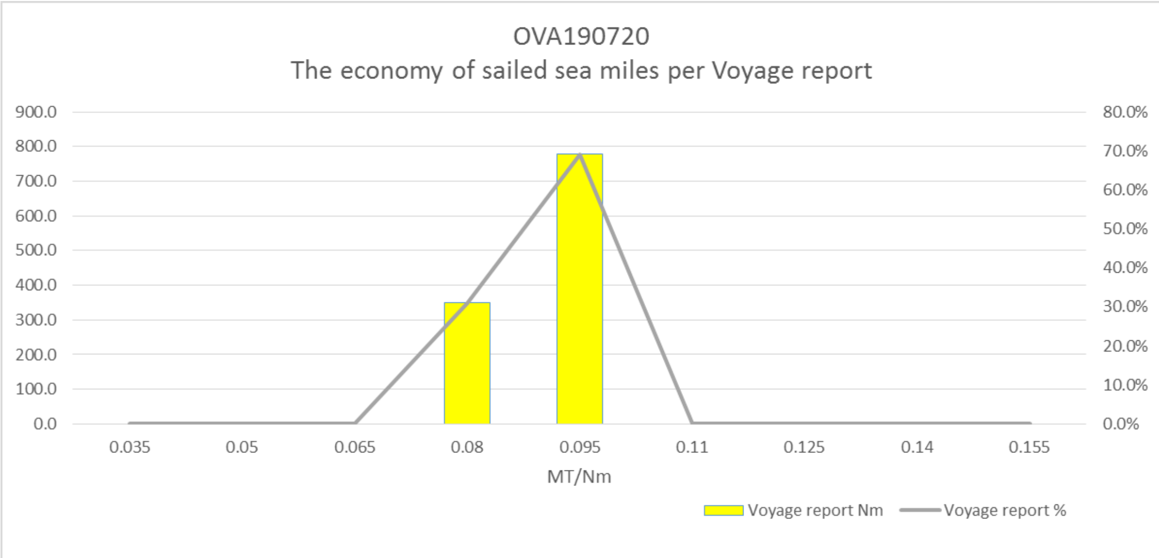


Figure16. Example of economy profile of the cruise as per voyage report data

The examples visualize the difference between information collected from the voyage report and the historical AIS data. As per the average speed of voyage reporting, the speed consumption of 0,095MT/NM represents most sailed distances with nearly 800NM or about 68% of the cruise's traveled sea mileages.

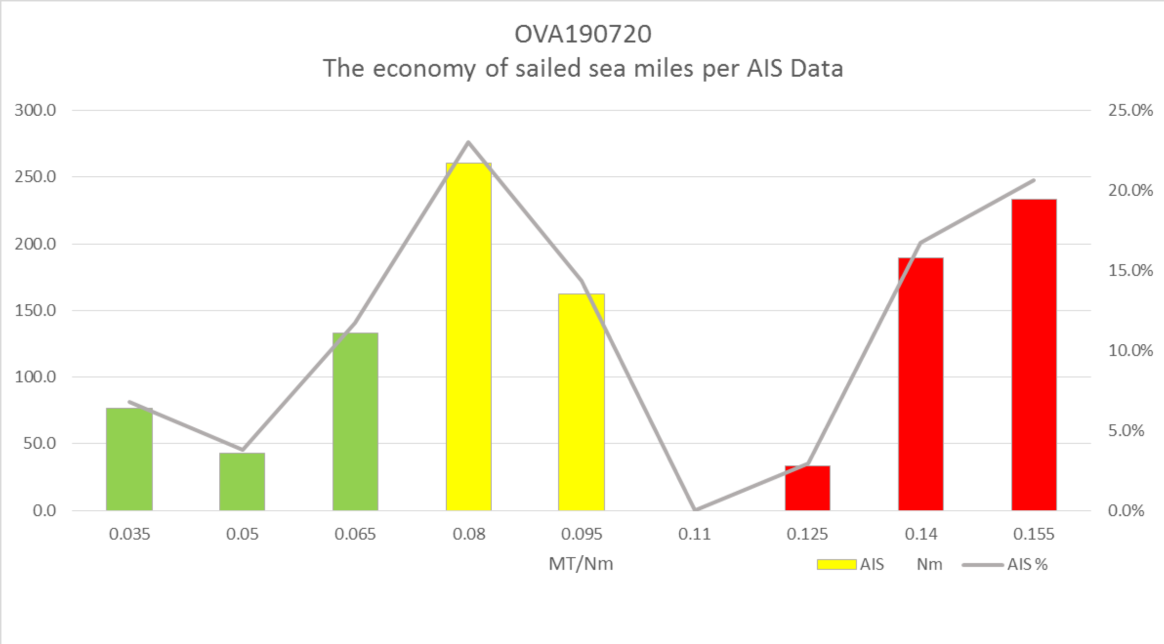


Figure 17. Example of economy profile of the cruise as per historical AIS data

The same cruise illustrated using historical AIS data shows that 0,095MT/NM speed consumption has dropped down to ~13% while the real speed consumption range has spread more widely.

The processed information from voyage report and historical AIS data were collected in table 11, where energy consumed in Metric Ton of fuel was calculated for three different scenarios at sea by using traffic-light colors for better visualization:

1. Average speed of voyage report

2. Average speed calculated by using historical data

3. Consumption based on the speed of historical AIS data

For clarification, the voyage report's average speed is the theoretical average speed; it does not consider possible speed increases or decrease due to navigational situations. Neither does it indicate possible changes to the calculated initial distances or variations to passage plans. For this reason, the average speed calculated by using historical data will give the ideal consumption for the finished cruise.

Table 11. Example of voyage fuel oil consumption results.

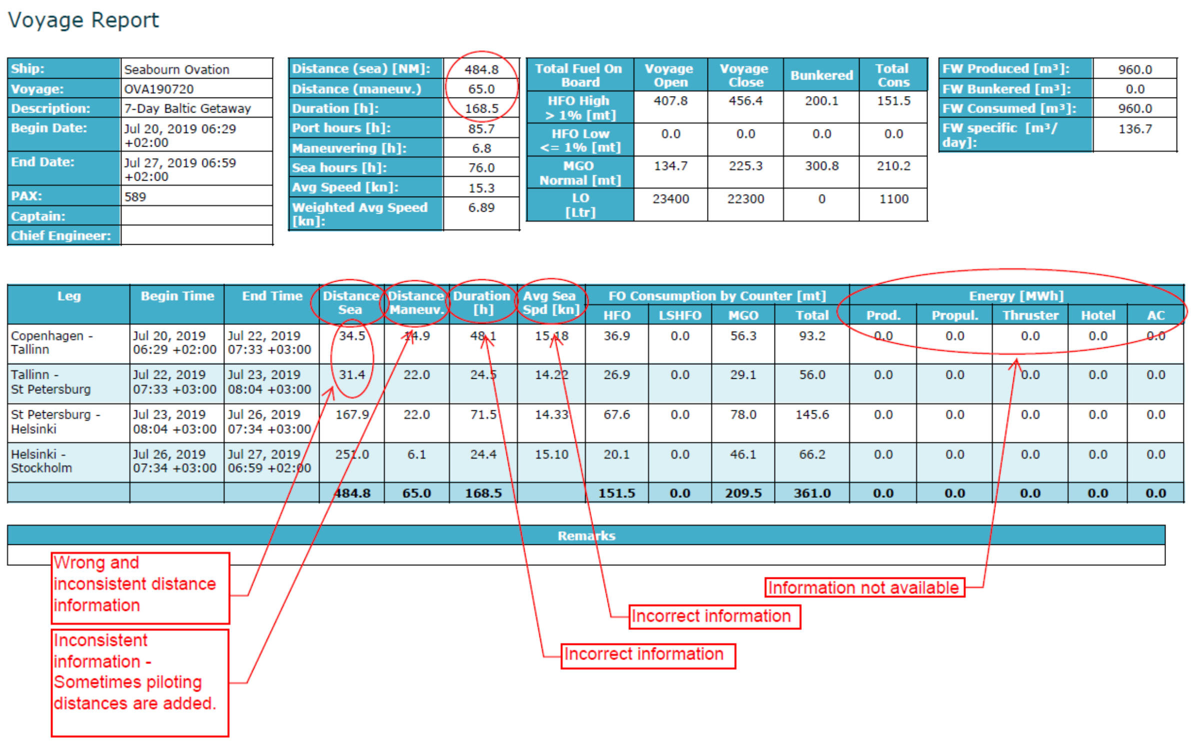
OVA190720												
MT/NM	Voyage report Nm	AIS Average Nm	AIS Nm	Voyage report %	AIS Av. %	AIS %	Voyage report MT	AIS Av. of legs MT	AIS MT	Voyage report %	AIS Av. %	AIS %
0.035	0.0	0.0	76.6	0.0%	0.0%	6.8%	0	0	2			
0.05	0.0	0.0	42.8	0.0%	0.0%	3.8%	0	0	2			
0.065	0.0	182.1	132.9	0.0%	16.3%	11.7%	0	12	7	0.0%	16.3%	22.3%
0.08	349.6	167.2	260.6	31.0%	15.0%	23.0%	24	12	19			
0.095	778.4	768.1	162.4	69.0%	68.7%	14.4%	67	64	14			
0.11	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	100.0%	83.7%	37.4%
0.125	0.0	0.0	33.2	0.0%	0.0%	2.9%	0	0	4			
0.14	0.0	0.0	189.5	0.0%	0.0%	16.7%	0	0	25			
0.155	0.0	0.0	233.2	0.0%	0.0%	20.6%	0	0	34	0.0%	0.0%	40.3%
Total	1128.0	1117.4	1131.2	100.0%	100.0%	100.0%	91.5	87.6	107.7	100.0%	100.0%	100.0%
Average	0.0811	0.0784	0.0953	MT/Nm			91.8	88.7	107.7	MT		

5.3 Findings

During the research, analysed historical AIS data was a useful tool for analysing the cruise profile and how well the originally planned voyage was followed. Especially for longer sea voyages, analysing historical AIS data benefiting from a better understanding of the cruise profile's normal formation.

It was often noticed that the information collected from the voyage reports were not consistent. Wrong, inaccurate, and misleading information was observed regularly.

For instance, in the Napa electronic voyage report illustrated in figure 18, the column Distance Sea [NM] was used for sea mileages or total mileages with or without piloting distances. As well the column Average Sea Speed [kn] was giving contradictory information.



Voyage Report

Ship:	Seabourn Ovation
Voyage:	OVA190720
Description:	7-Day Baltic Getaway
Begin Date:	Jul 20, 2019 06:29 +02:00
End Date:	Jul 27, 2019 06:59 +02:00
PAX:	589
Captain:	
Chief Engineer:	

Distance (sea) [NM]:	484.8
Distance (maneuv.)	65.0
Duration [h]:	168.5
Port hours [h]:	85.7
Maneuvering [h]:	6.8
Sea hours [h]:	76.0
Avg Speed [kn]:	15.3
Weighted Avg Speed [kn]:	6.89

Total Fuel On Board	Voyage Open	Voyage Close	Bunkered	Total Cons
HFO High > 1% [mt]	407.8	456.4	200.1	151.5
HFO Low <= 1% [mt]	0.0	0.0	0.0	0.0
MGO Normal [mt]	134.7	225.3	300.8	210.2
LO [Ltr]	23400	22300	0	1100

FW Produced [m³]:	960.0
FW Bunkered [m³]:	0.0
FW Consumed [m³]:	960.0
FW specific [m³/day]:	136.7

Leg	Begin Time	End Time	Distance Sea	Distance Maneuv.	Duration [h]	Avg Sea Spd [kn]	FO Consumption by Counter [mt]				Energy [MWh]				
							HFO	LSHFO	MGO	Total	Prod.	Propul.	Thruster	Hotel	AC
Copenhagen - Tallinn	Jul 20, 2019 06:29 +02:00	Jul 22, 2019 07:33 +03:00	34.5	14.9	48.1	15.18	36.9	0.0	56.3	93.2	0.0	0.0	0.0	0.0	0.0
Tallinn - St Petersburg	Jul 22, 2019 07:33 +03:00	Jul 23, 2019 08:04 +03:00	31.4	22.0	24.5	14.22	26.9	0.0	29.1	56.0	0.0	0.0	0.0	0.0	0.0
St Petersburg - Helsinki	Jul 23, 2019 08:04 +03:00	Jul 26, 2019 07:34 +03:00	167.9	22.0	71.5	14.33	67.6	0.0	78.0	145.6	0.0	0.0	0.0	0.0	0.0
Helsinki - Stockholm	Jul 26, 2019 07:34 +03:00	Jul 27, 2019 06:59 +02:00	251.0	6.1	24.4	15.10	20.1	0.0	46.1	66.2	0.0	0.0	0.0	0.0	0.0
			484.8	65.0	168.5		151.5	0.0	209.5	361.0	0.0	0.0	0.0	0.0	0.0

Remarks

Figure 18. Napa voyage report finding examples

For this reason, the Napa electronic voyage reports were used for observation-only, and the data for the research was collected from the old version, excel format Voyage Reporting tool (Table 8), which has been produced simultaneously with Napa electronic voyage report.

However, this report was not perfect neither as some of the required average speeds of the cruise's particular legs were overestimated, as illustrated as an example in figure 19. On cruise OVA190928 from Bristol, England to Rouen, France, on October 30th,2019, till October 1st, 2019, the required speed per Voyage Report was 19 knots, even when the average AIS speed was only 15.6 knots.

The author also discovered that some voyage reports had never been made. In the cases where the report was not available, a report called Cruise Schedule was used instead. This report is similar to the Excel format Voyage Report. The difference is that the Cruise Schedule has been produced before the cruise while the Voyage Report is done after completing the cruise.

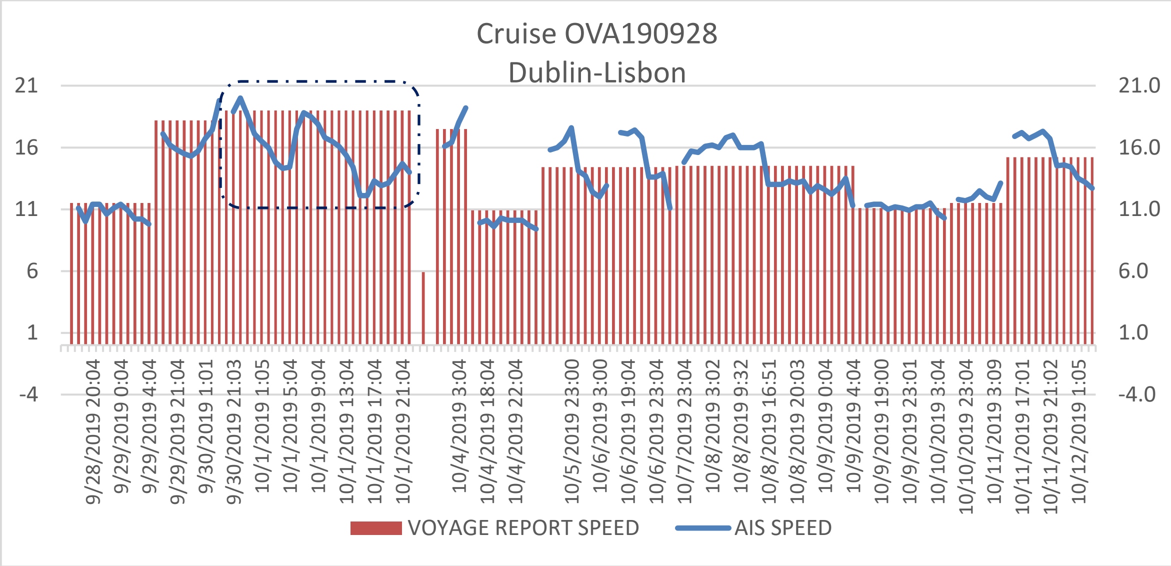


Figure 19. Cruise profile with overestimated speed of the leg based on Voyage report.

Based on processed historical AIS data, it seems that many legs of the cruises are following a similar trend. At the beginning of the sea voyage, the ship's speed was increased well above the required speed to get ahead of schedule. Then in some part of the voyage, the speed was reduced below the original required speed to reach the destination as planned (figure 20.). This commonly used operational method is called "sprint-and-loiter," assures on-time arrival. (Phil Ballou, 2008)

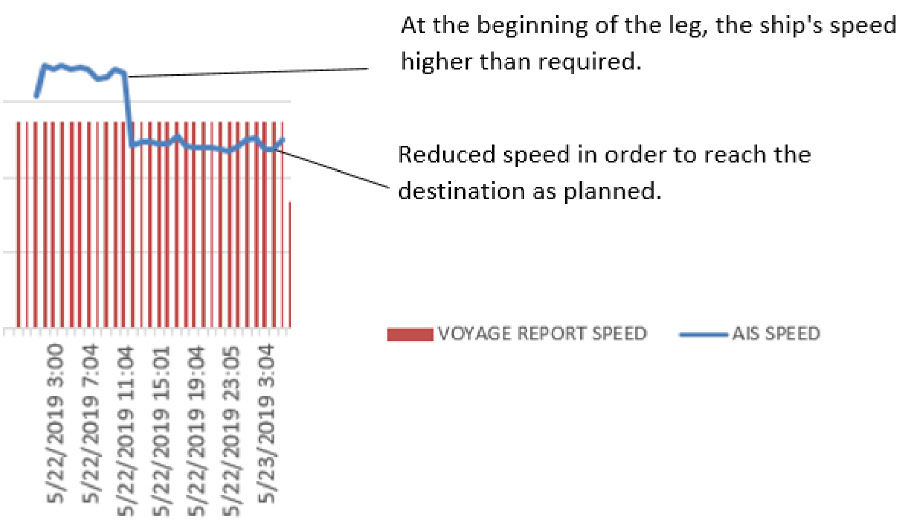


Figure 20. Typical "sprint-and-loiter," profile of the leg.

This phenomenon, by altering speed from the steady required speed, is increasing the energy consumption of the propulsion. When the speed is increased above the planned steady speed, the cost of sailed nautical milages [MT/NM] increases as well (figure 12). Especially with the annual cruise itinerary scheduled with a relatively high speed of 14.0 knots to 16.3 knots, which represents 60.8% sailed nautical miles per year (table 12.), the increased speed was found to be superfluous. By sailing at the average required speed, fuel savings would be nearly 10% of the fuel consumed compared to inconsistent speed.

Sure, in certain circumstances, due to weather, current, or dense traffic situations, the speed must be altered from the planned steady speed. However, this phenomenon is repeated in almost every trip and cannot be explained by an external situation.

The estimated annual fuel oil consumption of the propulsion at sea with 217g/kWh SFOC based on historical AIS data was ~4907MT. By following the average required speed, the fuel oil consumption at sea could be reduced to 4448MT, which is ~459MT or ~ 9.4% less fuel consumed annually (Table 12).

Table 12. Findings of the annual voyages

Seabourn Ovation sea voyages 2018-12-04 to 2019-12-01												
MT/NM	Voyage report Nm	AIS Average	AIS Nm	Voyage report %	AIS Av. %	AIS %	Voyage report	AIS Av. of legs MT	AIS MT	Voyage report %	AIS Av. %	AIS %
0.035	8237.5	7596.6	8475.0	12.6%	11.7%	13.0%	238	214	235			
0.05	5555.9	7078.6	8164.9	8.5%	10.9%	12.6%	245	306	356			
0.065	7727.0	9700.9	13387.3	11.8%	15.0%	20.6%	444	569	753	32.9%	37.7%	46.2%
0.08	18748.2	15930.6	10329.5	28.6%	24.6%	15.9%	1365	1124	719			
0.095	13593.2	15165.0	5530.8	20.8%	23.4%	8.5%	1141	1250	469			
0.11	7448.2	7216.0	4132.2	11.4%	11.2%	6.4%	761	747	421	60.8%	59.2%	30.7%
0.125	2717.7	1770.4	4662.0	4.2%	2.7%	7.2%	314	205	545			
0.14	434.1	177.6	6119.7	0.7%	0.3%	9.4%	56	23	794			
0.155	1019.9	75.5	4237.4	1.6%	0.1%	6.5%	147	11	615	6.4%	3.1%	23.1%
Total	65481.6	64711.2	65038.6	100.0%	100.0%	100%	4712.0	4448.0	4906.8	100.0%	100.0%	100.0%
Average	0.0720	0.0687	0.0754	MT/Nm				Difference	458.8	MT		
									9.4	%		

By sailing with average required speed, the most expensive speed range above 16.4 knots, marked in red would be reduced from 23.1% down to 3.1%. In other words, the most expensive annual nautical mileages would be reduced from 15,000 Nm to 2,000Nm. Simultaneously, the most common speed range would increase from green 46.2% to yellow 59.2% because of the annual cruise itinerary scheduled at a relatively high speed, as mentioned earlier.

The most common speed range confirms that the annual itinerary is sailed at a relatively high and uneconomical speed with room for improvement. In the ship's specification, the design dimension of 15kn service speed at a depth of 6.53m is in the middle of the yellow speed range. (Fincantieri S.p.A, 2015) For instance, due to more significant displacement of the ship during the operation that at sea trial, the design service speed is not as economical speed as it should. Therefore, the design service speed should not be used as an average speed when planning future cruises.

6 Discussion

In general, the author has been able to answer to all the research questions specified earlier.

The slow steaming is improving the fuel economy and reducing GHG emissions. Especially in the cruise industry, where slow steaming has no economic impact on to value or volume of the cargo transported, the cruise planners can design the itinerary plan with a lower average speed without impacting guest satisfaction. Slow steaming might positively impact smoother and more relaxing sailing with less hull vibration, noise, or smell of exhaust gasses.

This study clearly demonstrates that altering from cruise schedule's speed using the "sprint and loiter" strategy will significantly increase fuel consumption. The planned steady cruise speed should be used, especially for modern ships with all navigational and meteorological aids.

Using AIS data collection as part of voyage reporting can reduce fuel oil consumption. The AIS data show the true profile of the cruise and highlight deviations from the original cruise plan. By doing so, ship operators and managers can address anomalies and demand a return to the original cruise plan. The old Excel file and new Napa program-based reporting have the same weak spots. The manually filed reports often have typing errors or have been wrongly used depending on the officer's knowledge who has submitted the report. Also, the numerical report is not the most visual method to tell the message. The person reading the report might not see the difference between the cruise legs as it's currently presented. Comparing AIS data to a planned voyage in the chart would give a better overview easily without more profound technical or nautical knowledge about the ship in question. Adding a completed cruise's profile for reporting instead of an average speed adds another much-needed dimension to reporting. Sometimes, AIS data may not always be available, as is generally assumed. The world's specific locations have no or limited terrestrial AIS receivers, and the AIS data is transferred via satellites only. In such regions, the gap between the data received can be hours or even days. Johansson et al. (2017) have been successfully using route generation algorithms handling gaps between received AIS data. However, route generation algorithms as a part of voyage reporting might be superfluous, as the reason for reporting is highlighting the deviations from the voyage planning.

When ship specification is signed between owner and shipbuilder, the service speed and the propulsion power required to achieve it have been agreed. Typically, this clause has penalties and sometimes even bonuses if the required speed and power have not met or have been exceeded. This puts more pressure on the shipyard to succeed in the speed trial, which usually is just a single opportunity. For this reason, the shipbuilder wants to make the test as early as possible, when the ship has the lightest displacement but still within the tolerances agreed upon. The shipbuilder might also take advantage of the ISO standard, which is not specific in terms of variables, and choose a wind and wave resistance calculation method that is favorable to it. (Henk J.J. van den Boom, 2014)

Based on the sea trial result, the Speed-Power curve is generated (figure 8), which might not be accurate enough. The selected speed range, 14 knots to 19 knots of the formed curve, was insufficient. For these reasons, the owner has received limited and narrow information about the ship's performance. The cruise designers are then using the ship's service and maximum speed information to plan future cruise itineraries.

To find the most economical speed range of the ship, the shipbuilder should generate the Fuel Consumption [MT/Nm] – Propulsion Power (kW] curve, as presented in figure 12. This tool would give more valuable information about the ship's performance than the old fashion Speed-Power curve. The cruising should be a relaxing experience without rushing from point A to point B; therefore, the cruises should be designed with a significantly lower speed. This would be economically highly profitable for the shipowner, together with less GHG emissions produced.

7 Conclusion

It is crucial for a better fuel economy to follow the average required speed as closely as practically possible. This would give up to a ~9% fuel saving for the propulsion consumption at sea without additional investment.

Present voyage reporting has shown to be inaccurate and needs improvement. Additionally, the voyage reporting content should be revised to better serve the most economical operation of the ship.

The available AIS data and actual speed trend profiles at sea from the pilot station to the pilot station is giving a better overview of the completed cruise. By improving the voyage reporting, the persons in charge onboard and shore side could get more accurate information about the completed cruise and take the corrective action when needed. Also, commenting on unrealistic voyage planning versus committed cruises would be more accessible by using the speed trends as a part of the cruise reporting.

The Neptune data-collecting platform has not been utilized fully, as shown with historical AIS data collected from a commercial provider. The Neptune has all necessary data available such as ship speed, position, propulsion load, specific fuel oil consumption in order to monitor the performance and give guidance for more energy-efficient operation of the ship, but unfortunately, this has not been utilized.

The itinerary of the annual cruises is planned with 60% of the time with a relatively high speed, 13.9 to 16.2 knots, while the economic ”green zone” speed represents only 1/3 of the time. This might be due to the unrealistic high design service speed of the ship specification. (Fincantieri S.p.A, 2015) There is a great potential for emission reduction and fuel saving by taking economical speed into consideration in itinerary planning. Reducing one knot of annual itinerary speed would save nearly 1000MT of fuel annually or 20% from the fuel used for sea passages.

As necessary as is the economic saving by reducing consumption of fuel is the reduction of CO_2 emissions and the public image of the cruise line towards the clients and society. For the cruising industry to recover after COVID-19 outbreak and improve the public image, such as steps toward greener operations, are paramount for the future success.

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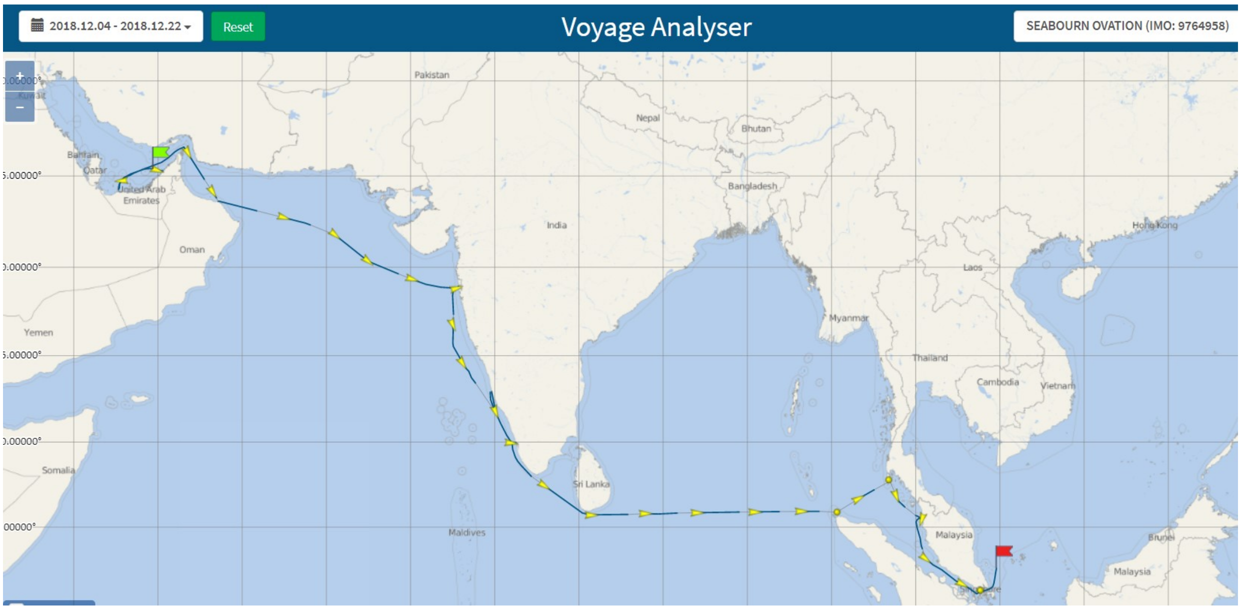
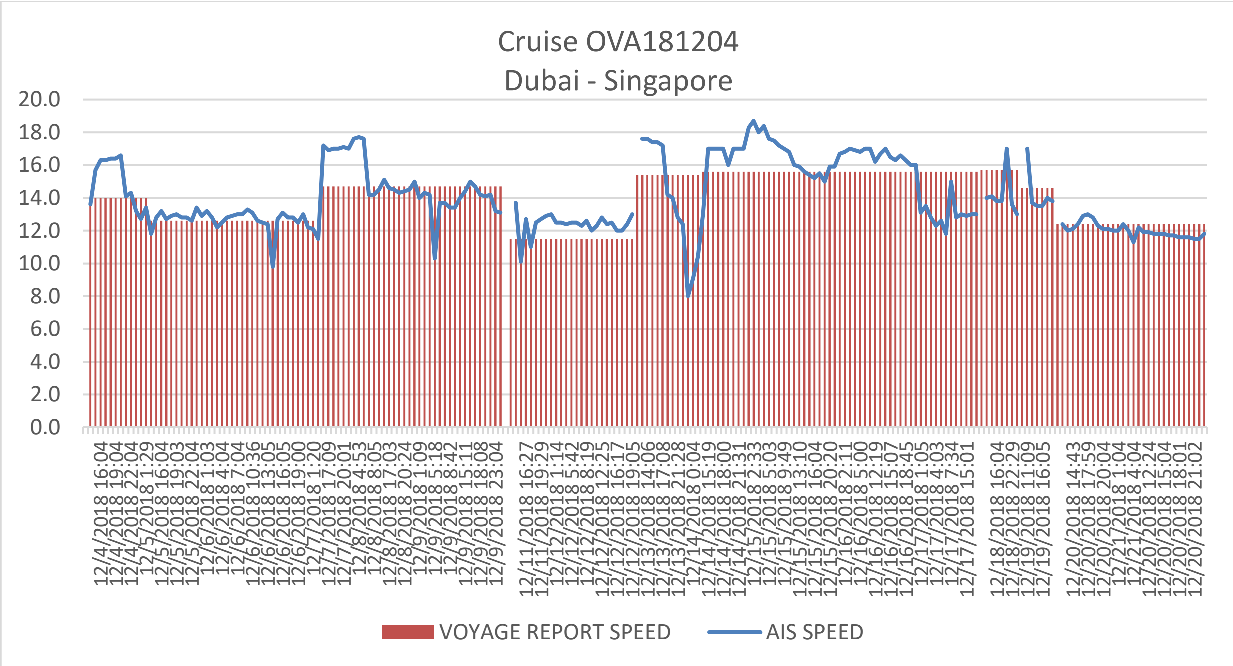
Appendices

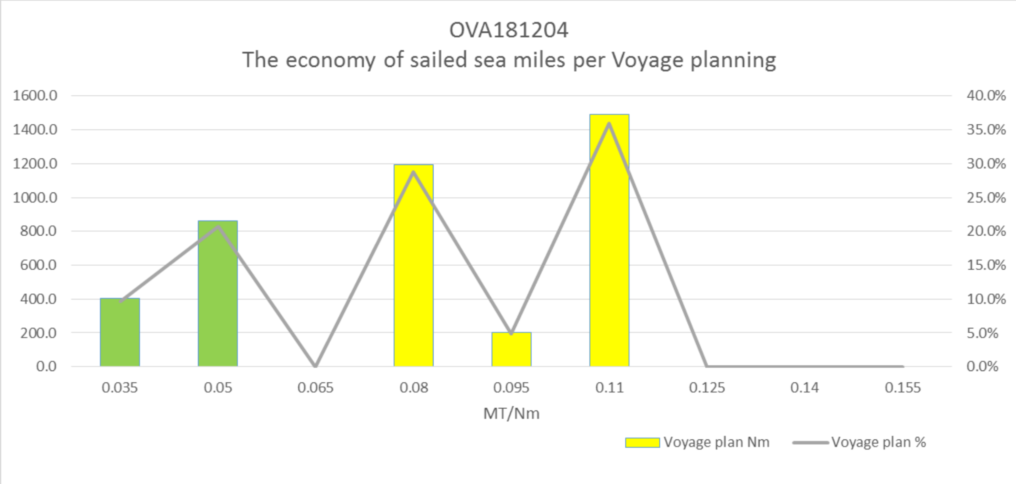
Voyages from December 4th, 2018 thru December 2nd, 2019

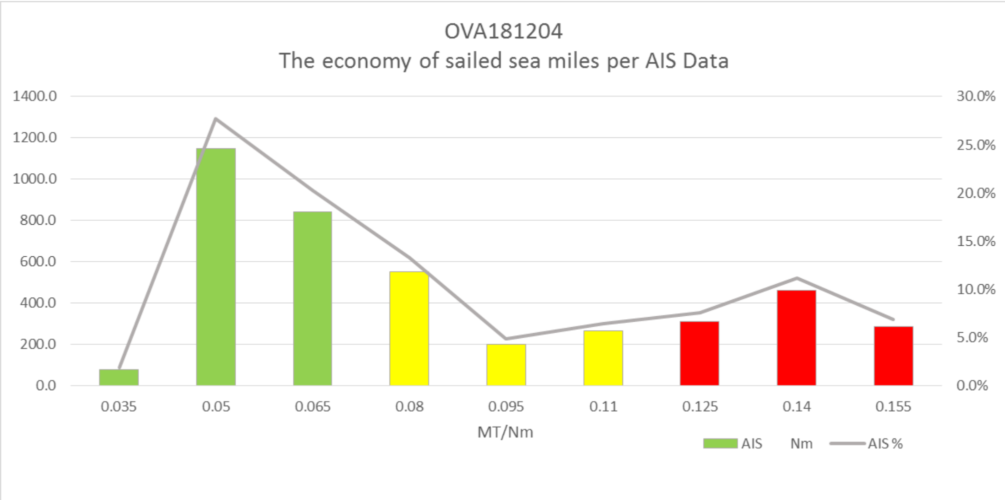
CRUISE NO:	CRUISE NAME	DATE
OVA181204	Dubai - Singapore	4.12.2018-21.12.2018
OVA181222	Singapore – Hong Kong	22.12.2018-04.01.2019
OVA190105	Hong Kong - Singapore	05.01.2019-18.01.2019
OVA190119	Singapore – Hong Kong	19.01.2019-01.02.2019
OVA190202	Hong Kong – Manila - Singapore	02.02.2019-15.02.2019
OVA190216	Singapore – Hong Kong	16.02.2019-01.03.2019
OVA190302	Hong Kong - Singapore	02.03.2019-15.03.2019
OVA190316	Singapore - Dubai	16.03.2019-06.04.2019
OVA190407	Dubai - Piraeus	07.04.2019-26.04.2019
OVA190427	Piraeus - Barcelona	27.04.2019-04.05.2019
OVA190505	Barcelona - Lisbon	05.05.2019-14.05.2019
OVA190515	Lisbon - Amsterdam	15.05.2019-28.05.2019
OVA190529	Amsterdam - Dover	29.05.2019-06.06.2019
OVA190607	Dover – Nordkapp - Copenhagen	07.06.2019-21.6.2019
OVA190622	Copenhagen – Saint Petersburg - Stockholm	22.06.2019-28.06.2019
OVA190629	Stockholm – Saint Petersburg - Copenhagen	29.06.2019-05.07.2019
OVA190706	Copenhagen – Nordkapp - Copenhagen	06.07.2019-19.07.2019
OVA190720	Copenhagen – Saint Petersburg - Stockholm	20.07.2019-26.07.2019
OVA190727	Stockholm – Saint Petersburg - Copenhagen	27.07.2019-02.08.2019
OVA190803	Copenhagen – Newcastle upon Tyne – Lervik -	03.08.2019-16.08.2019
OVA190817	Copenhagen – Saint Petersburg - Stockholm	17.08.2019-23.08.2019
OVA190824	Stockholm – Saint Petersburg - Copenhagen	24.08.2019-30.08.2019
OVA190831	Copenhagen - Dublin	31.08.2019-13.09.2019
OVA190914	Dublin – Newhaven (Edinburgh) - Dublin	14.09.2019-27.09.2019
OVA190928	Dublin - Lisbon	28.09.2019-11.10.
OVA191012	Lisbon – Portofino - Barcelona	12.10.2019-22.10.2019
OVA191023	Barcelona – Monte Carlo	23.10.2019-29.10.2019
OVA191030	Monte Carlo - Valletta	30.10.2019-05.11.2019
OVA191106	Valletta - Piraeus	06.11.2019-12.11.2019
OVA191113	Piraeus - Dubai	13.11.2019-01.12.2019

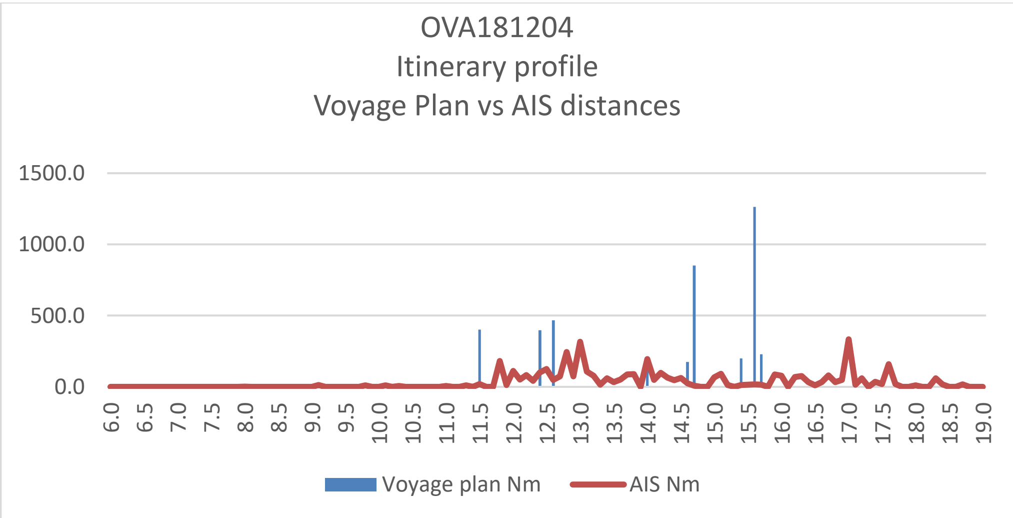


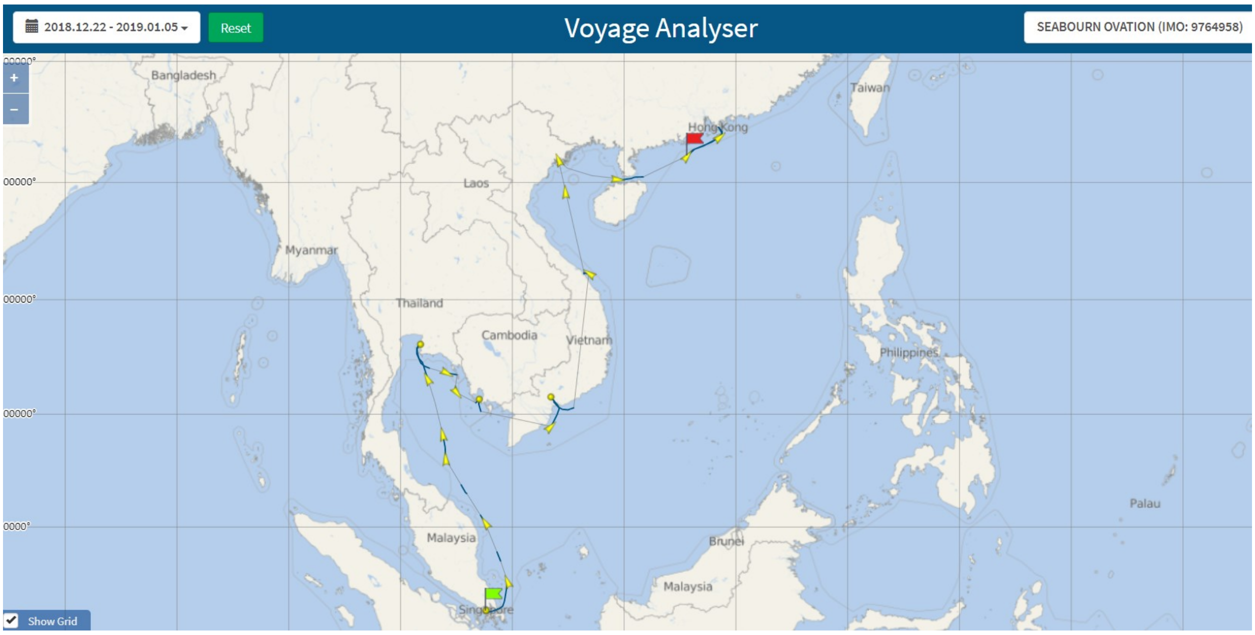


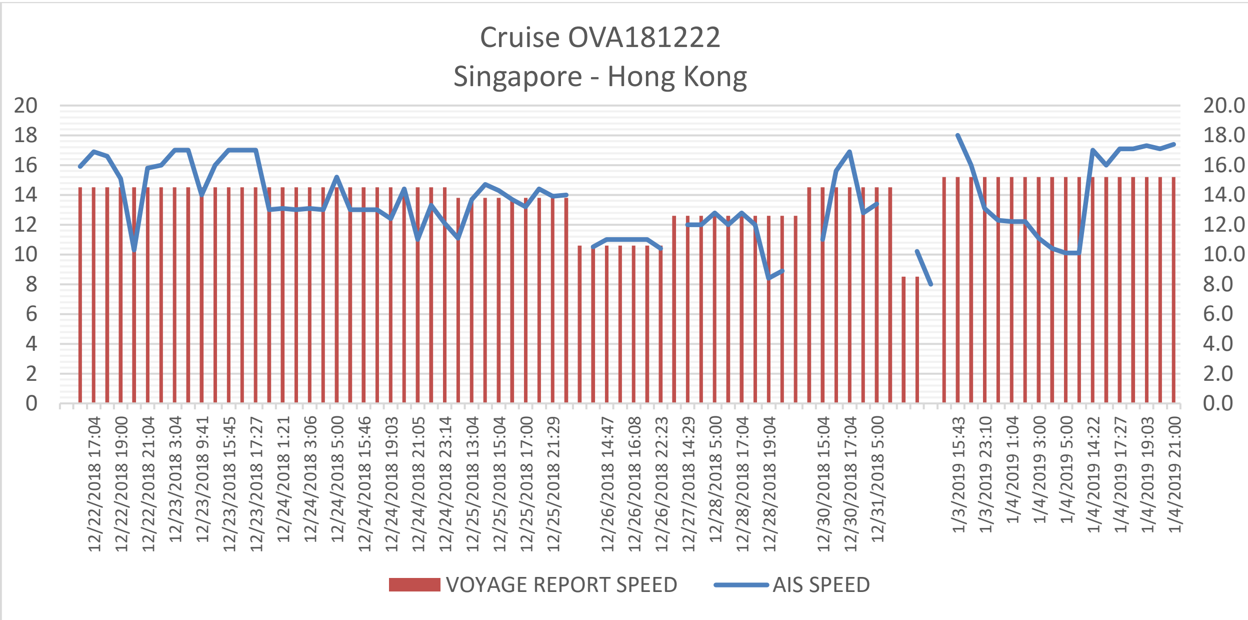
OVA181204												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	402.5	0.0	77.4	9.7%	0.0%	1.9%	14	0	2			
0.05	863.0	1290.6	1150.0	20.8%	31.0%	27.7%	38	56	49			
0.065	0.0	180.7	841.3	0.0%	4.3%	20.3%	0	12	46	30.5%	35.4%	49.9%
0.08	1195.8	373.4	550.1	28.8%	9.0%	13.3%	91	25	38			
0.095	200.2	1036.0	201.4	4.8%	24.9%	4.9%	18	82	17			
0.11	1491.2	1279.8	266.7	35.9%	30.8%	6.4%	143	127	28	69.5%	64.6%	24.5%
0.125	0.0	0.0	312.9	0.0%	0.0%	7.5%	0	0	37			
0.14	0.0	0.0	463.2	0.0%	0.0%	11.2%	0	0	60			
0.155	0.0	0.0	286.3	0.0%	0.0%	6.9%	0	0	41	0.0%	0.0%	25.6%
Total	4152.8	4160.5	4149.3	100.0%	100.0%	100.0%	303.2	302.0	317.8	100.0%	100.0%	100.0%
Average	0.0730	0.0726	0.0766	MT/Nm			302.9	301.2	317.8	MT		


OVA181204
The economy of sailed sea miles per Voyage planning
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

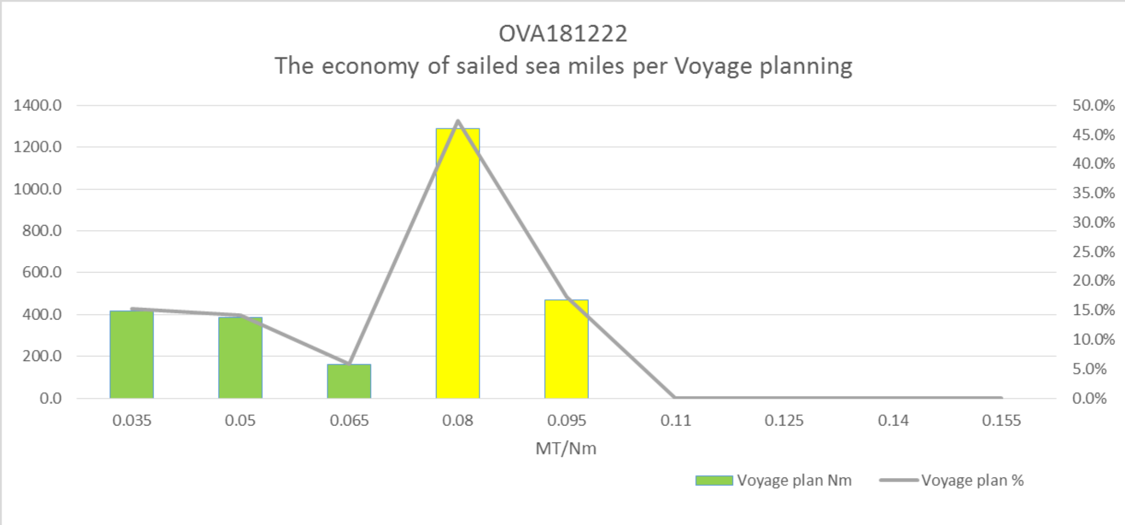

OVA181204
The economy of sailed sea miles per AIS Data
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS
Nm
AIS %

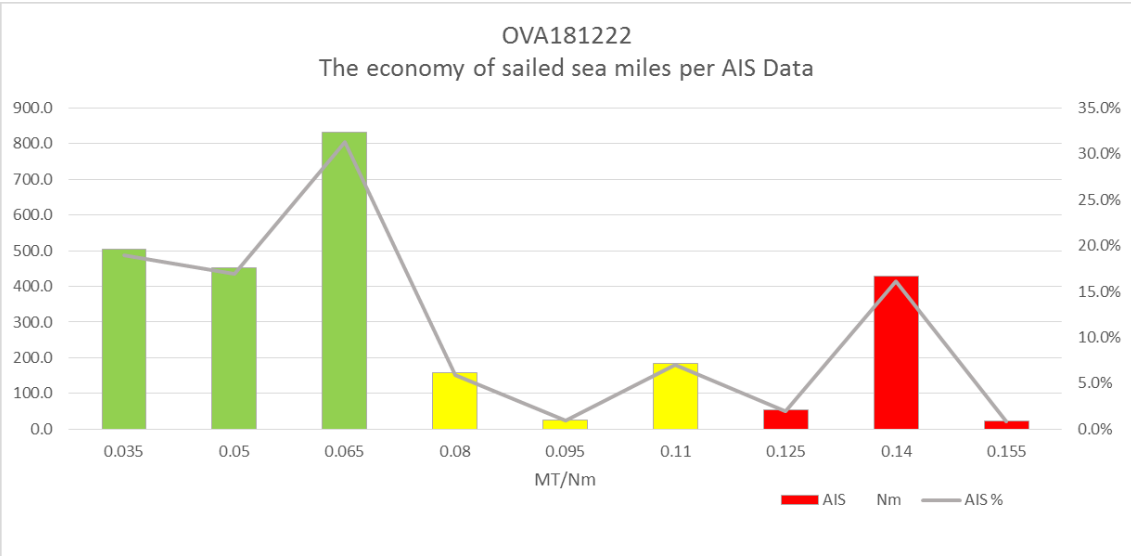

OVA181204
Itinerary profile
Voyage Plan vs AIS distances
1500.0
1000.0
500.0
0.0
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
11.5
12.0
12.5
13.0
13.5
14.0
14.5
15.0
15.5
16.0
16.5
17.0
17.5
18.0
18.5
19.0
Voyage plan Nm
AIS Nm

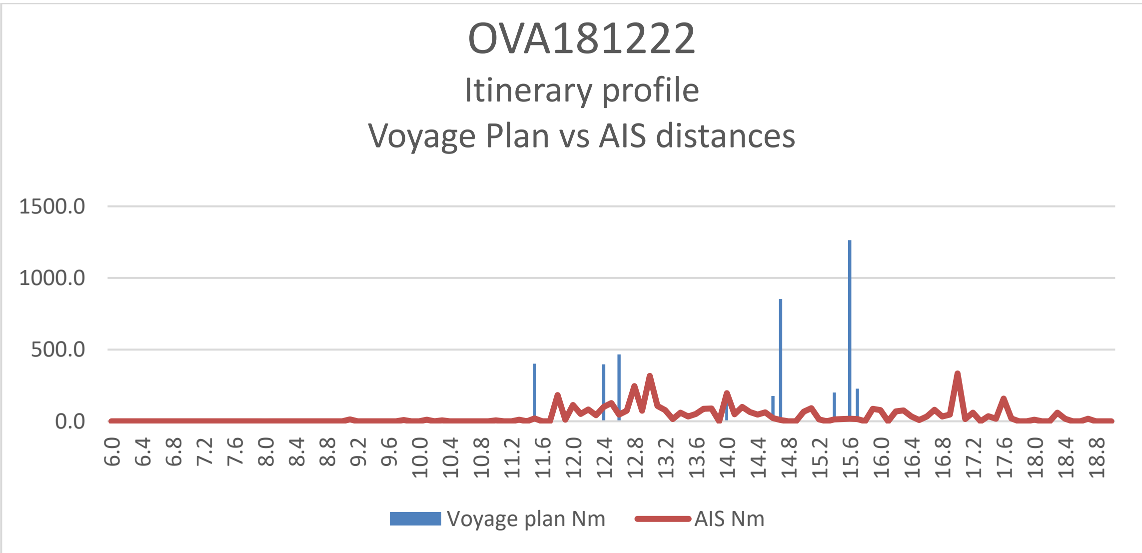


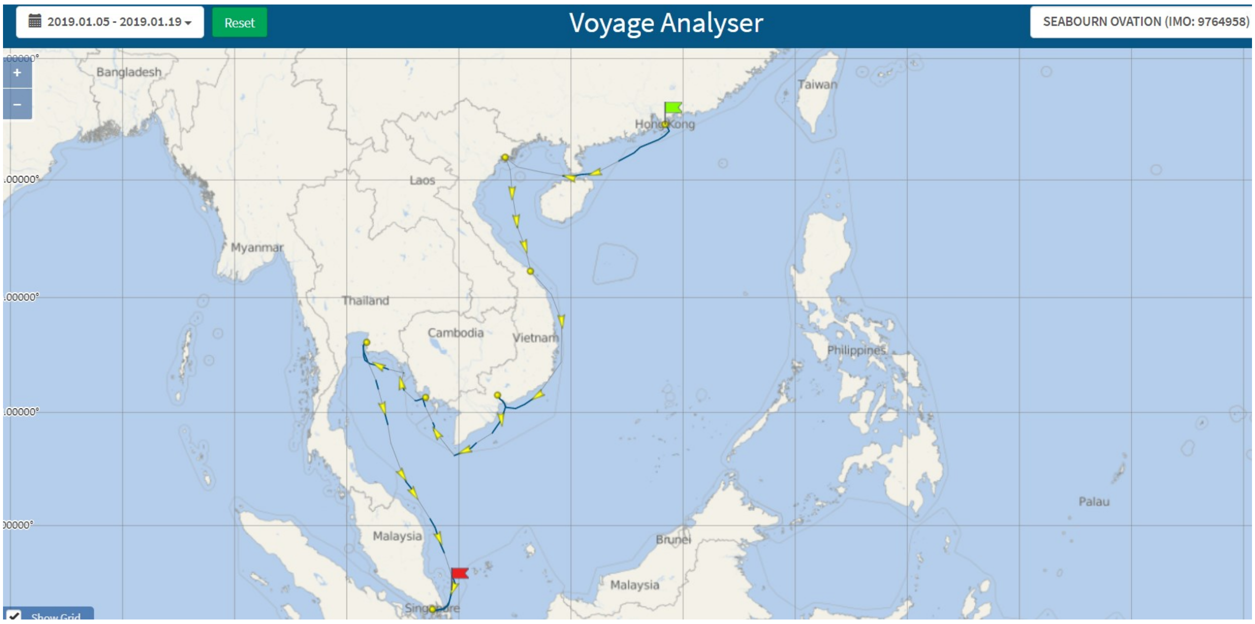


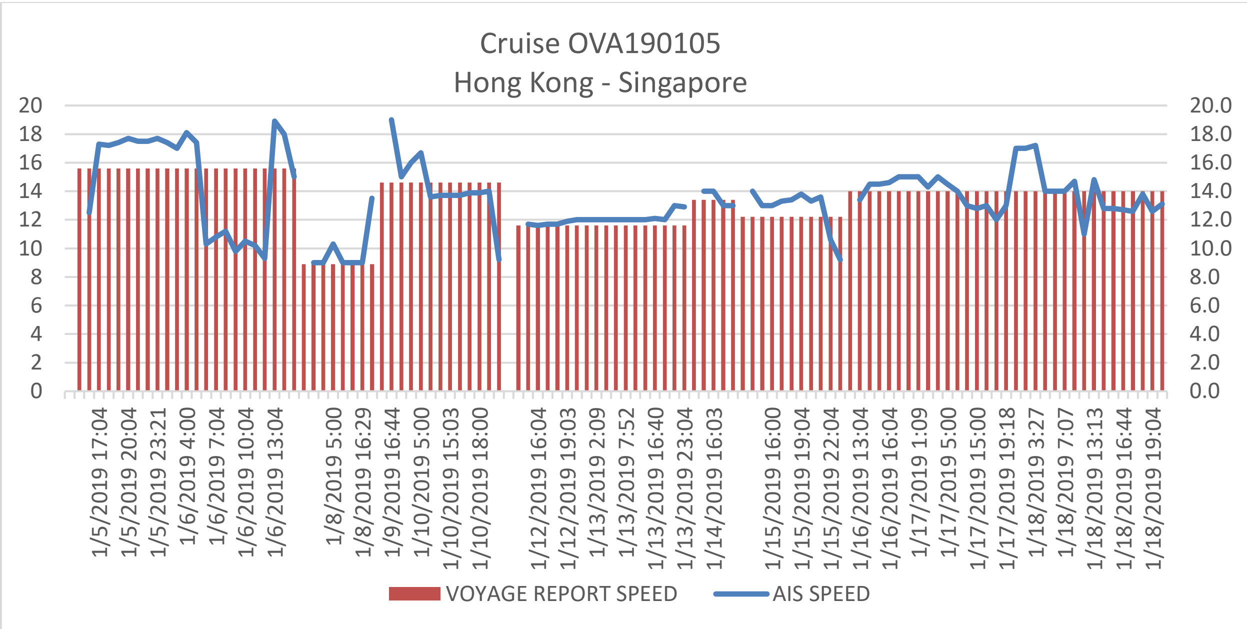
OVA181222												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	416.2	777.5	503.3	15.3%	29.3%	18.9%	11	21	13			
0.05	384.3	0.0	450.8	14.1%	0.0%	17.0%	17	0	19			
0.065	158.7	623.2	830.8	5.8%	23.5%	31.3%	10	39	45	35.2%	52.8%	67.2%
0.08	1290.7	1252.0	157.4	47.4%	47.2%	5.9%	96	92	11			
0.095	471.2	0.0	25.9	17.3%	0.0%	1.0%	41	0	2			
0.11	0.0	0.0	185.1	0.0%	0.0%	7.0%	0	0	19	64.8%	47.2%	13.9%
0.125	0.0	0.0	53.0	0.0%	0.0%	2.0%	0	0	6			
0.14	0.0	0.0	428.6	0.0%	0.0%	16.1%	0	0	55			
0.155	0.0	0.0	22.0	0.0%	0.0%	0.8%	0	0	3	0.0%	0.0%	19.0%
Total	2721.1	2652.8	2656.9	100.0%	100.0%	100.0%	174.7	152.9	174.6	100.0%	100.0%	100.0%
Average	0.0642	0.0576	0.0657	MT/Nm			170.6	153.1	174.6	MT		


OVA181222
The economy of sailed sea miles per Voyage planning
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

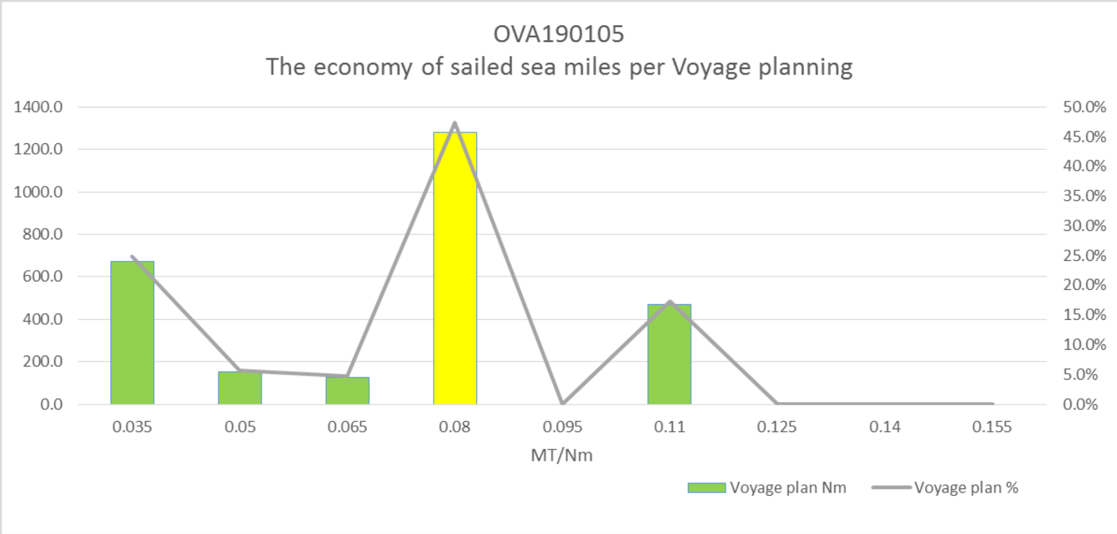

OVA181222
The economy of sailed sea miles per AIS Data
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %


OVA181222
Itinerary profile
Voyage Plan vs AIS distances
1500.0
1000.0
500.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

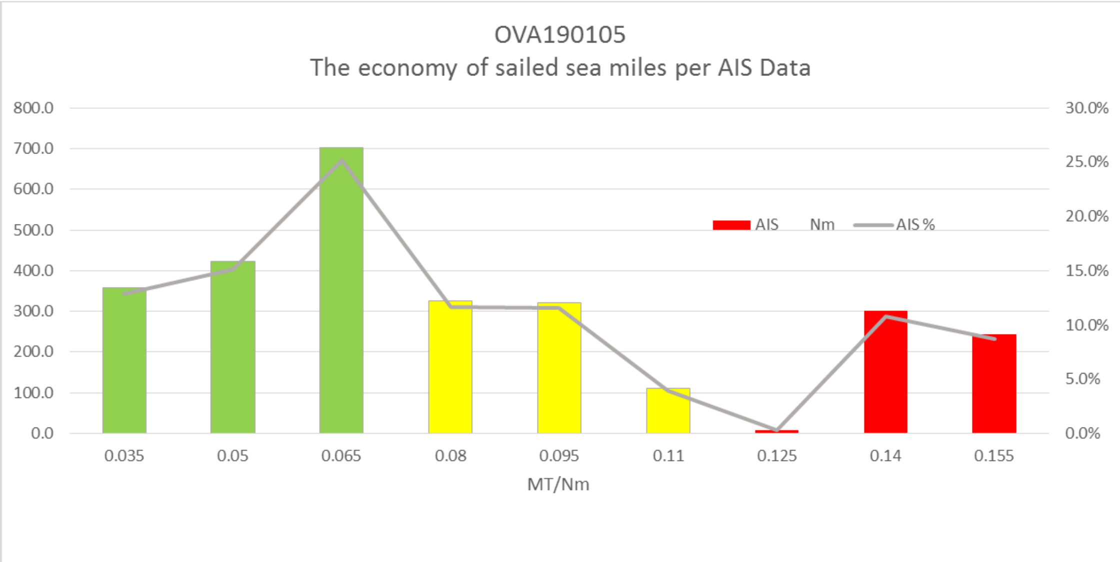




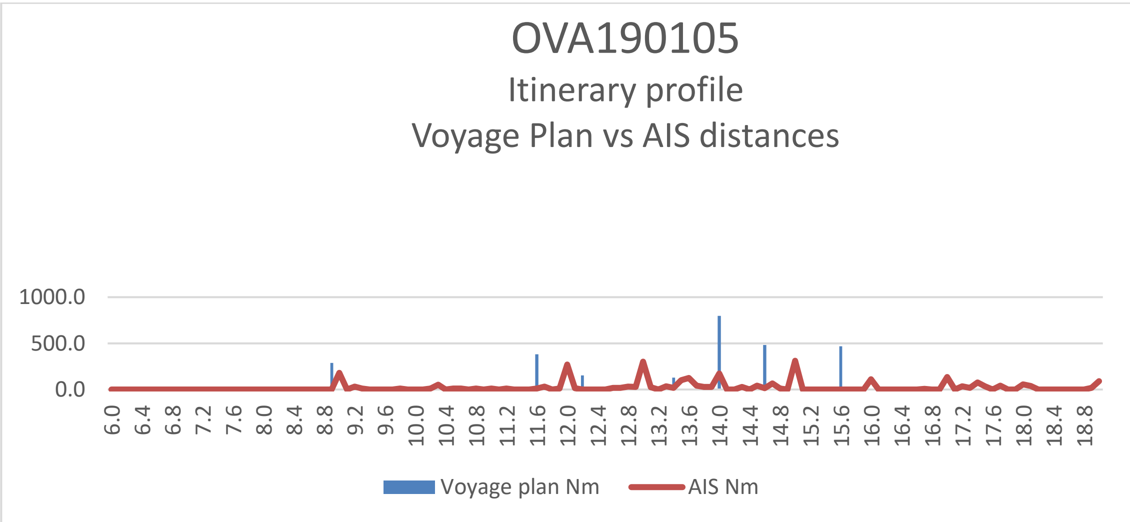
OVA190105												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	672.0	334.7	358.1	24.9%	12.3%	12.8%	20	9	9			
0.05	152.5	554.3	423.0	5.6%	20.4%	15.1%	6	22	17			
0.065	127.3	127.3	703.1	4.7%	4.7%	25.2%	7	7	39	35.3%	37.3%	53.1%
0.08	1279.8	1260.0	325.1	47.4%	46.3%	11.6%	89	83	23			
0.095	0.0	447.2	321.7	0.0%	16.4%	11.5%	0	36	27			
0.11	468.3	0.0	109.9	17.3%	0.0%	3.9%	45	0	11	64.7%	62.7%	27.1%
0.125	0.0	0.0	8.7	0.0%	0.0%	0.3%	0	0	1			
0.14	0.0	0.0	300.9	0.0%	0.0%	10.8%	0	0	40			
0.155	0.0	0.0	243.7	0.0%	0.0%	8.7%	0	0	36	0.0%	0.0%	19.8%
Total	2699.9	2723.6	2794.1	100.0%	100.0%	100.0%	167.1	157.2	202.2	100.0%	100.0%	100.0%
Average	0.0619	0.0577	0.0724	MT/Nm			172.9	161.3	202.2	MT		



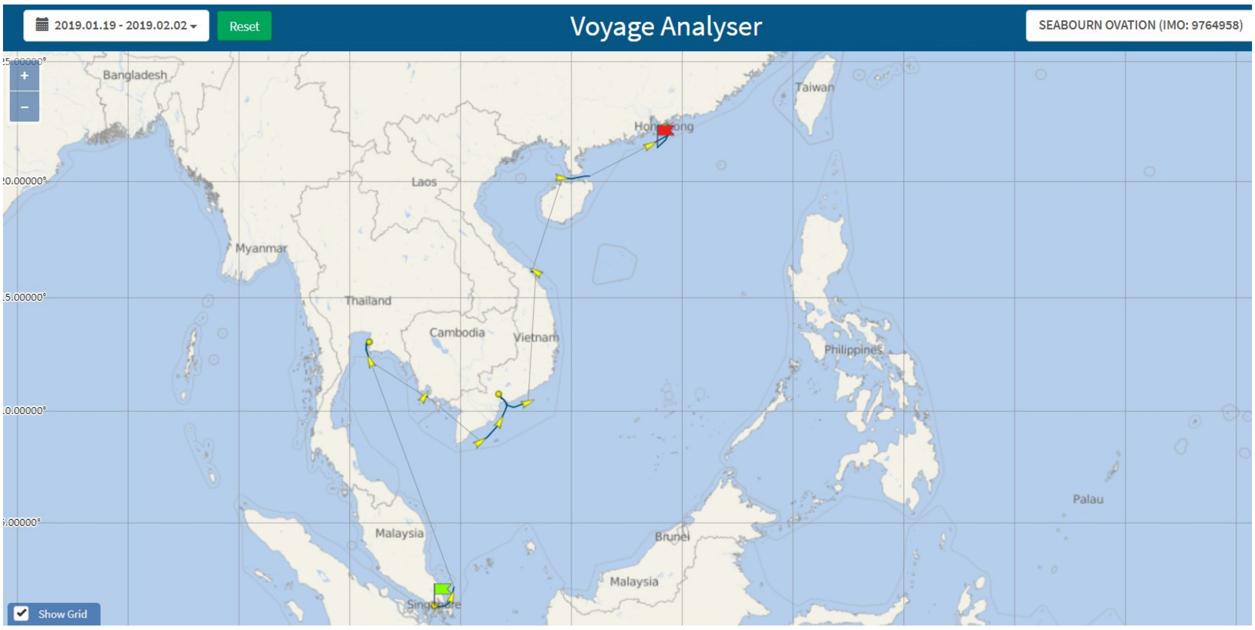
OVA190105
The economy of sailed sea miles per Voyage planning
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

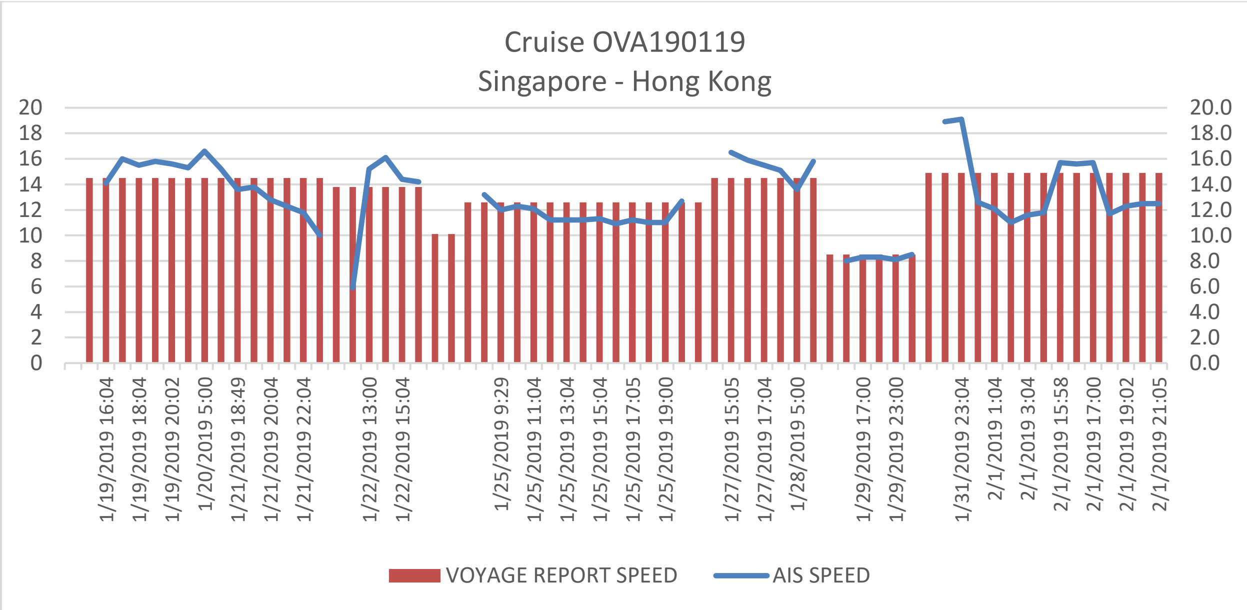


OVA190105
The economy of sailed sea miles per AIS Data
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
AIS Nm
AIS %
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm

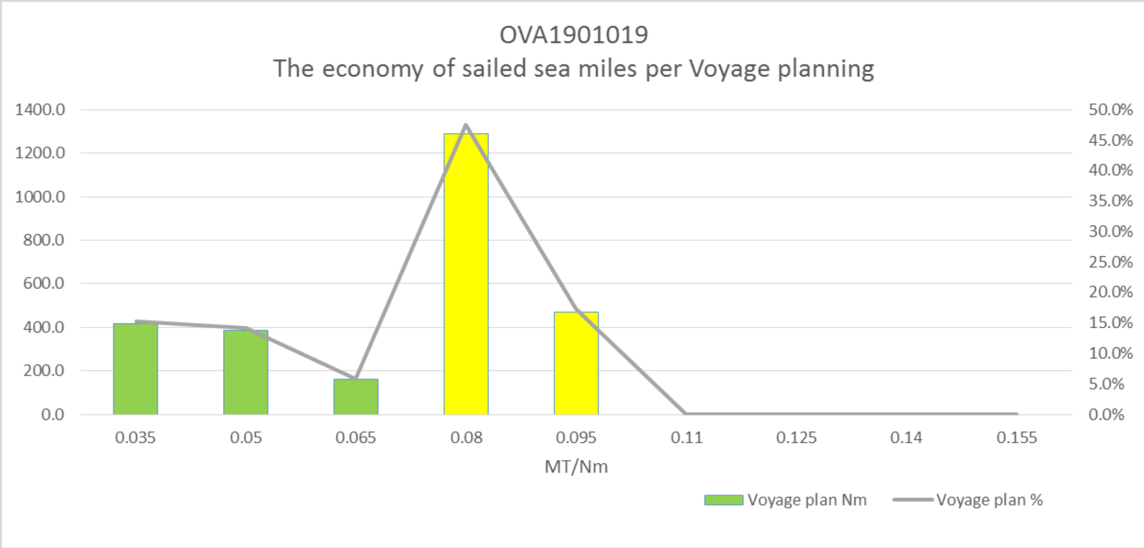


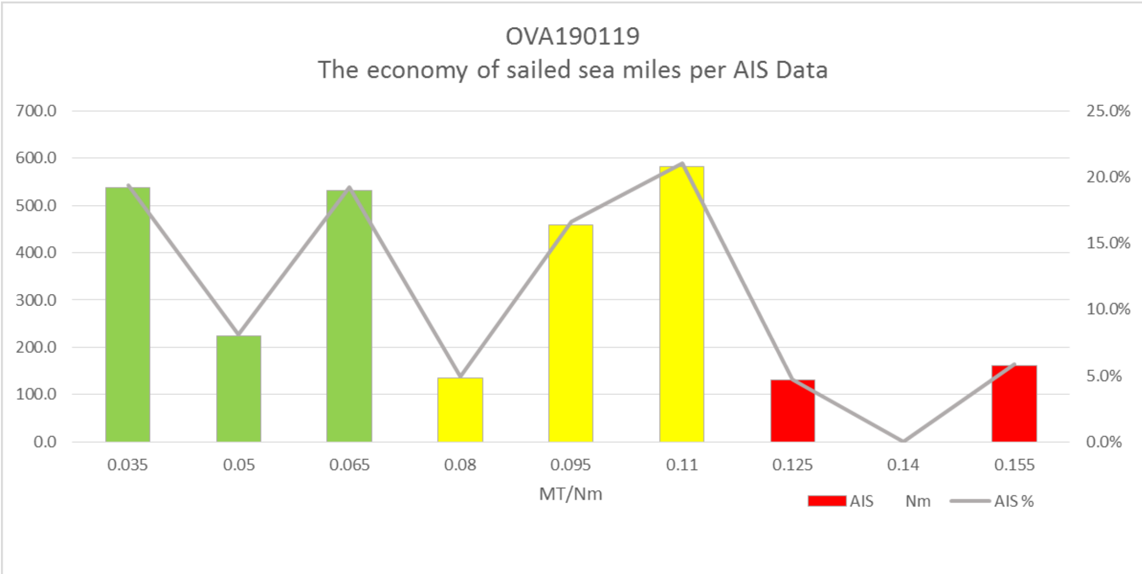
OVA190105
Itinerary profile
Voyage Plan vs AIS distances
1000.0
500.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

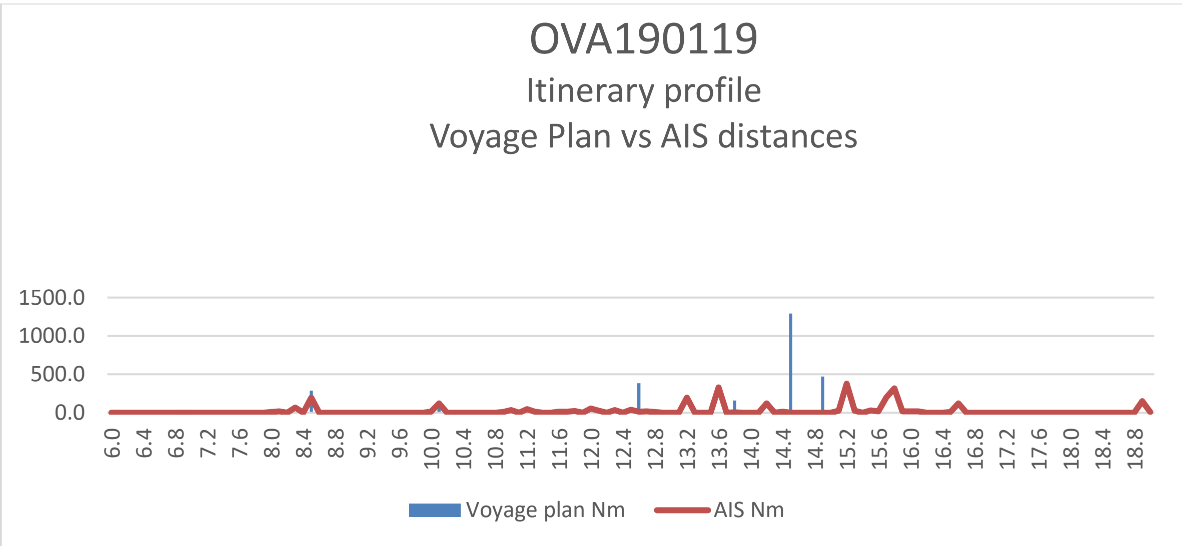


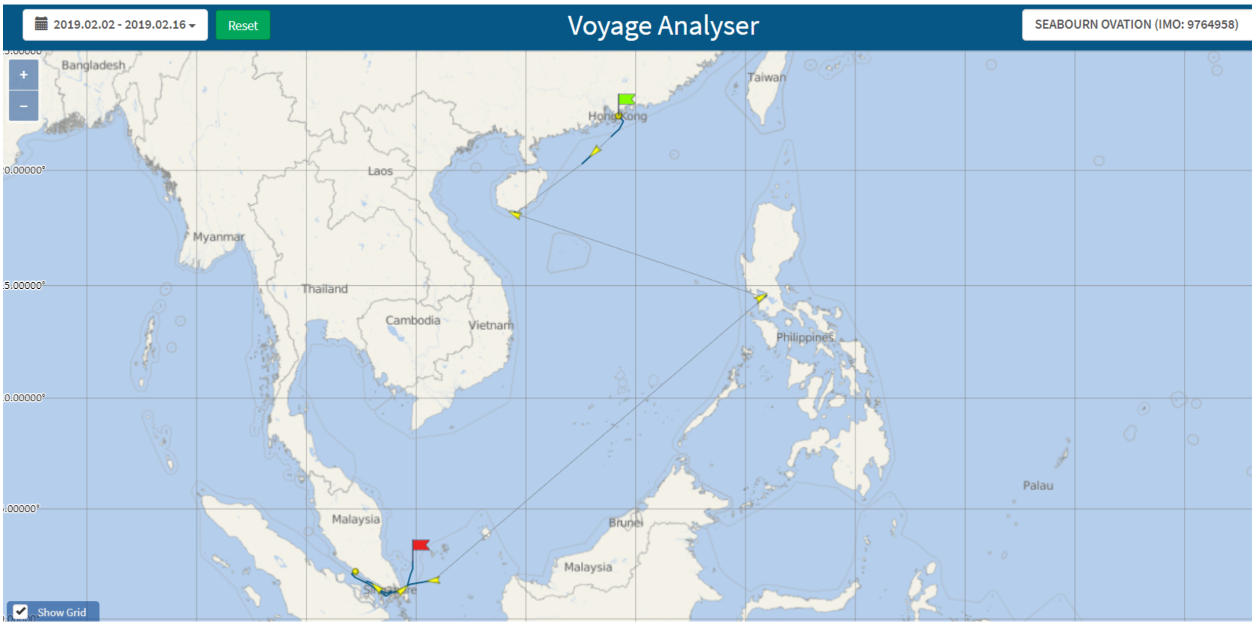


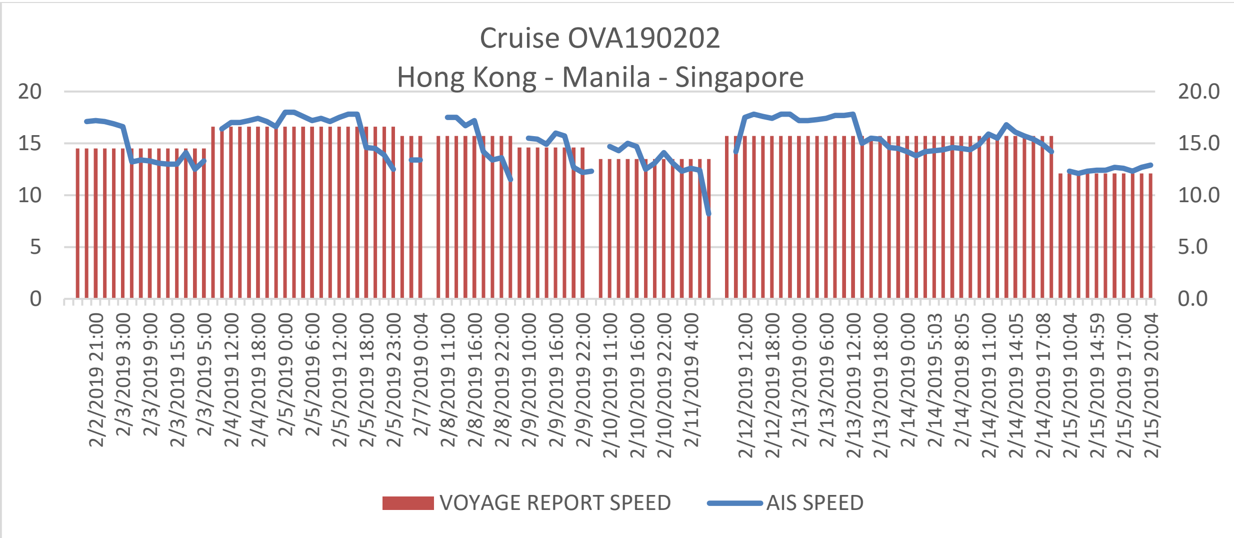
OVA190119												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	415.2	388.4	536.7	15.3%	14.8%	19.4%	10	10	14			
0.05	384.3	356.8	224.7	14.1%	13.6%	8.1%	17	13	9			
0.065	158.7	1355.9	532.2	5.8%	51.7%	19.3%	10	84	30	35.3%	80.2%	46.8%
0.08	1290.5	0.0	135.6	47.5%	0.0%	4.9%	96	0	9			
0.095	469.4	519.3	459.6	17.3%	19.8%	16.6%	38	48	40			
0.11	0.0	0.0	582.7	0.0%	0.0%	21.1%	0	0	58	64.7%	19.8%	42.6%
0.125	0.0	0.0	130.5	0.0%	0.0%	4.7%	0	0	15			
0.14	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.155	0.0	0.0	162.3	0.0%	0.0%	5.9%	0	0	23	0.0%	0.0%	10.6%
Total	2718.1	2620.5	2764.3	100.0%	100.0%	100.0%	171.5	154.6	199.7	100.0%	100.0%	100.0%
Average	0.0631	0.0590	0.0722	MT/Nm			174.4	163.1	199.7	MT		


OVA1901019
The economy of sailed sea miles per Voyage planning
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

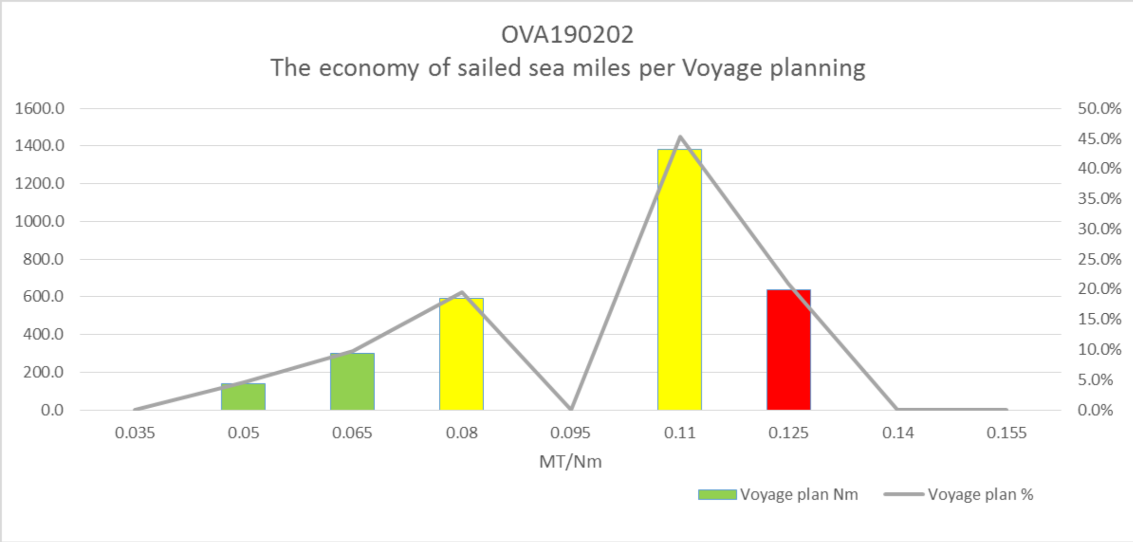

OVA190119
The economy of sailed sea miles per AIS Data
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

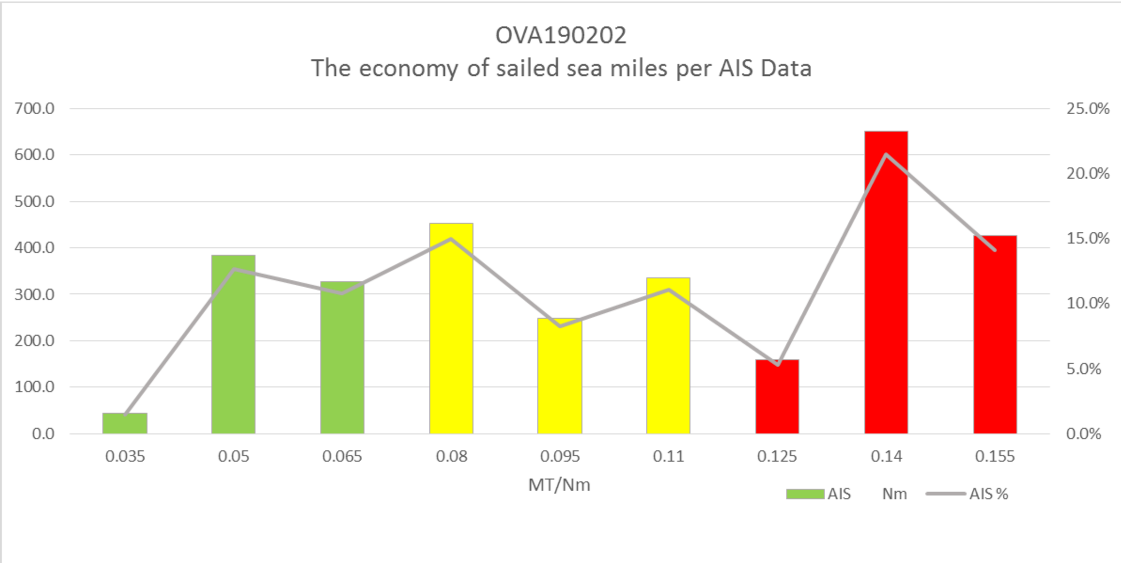

OVA190119
Itinerary profile
Voyage Plan vs AIS distances
1500.0
1000.0
500.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

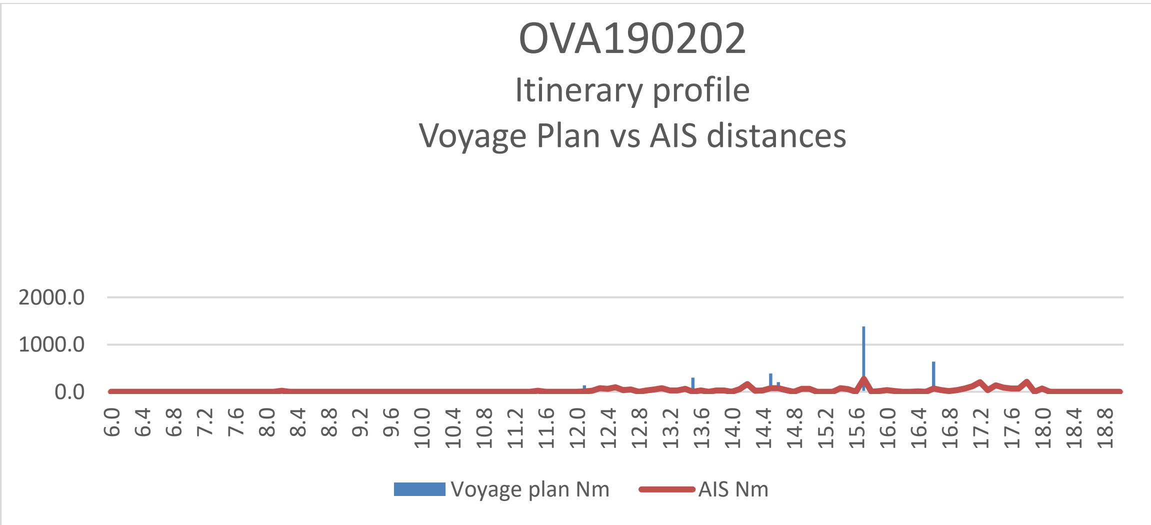


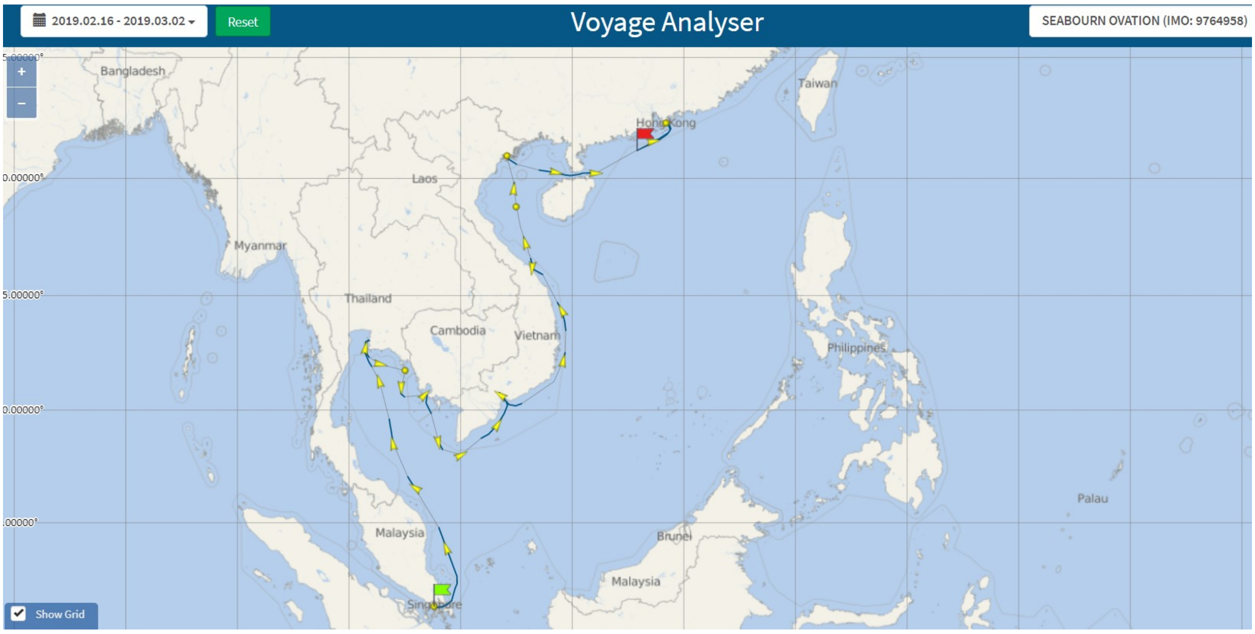


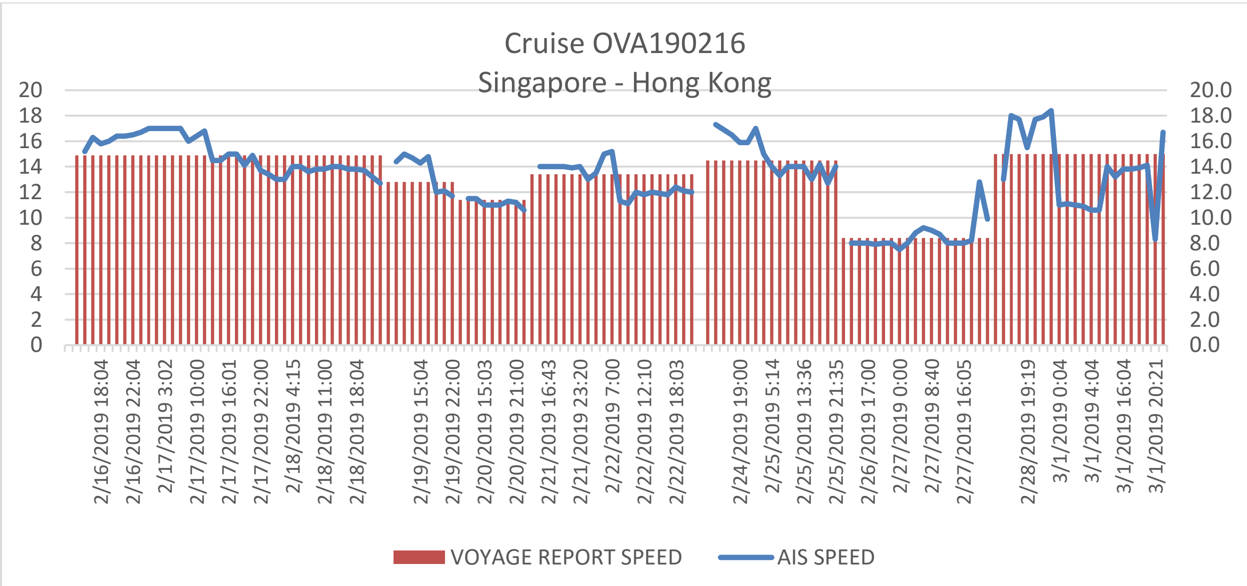
OVA190202												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	44.1	0.0%	0.0%	1.5%	0	0	1			
0.05	137.9	422.1	383.8	4.5%	14.1%	12.7%	5	19	17			
0.065	297.2	0.0	326.7	9.8%	0.0%	10.8%	17	0	18	14.3%	14.1%	24.9%
0.08	591.5	793.1	453.4	19.4%	26.5%	15.0%	44	56	33			
0.095	0.0	207.9	249.1	0.0%	7.0%	8.2%	0	17	22			
0.11	1380.3	935.1	334.7	45.4%	31.3%	11.0%	134	93	33	64.8%	64.8%	34.2%
0.125	636.6	628.9	160.4	20.9%	21.1%	5.3%	75	71	19			
0.14	0.0	0.0	650.4	0.0%	0.0%	21.5%	0	0	86			
0.155	0.0	0.0	426.8	0.0%	0.0%	14.1%	0	0	62	20.9%	21.1%	40.9%
Total	3043.6	2987.1	3029.4	100.0%	100.0%	100.0%	275.9	256.1	291.4	100.0%	100.0%	100.0%
Average	0.0907	0.0857	0.0962	MT/Nm			274.6	259.7	291.4	MT		


OVA190202
The economy of sailed sea miles per Voyage planning
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

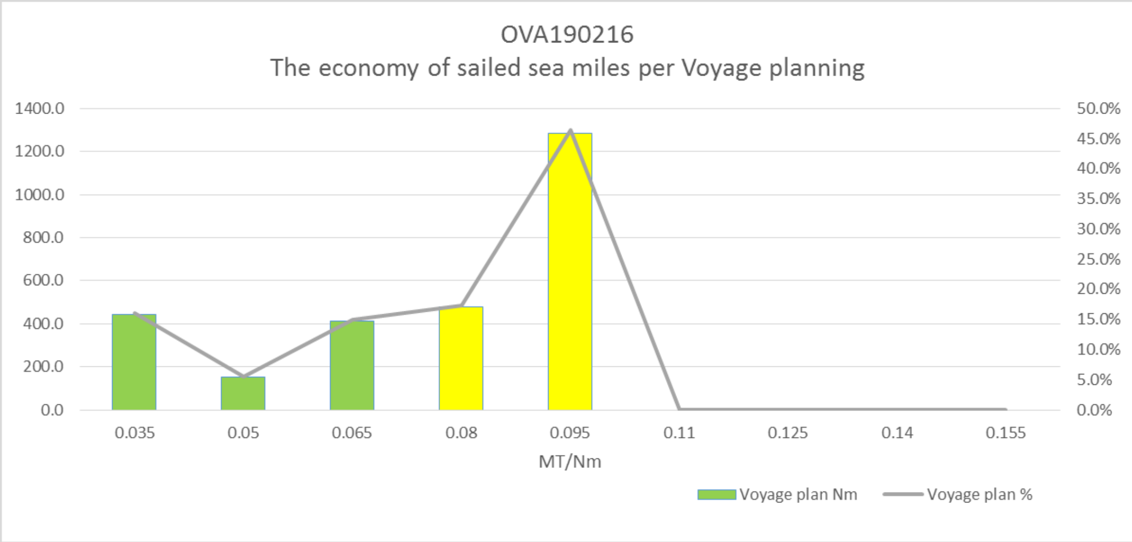

OVA190202
The economy of sailed sea miles per AIS Data
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

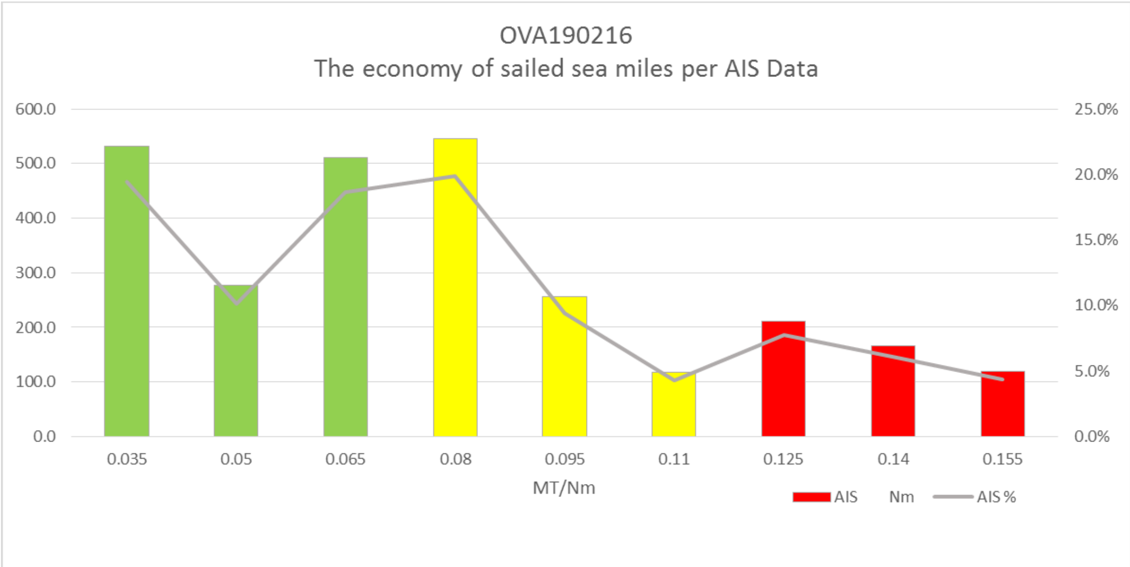

OVA190202
Itinerary profile
Voyage Plan vs AIS distances
2000.0
1000.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

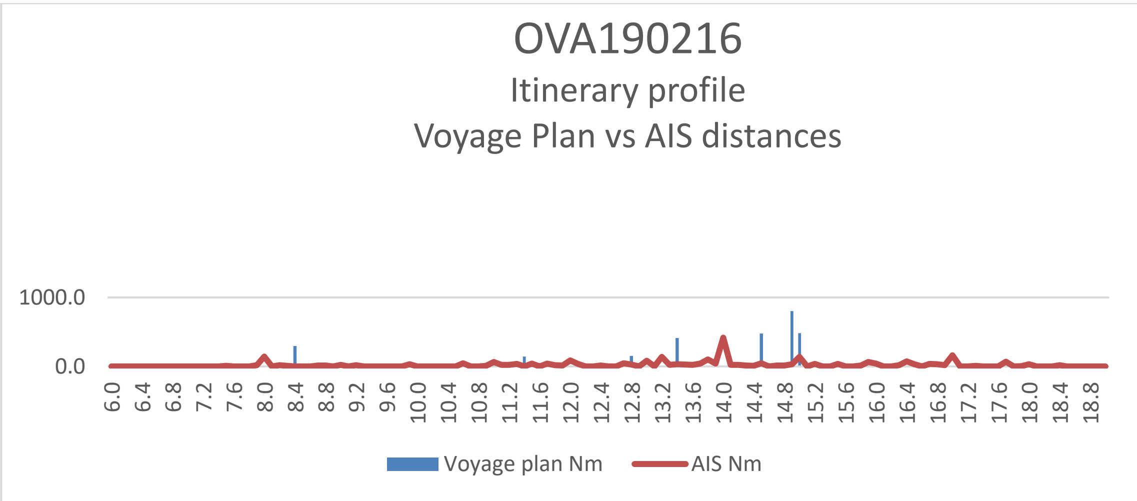


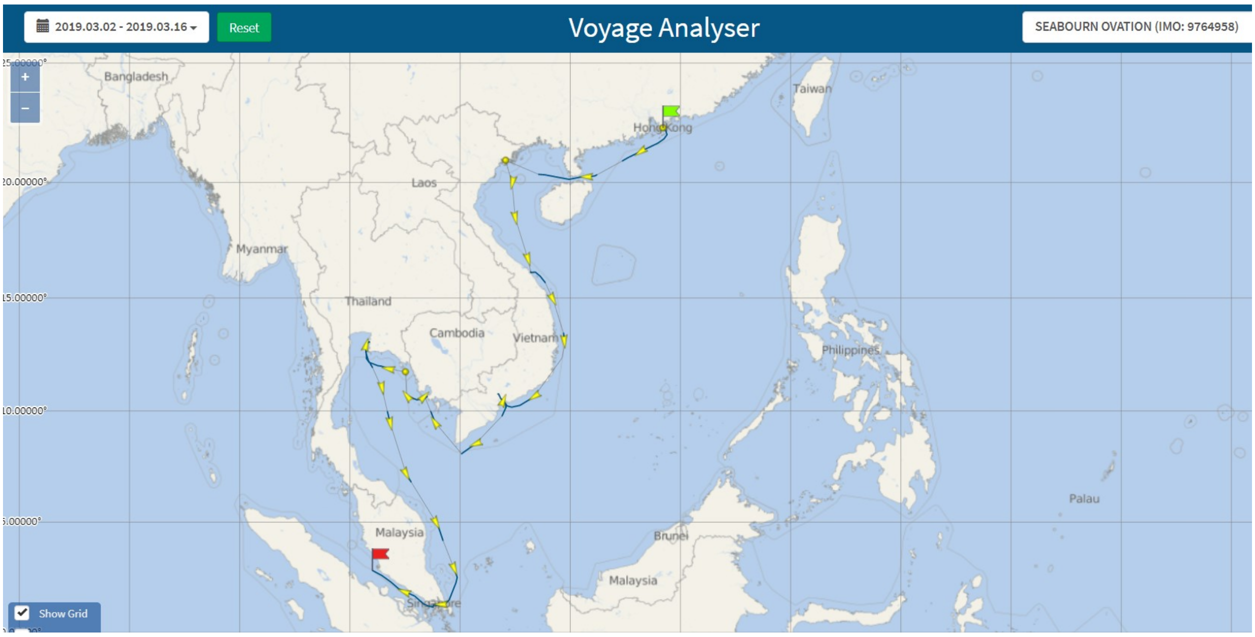


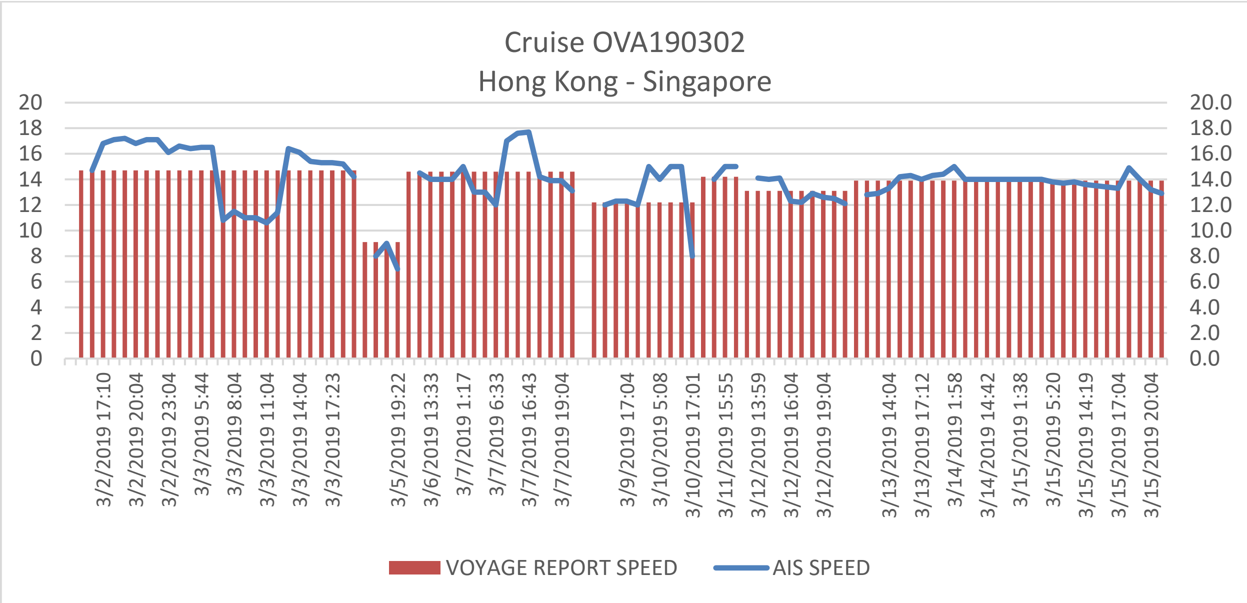
OVA190216												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	442.8	446.1	531.8	16.0%	16.3%	19.4%	12	12	15			
0.05	151.3	397.1	277.2	5.5%	14.5%	10.1%	7	20	11			
0.065	412.5	158.3	511.8	14.9%	5.8%	18.7%	23	9	29	36.3%	36.5%	48.2%
0.08	479.0	448.2	545.5	17.3%	16.3%	19.9%	36	29	37			
0.095	1284.4	1293.0	257.0	46.4%	47.1%	9.4%	106	104	22			
0.11	0.0	0.0	117.2	0.0%	0.0%	4.3%	0	0	12	63.7%	63.5%	33.6%
0.125	0.0	0.0	212.0	0.0%	0.0%	7.7%	0	0	25			
0.14	0.0	0.0	166.6	0.0%	0.0%	6.1%	0	0	21			
0.155	0.0	0.0	119.2	0.0%	0.0%	4.4%	0	0	17	0.0%	0.0%	18.2%
Total	2769.9	2742.8	2738.5	100.0%	100.0%	100.0%	183.6	174.0	188.4	100.0%	100.0%	100.0%
Average	0.0663	0.0635	0.0688	MT/Nm			181.5	173.8	188.4	MT		


OVA190216
The economy of sailed sea miles per Voyage planning
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

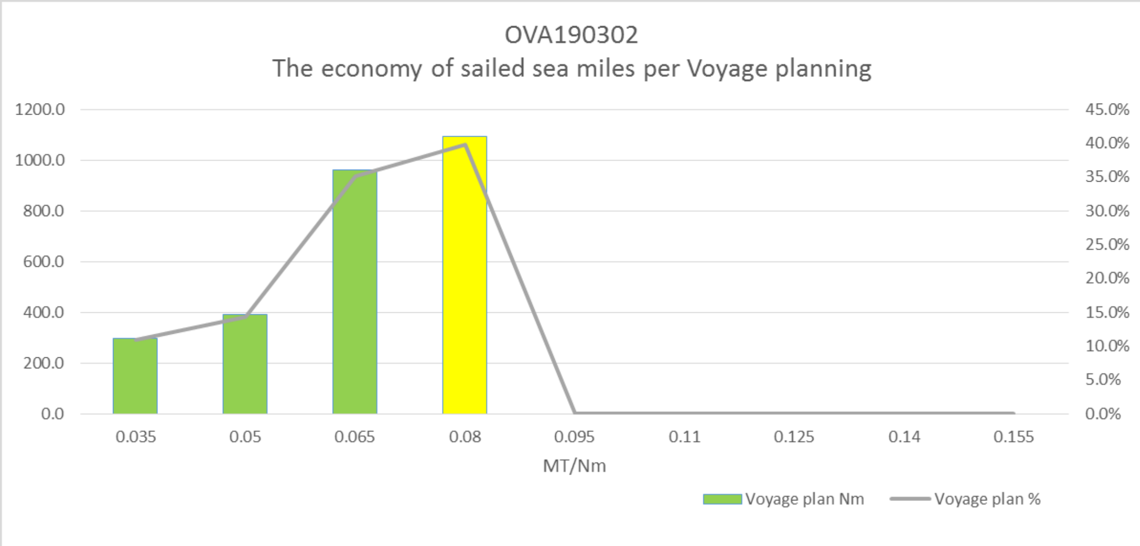

OVA190216
The economy of sailed sea miles per AIS Data
600.0
500.0
400.0
300.0
200.0
100.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %


OVA190216
Itinerary profile
Voyage Plan vs AIS distances
1000.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

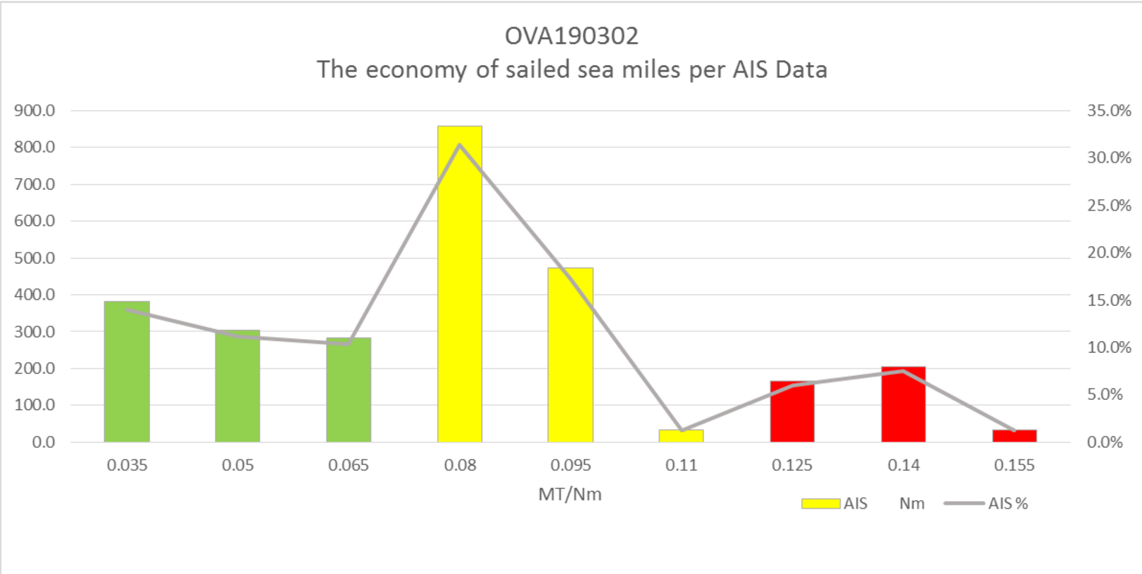




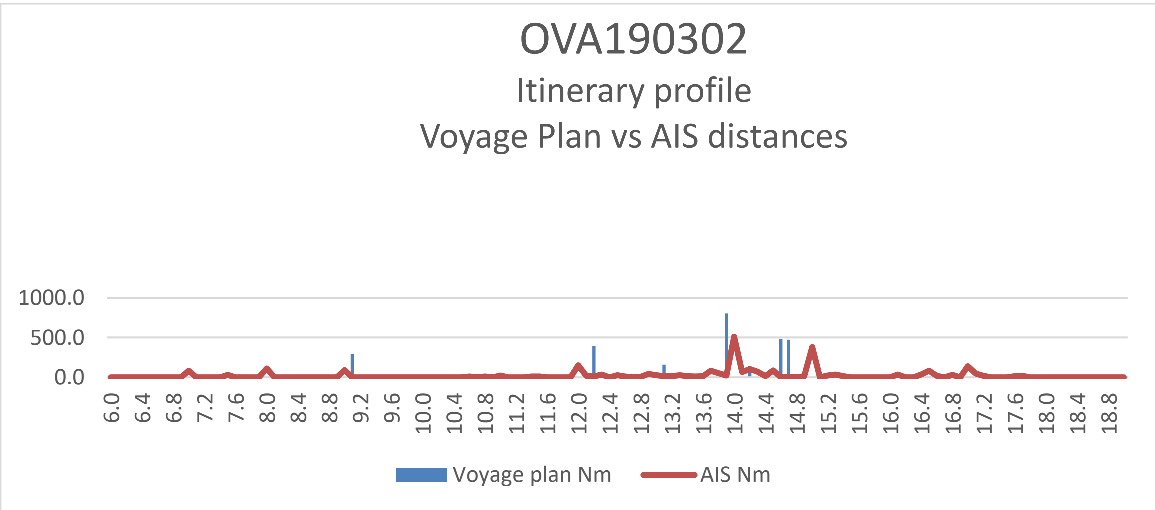
OVA190302												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	297.9	258.6	382.1	10.8%	9.5%	14.0%	7	6	10			
0.05	392.4	556.0	303.9	14.3%	20.5%	11.1%	16	25	13			
0.065	962.6	797.2	282.0	35.1%	29.4%	10.3%	60	50	16	60.2%	59.5%	35.4%
0.08	1092.6	616.4	857.1	39.8%	22.8%	31.3%	83	45	58			
0.095	0.0	480.0	472.4	0.0%	17.7%	17.3%	0	39	40			
0.11	0.0	0.0	33.2	0.0%	0.0%	1.2%	0	0	4	39.8%	40.5%	49.8%
0.125	0.0	0.0	164.8	0.0%	0.0%	6.0%	0	0	19			
0.14	0.0	0.0	205.1	0.0%	0.0%	7.5%	0	0	26			
0.155	0.0	0.0	34.5	0.0%	0.0%	1.3%	0	0	5	0.0%	0.0%	14.8%
Total	2745.5	2708.2	2735.2	100.0%	100.0%	100.0%	165.5	165.2	190.4	100.0%	100.0%	100.0%
Average	0.0603	0.0610	0.0696	MT/Nm			164.9	166.9	190.4	MT		



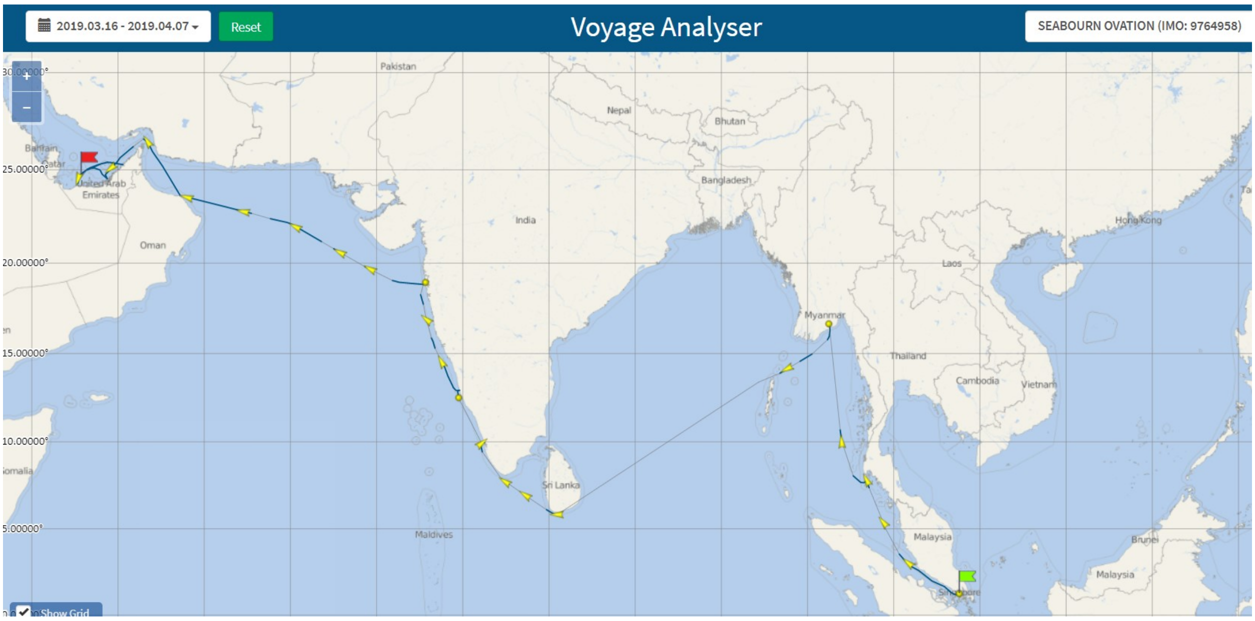
OVA190302
The economy of sailed sea miles per Voyage planning
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

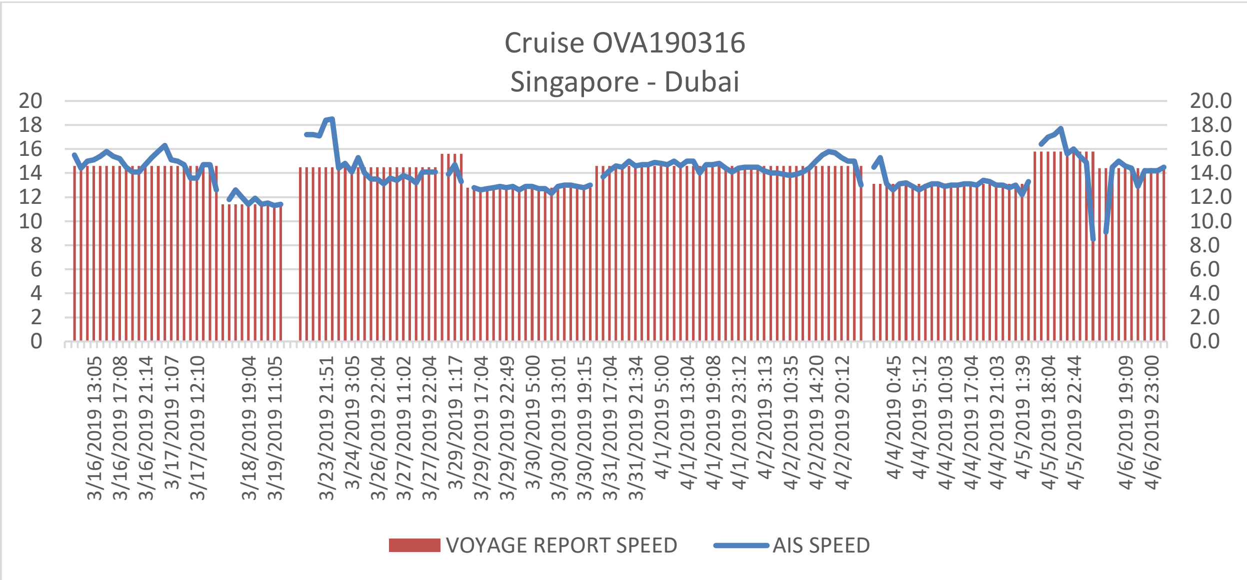


OVA190302
The economy of sailed sea miles per AIS Data
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

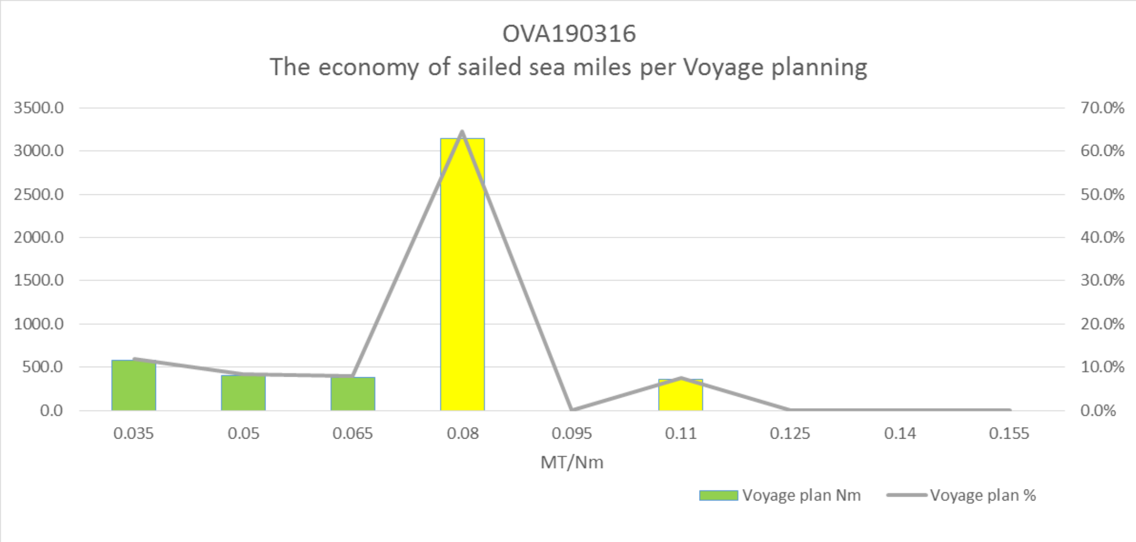


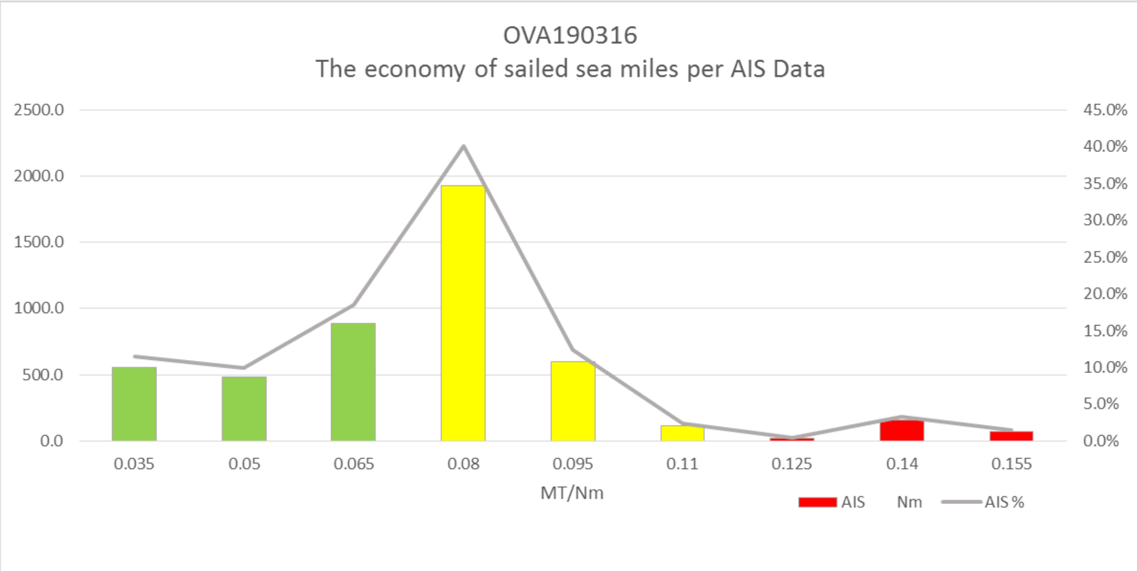
OVA190302
Itinerary profile
Voyage Plan vs AIS distances
1000.0
500.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

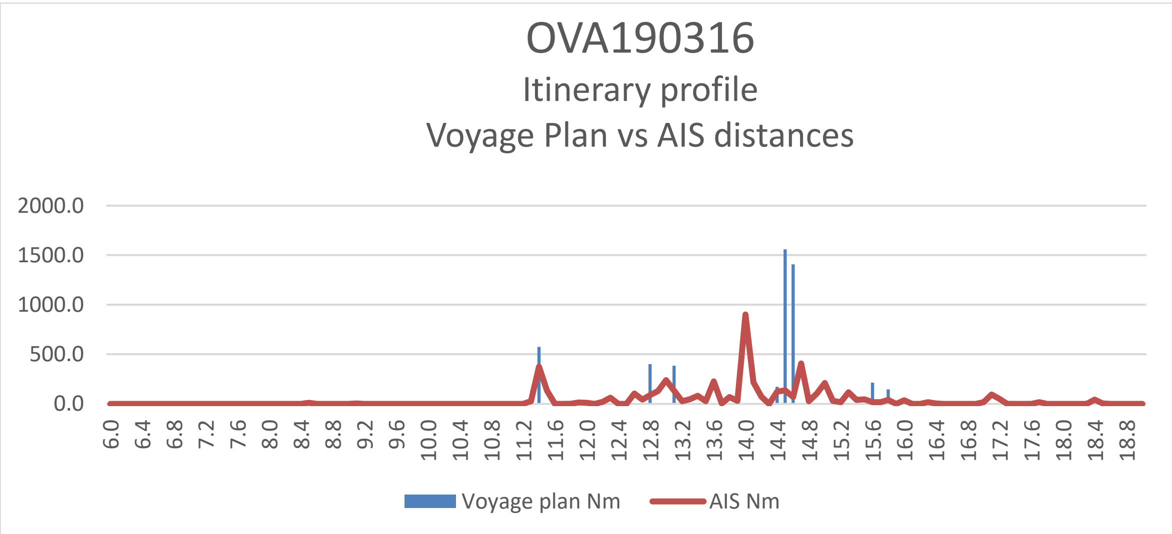


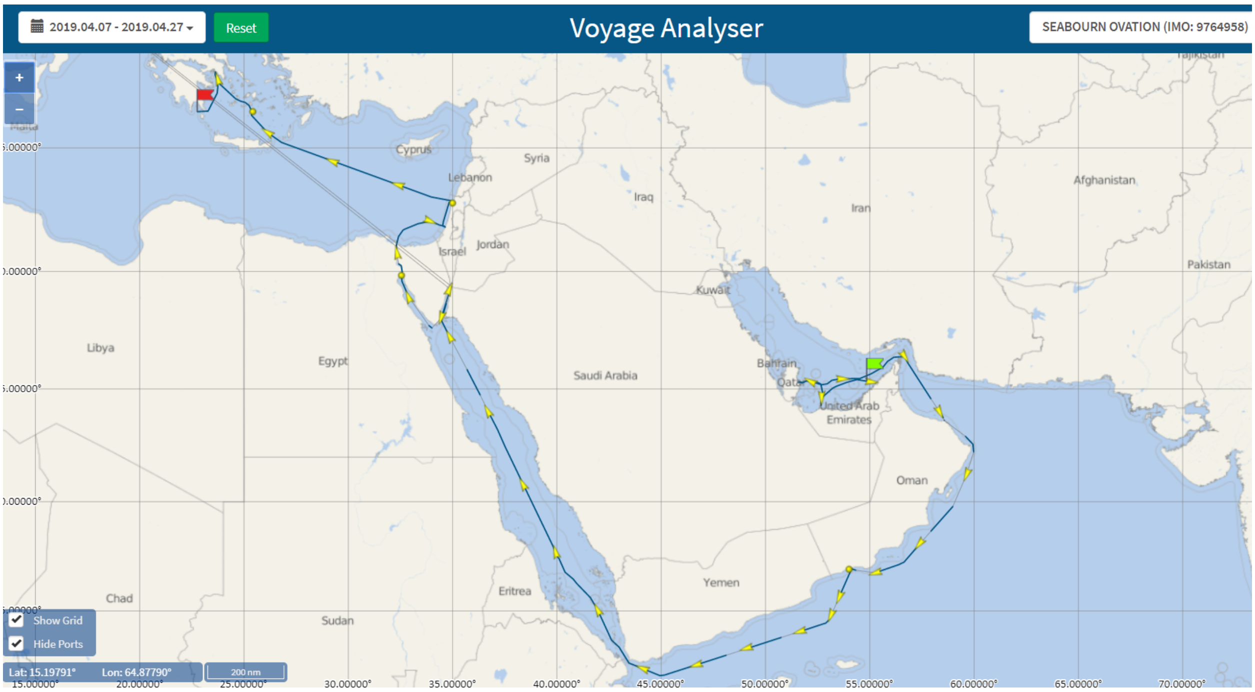


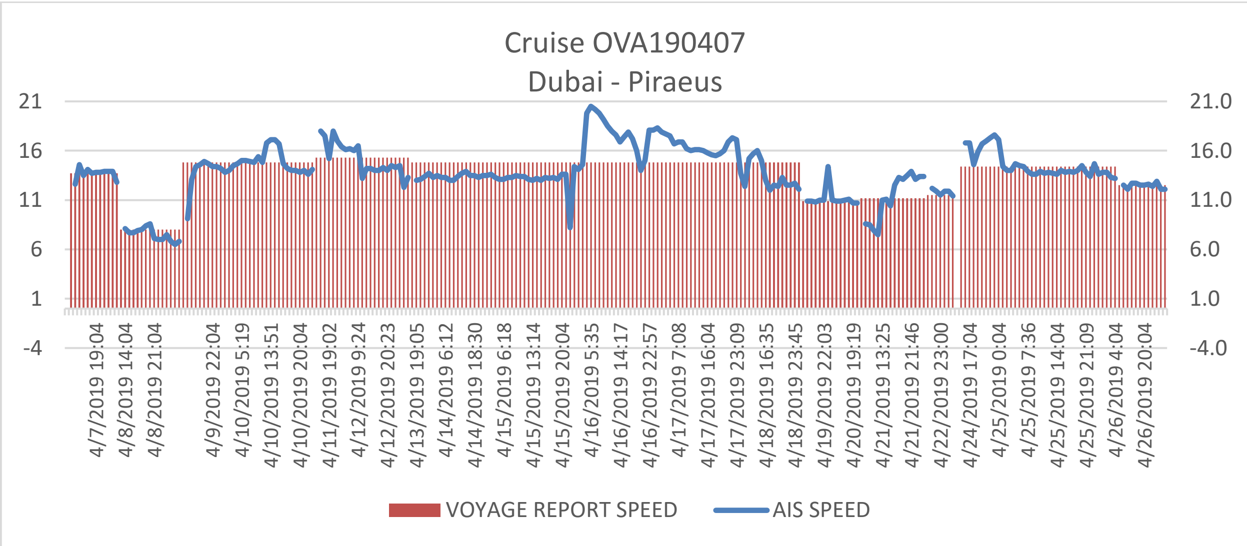
OVA190316												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	574.9	0.0	555.0	11.8%	0.0%	11.5%	19	0	18			
0.05	402.8	992.8	479.3	8.3%	20.5%	10.0%	19	40	22			
0.065	385.1	550.7	889.4	7.9%	11.4%	18.5%	20	30	49	28.0%	31.8%	40.0%
0.08	3141.2	1714.6	1930.6	64.6%	35.3%	40.1%	235	123	135			
0.095	0.0	1592.5	595.7	0.0%	32.8%	12.4%	0	127	51			
0.11	359.9	0.0	113.5	7.4%	0.0%	2.4%	35	0	11	72.0%	68.2%	54.8%
0.125	0.0	0.0	22.1	0.0%	0.0%	0.5%	0	0	2			
0.14	0.0	0.0	159.5	0.0%	0.0%	3.3%	0	0	21			
0.155	0.0	0.0	68.2	0.0%	0.0%	1.4%	0	0	10	0.0%	0.0%	5.2%
Total	4863.9	4850.6	4813.4	100.0%	100.0%	100.0%	328.1	320.2	319.7	100.0%	100.0%	100.0%
Average	0.0675	0.0660	0.0664	MT/Nm			324.7	317.8	319.7	MT		


OVA190316
The economy of sailed sea miles per Voyage planning
MT/Nm
Voyage plan Nm
Voyage plan %

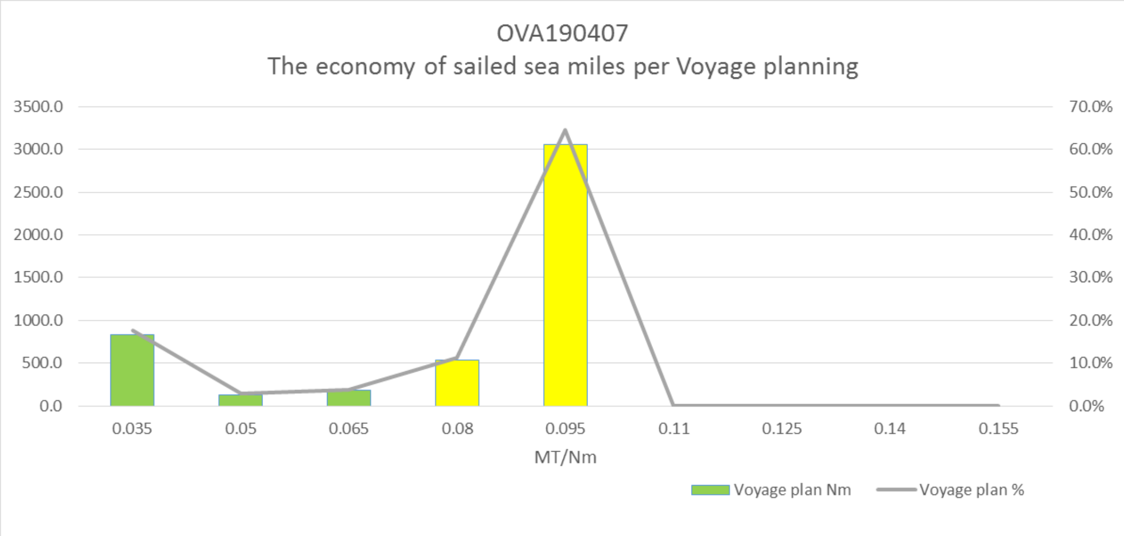

OVA190316
The economy of sailed sea miles per AIS Data
MT/Nm
AIS Nm
AIS %

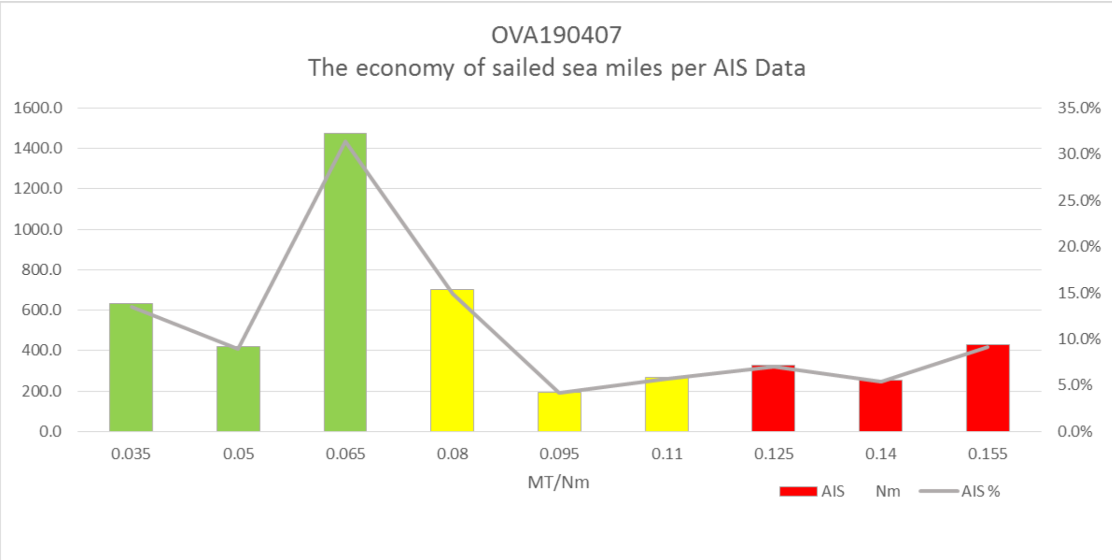

OVA190316
Itinerary profile
Voyage Plan vs AIS distances
Voyage plan Nm
AIS Nm

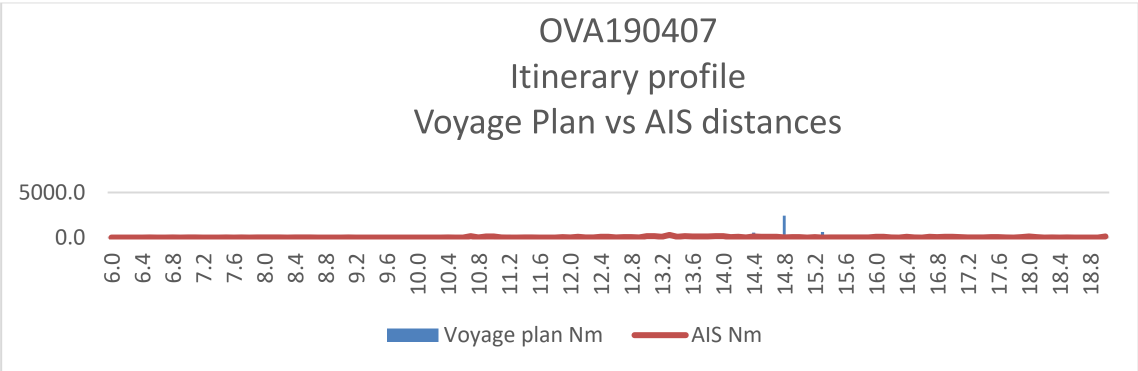


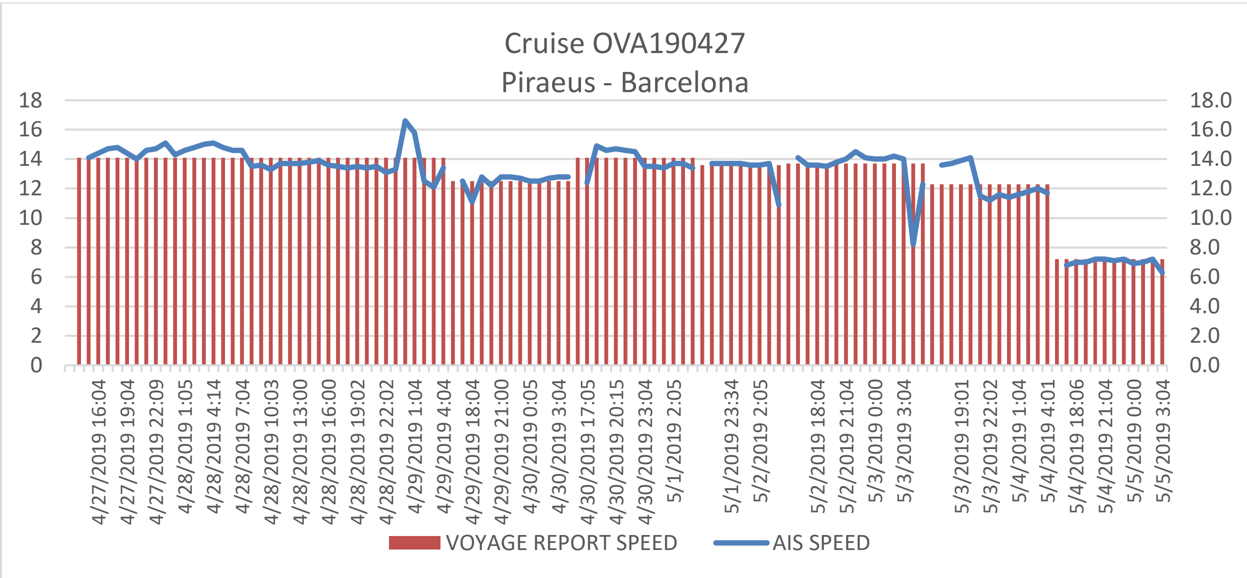


OVA190407												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	836.4	774.0	633.4	17.7%	16.4%	13.5%	25	24	18			
0.05	131.0	203.9	421.6	2.8%	4.3%	9.0%	6	8	18			
0.065	178.6	177.3	1474.8	3.8%	3.8%	31.3%	11	10	84	24.2%	24.5%	53.7%
0.08	532.6	1031.9	700.4	11.3%	21.8%	14.9%	39	77	50			
0.095	3051.3	2537.1	195.0	64.5%	53.7%	4.1%	249	206	17			
0.11	0.0	0.0	268.2	0.0%	0.0%	5.7%	0	0	28	75.8%	75.5%	24.7%
0.125	0.0	0.0	329.7	0.0%	0.0%	7.0%	0	0	39			
0.14	0.0	0.0	254.7	0.0%	0.0%	5.4%	0	0	33			
0.155	0.0	0.0	429.3	0.0%	0.0%	9.1%	0	0	63	0.0%	0.0%	21.5%
Total	4729.8	4724.1	4707.1	100.0%	100.0%	100.0%	329.0	325.1	349.6	100.0%	100.0%	100.0%
Average	0.0696	0.0688	0.0743	MT/Nm			327.5	323.9	349.6	MT		

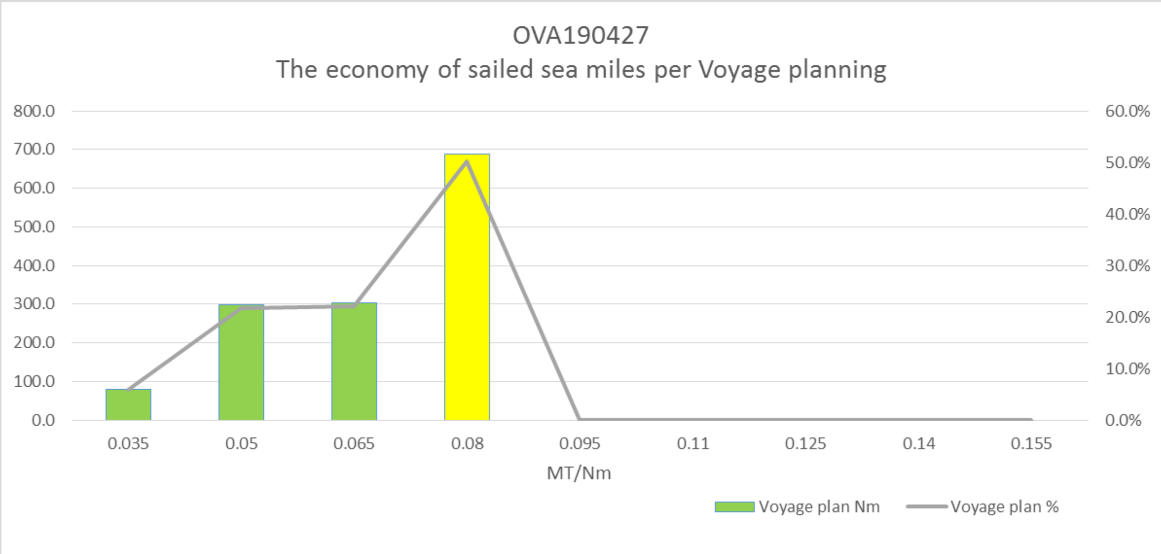

OVA190407
The economy of sailed sea miles per Voyage planning
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035 0.05 0.065 0.08 0.095 0.11 0.125 0.14 0.155
MT/Nm
Voyage plan Nm
Voyage plan %

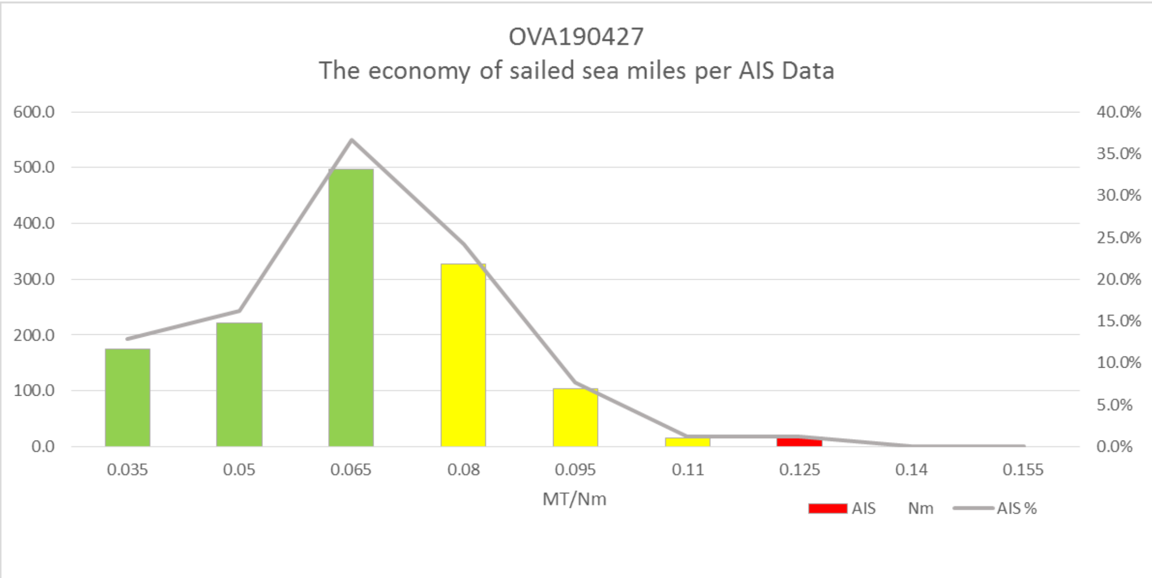

OVA190407
The economy of sailed sea miles per AIS Data
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035 0.05 0.065 0.08 0.095 0.11 0.125 0.14 0.155
MT/Nm
AIS Nm
AIS %

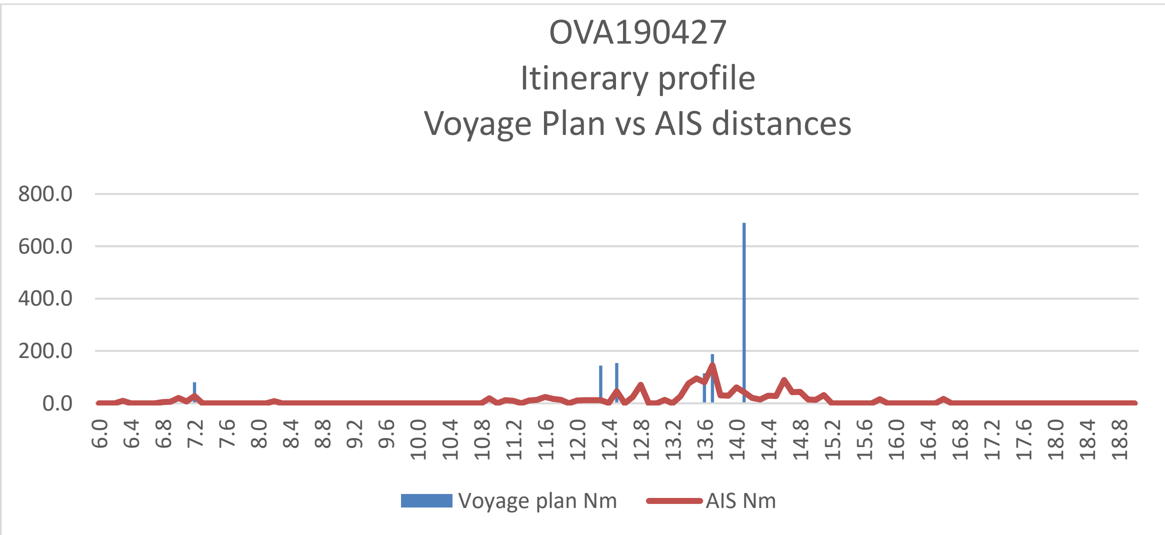

OVA190407
Itinerary profile
Voyage Plan vs AIS distances
5000.0
0.0
6.0 6.4 6.8 7.2 7.6 8.0 8.4 8.8 9.2 9.6 10.0 10.4 10.8 11.2 11.6 12.0 12.4 12.8 13.2 13.6 14.0 14.4 14.8 15.2 15.6 16.0 16.4 16.8 17.2 17.6 18.0 18.4 18.8
Voyage plan Nm
AIS Nm

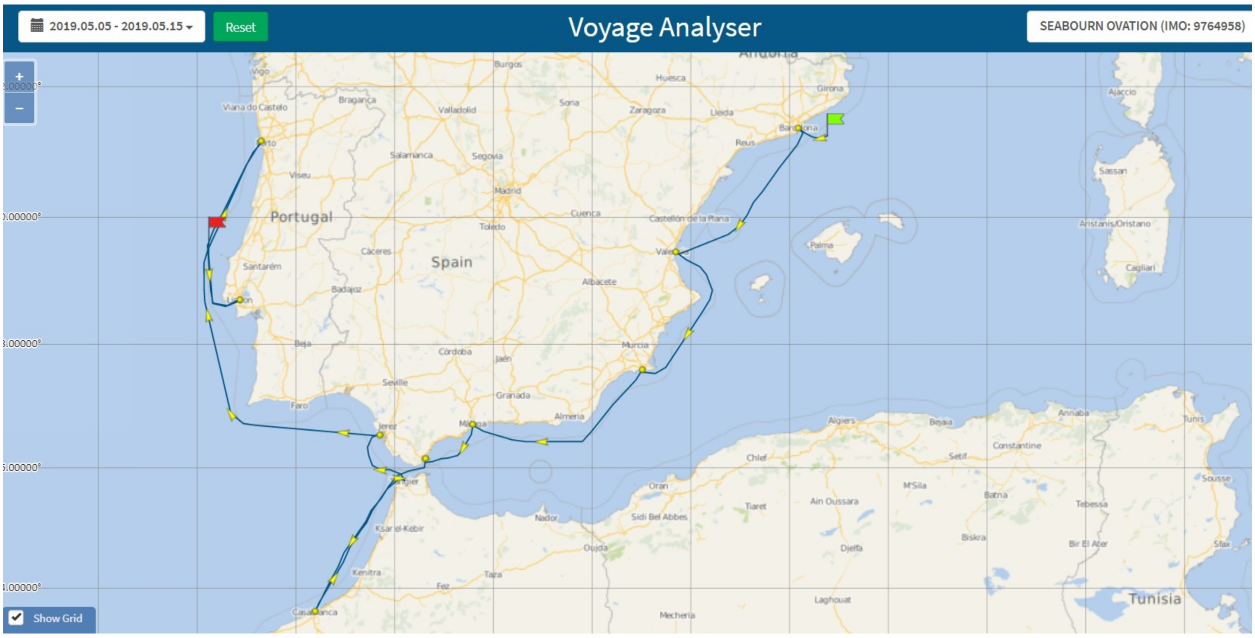


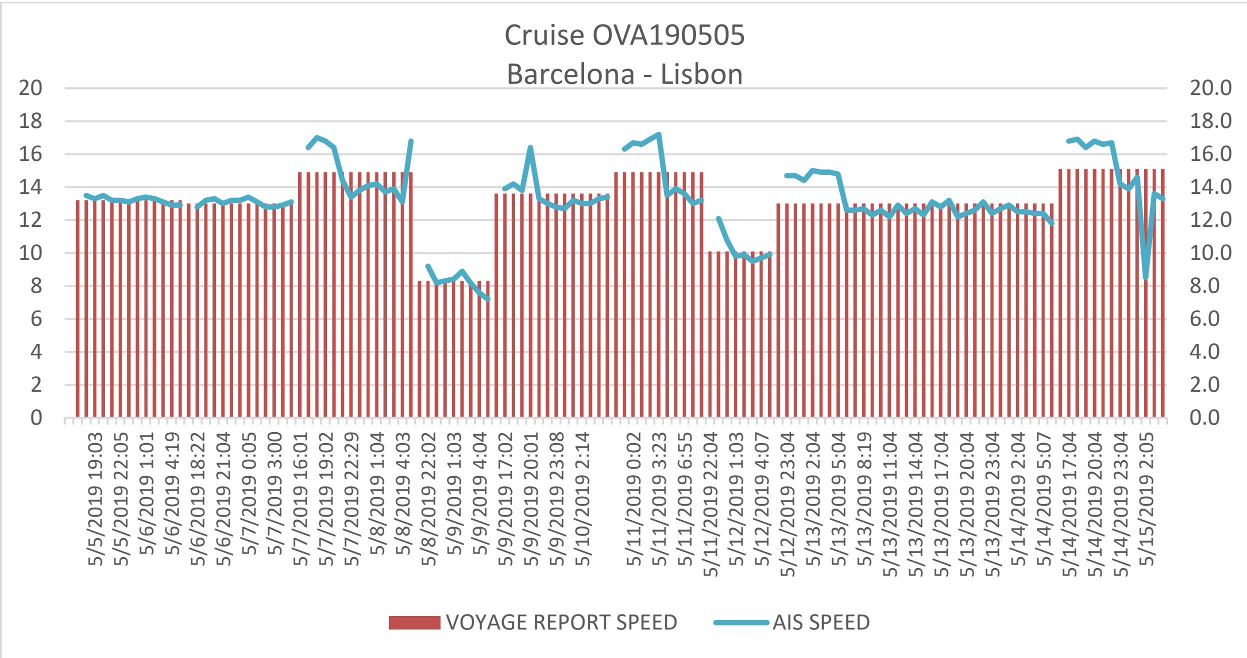
OVA190427												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	80.0	76.7	174.2	5.8%	5.7%	12.8%	2	2	5			
0.05	297.7	297.7	220.7	21.7%	22.0%	16.3%	13	13	10			
0.065	303.3	448.3	498.0	22.1%	33.1%	36.7%	18	26	29	49.7%	60.7%	65.8%
0.08	689.0	532.0	327.8	50.3%	39.3%	24.2%	46	36	24			
0.095	0.0	0.0	104.1	0.0%	0.0%	7.7%	0	0	9			
0.11	0.0	0.0	15.8	0.0%	0.0%	1.2%	0	0	2	50.3%	39.3%	33.0%
0.125	0.0	0.0	16.6	0.0%	0.0%	1.2%	0	0	2			
0.14	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	0.0%	0.0%	1.2%
Total	1370.0	1354.7	1357.2	100.0%	100.0%	100.0%	79.4	76.1	79.6	100.0%	100.0%	100.0%
Average	0.0579	0.0562	0.0587	MT/Nm			78.6	76.3	79.6	MT		
								Difference	3.5	MT		


OVA190427
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

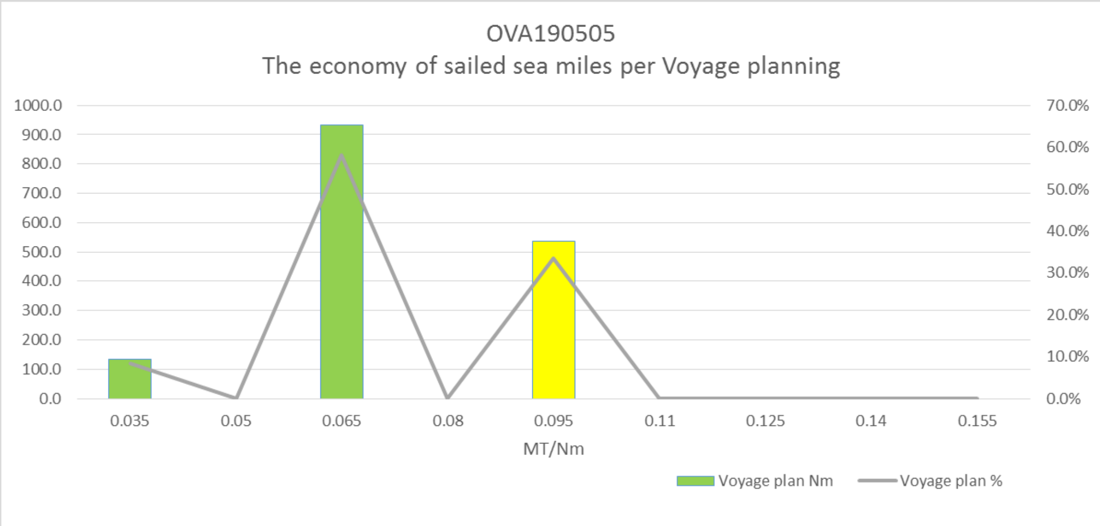

OVA190427
The economy of sailed sea miles per AIS Data
600.0
500.0
400.0
300.0
200.0
100.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

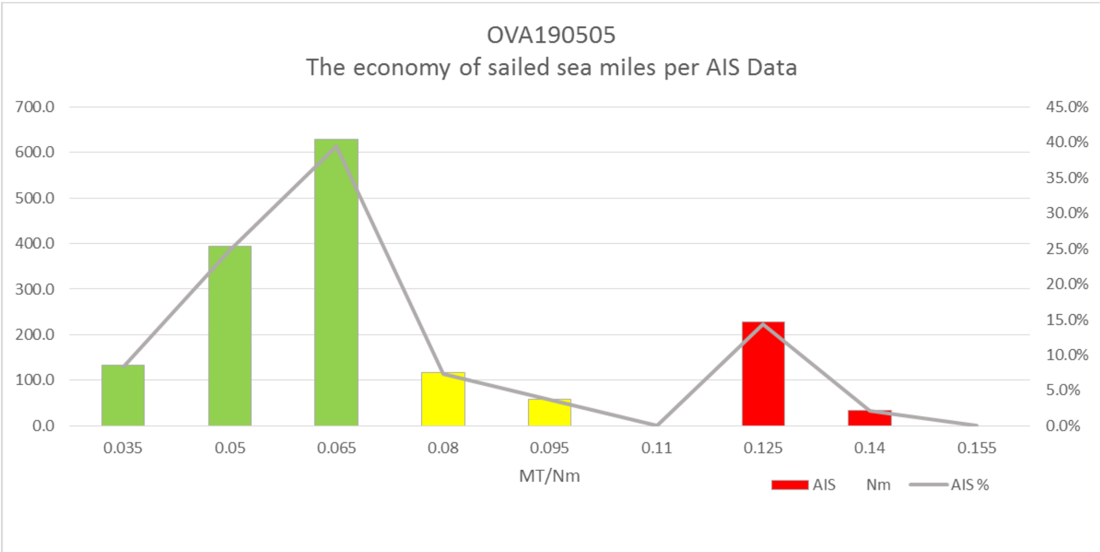

OVA190427
Itinerary profile
Voyage Plan vs AIS distances
800.0
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

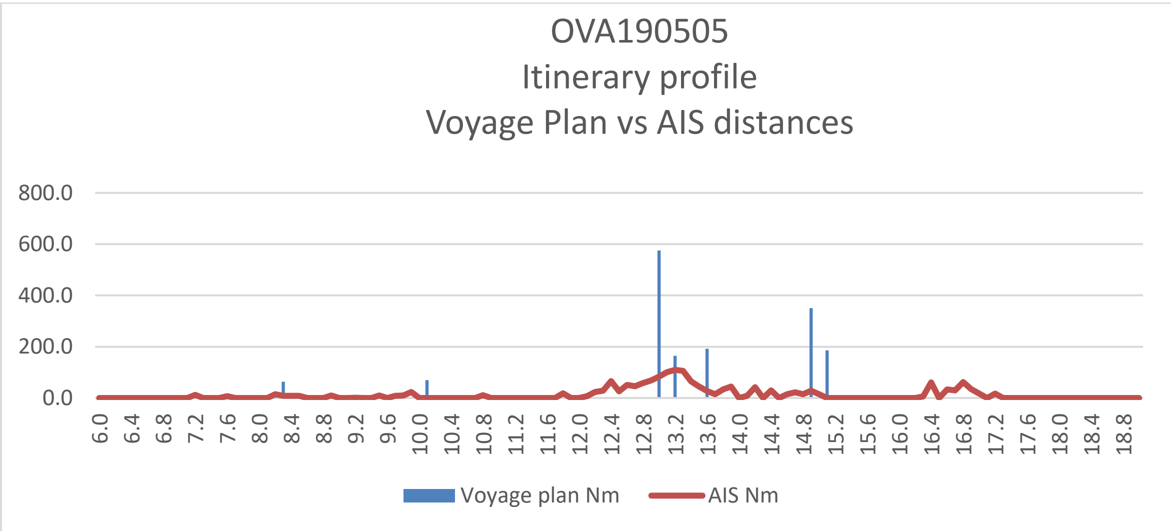


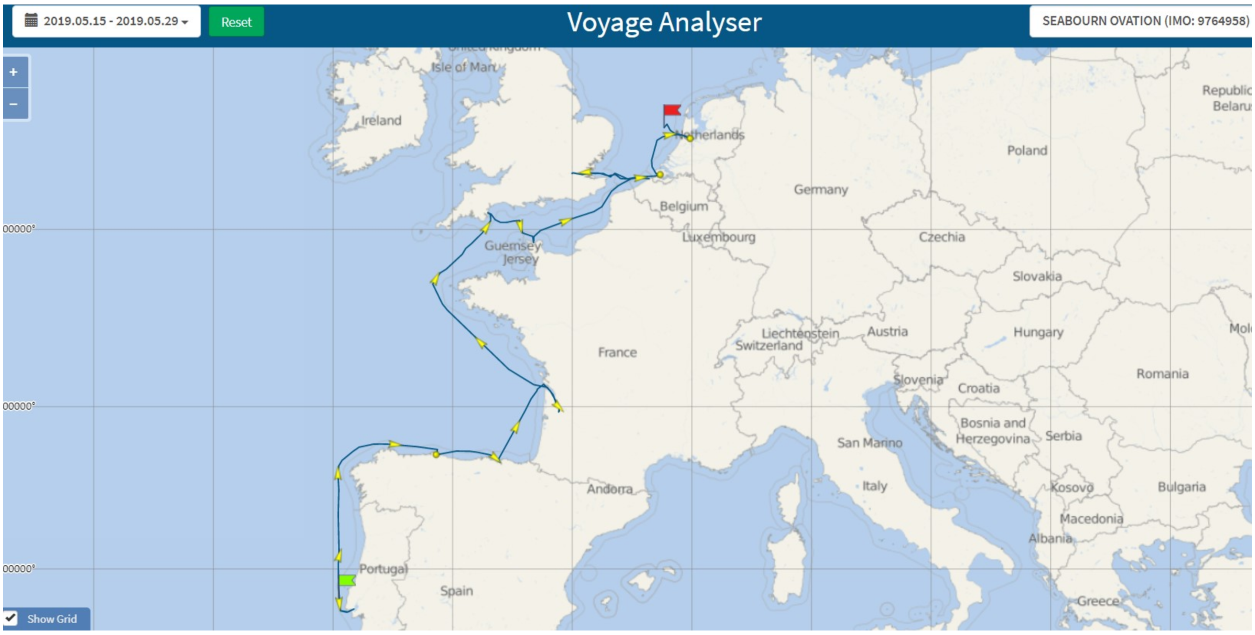


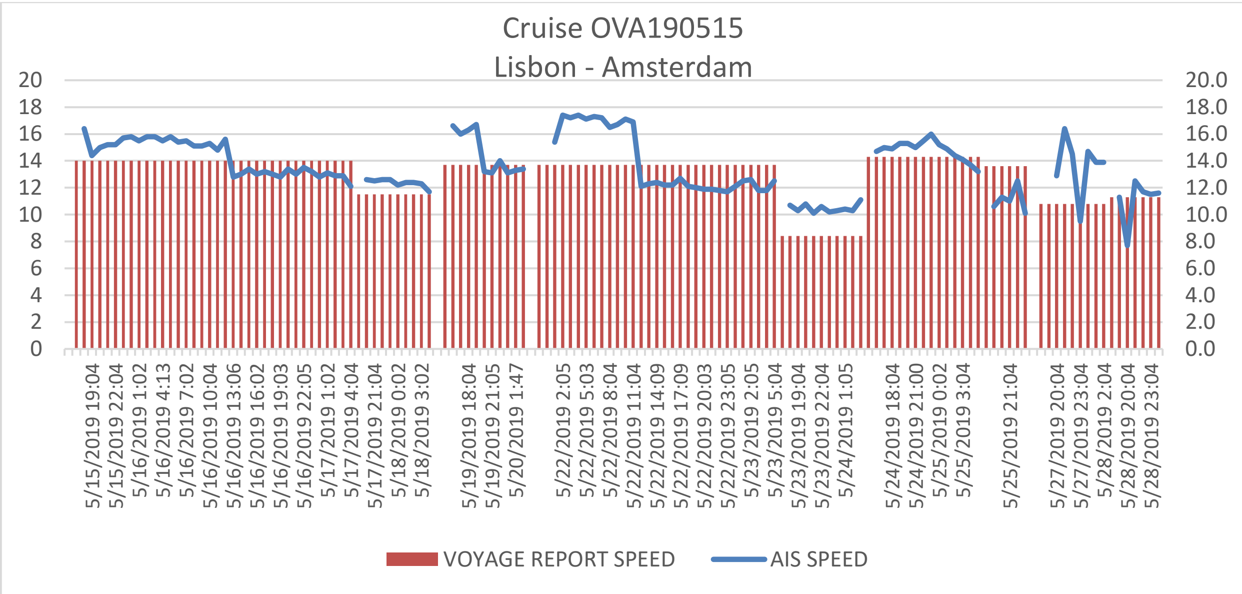
OVA190505												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	133.5	132.7	132.6	8.3%	8.3%	8.3%	3	3	3			
0.05	0.0	0.0	394.2	0.0%	0.0%	24.8%	0	0	18			
0.065	932.5	932.3	628.9	58.2%	58.3%	39.5%	49	49	35	66.5%	66.6%	72.6%
0.08	0.0	180.8	117.4	0.0%	11.3%	7.4%	0	14	8			
0.095	535.9	352.7	58.4	33.5%	22.1%	3.7%	44	29	5			
0.11	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	33.5%	33.4%	11.0%
0.125	0.0	0.0	227.5	0.0%	0.0%	14.3%	0	0	27			
0.14	0.0	0.0	33.7	0.0%	0.0%	2.1%	0	0	4			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	0.0%	0.0%	16.4%
Total	1601.9	1598.5	1592.7	100.0%	100.0%	100.0%	96.9	96.0	100.3	100.0%	100.0%	100.0%
Average	0.0605	0.0601	0.0629	MT/Nm			96.4	95.7	100.3	MT		


OVA190505
The economy of sailed sea miles per Voyage planning
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

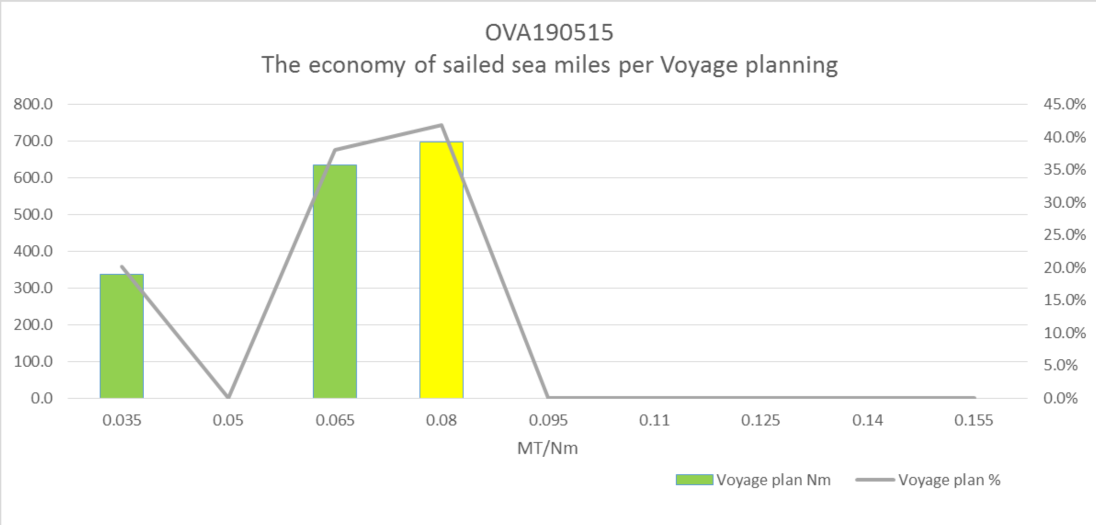

OVA190505
The economy of sailed sea miles per AIS Data
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

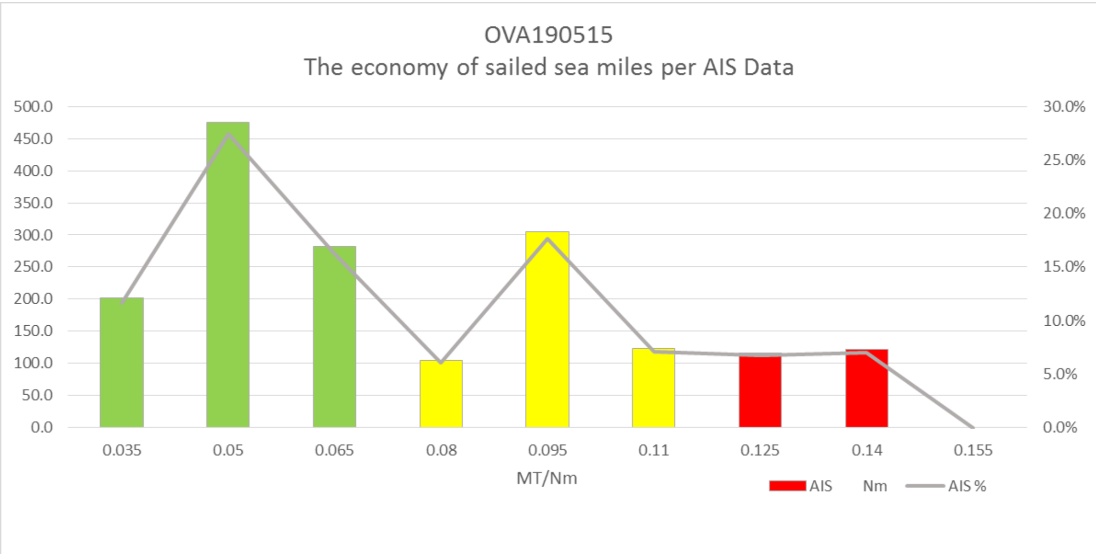

OVA190505
Itinerary profile
Voyage Plan vs AIS distances
800.0
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

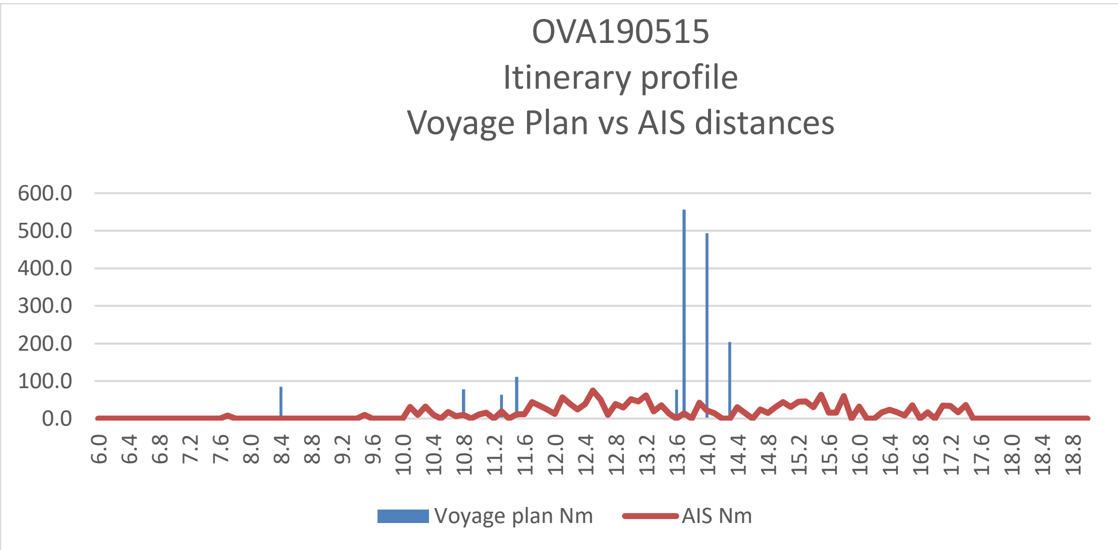


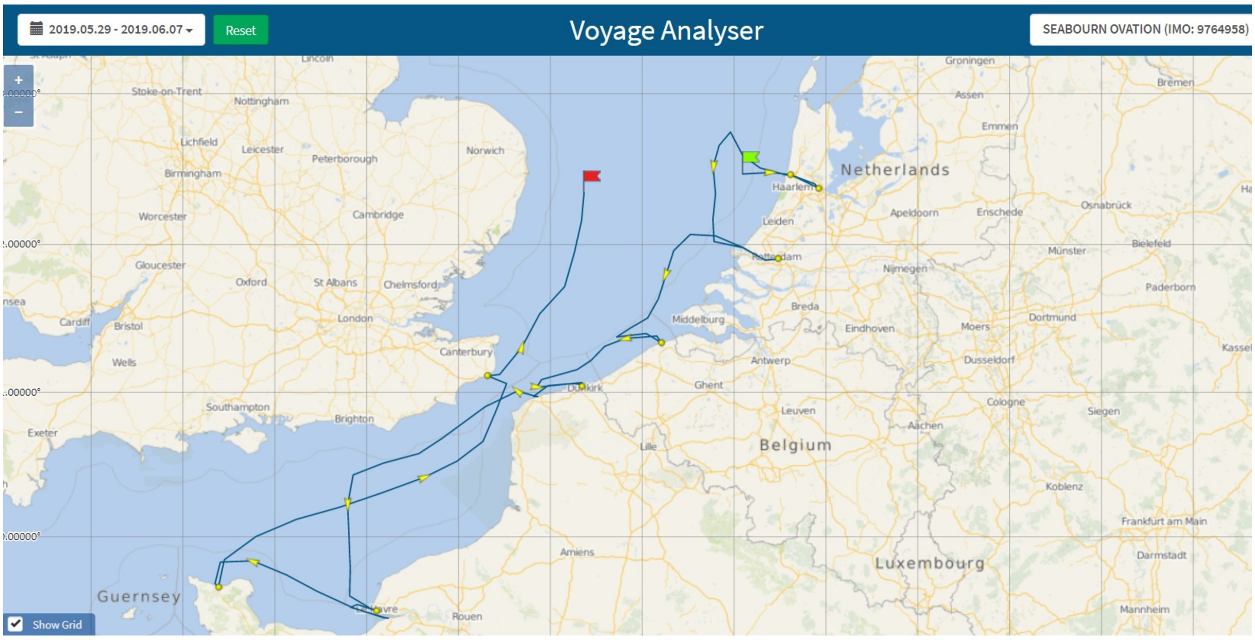


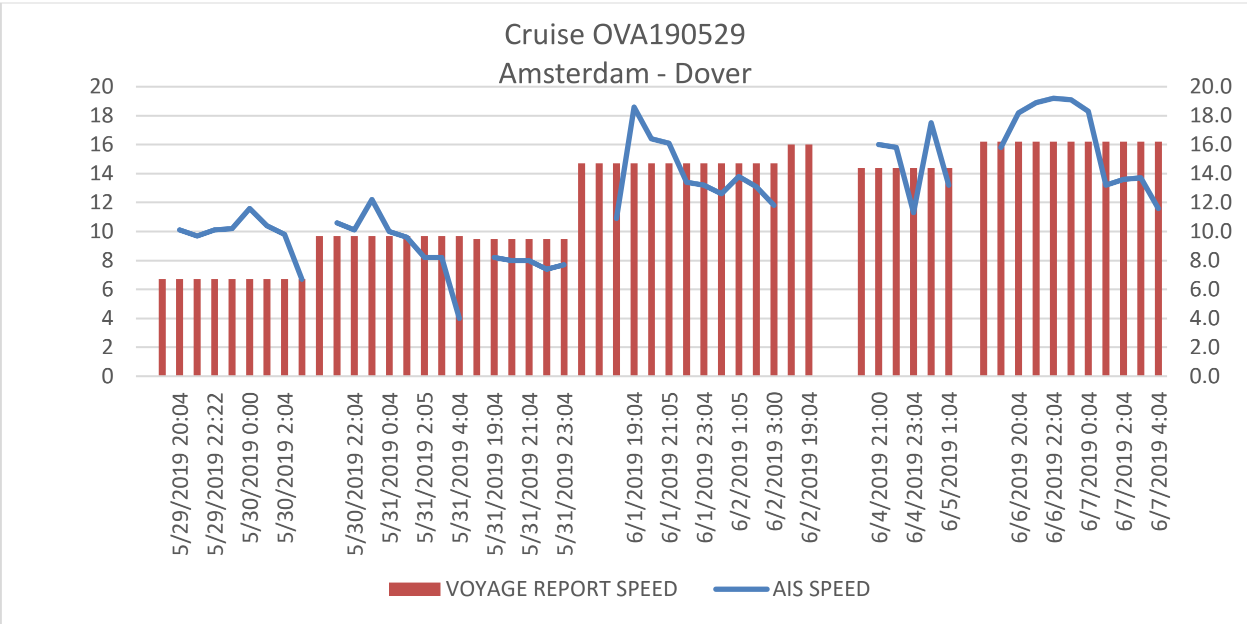
OVA190515												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	336.8	229.3	202.0	20.2%	13.2%	11.7%	10	6	6			
0.05	0.0	118.9	474.9	0.0%	6.9%	27.5%	0	5	20			
0.065	633.6	513.5	282.0	38.0%	29.6%	16.3%	38	33	16	58.2%	49.7%	55.4%
0.08	697.5	870.5	105.0	41.8%	50.3%	6.1%	47	64	8			
0.095	0.0	0.0	304.9	0.0%	0.0%	17.6%	0	0	27			
0.11	0.0	0.0	123.4	0.0%	0.0%	7.1%	0	0	12	41.8%	50.3%	30.8%
0.125	0.0	0.0	116.4	0.0%	0.0%	6.7%	0	0	14			
0.14	0.0	0.0	121.4	0.0%	0.0%	7.0%	0	0	16			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	0.0%	0.0%	13.7%
Total	1668.0	1732.2	1730.0	100.0%	100.0%	100.0%	95.2	107.5	117.3	100.0%	100.0%	100.0%
Average	0.0571	0.0620	0.0678	MT/Nm			98.7	107.3	117.3	MT		


OVA190515
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

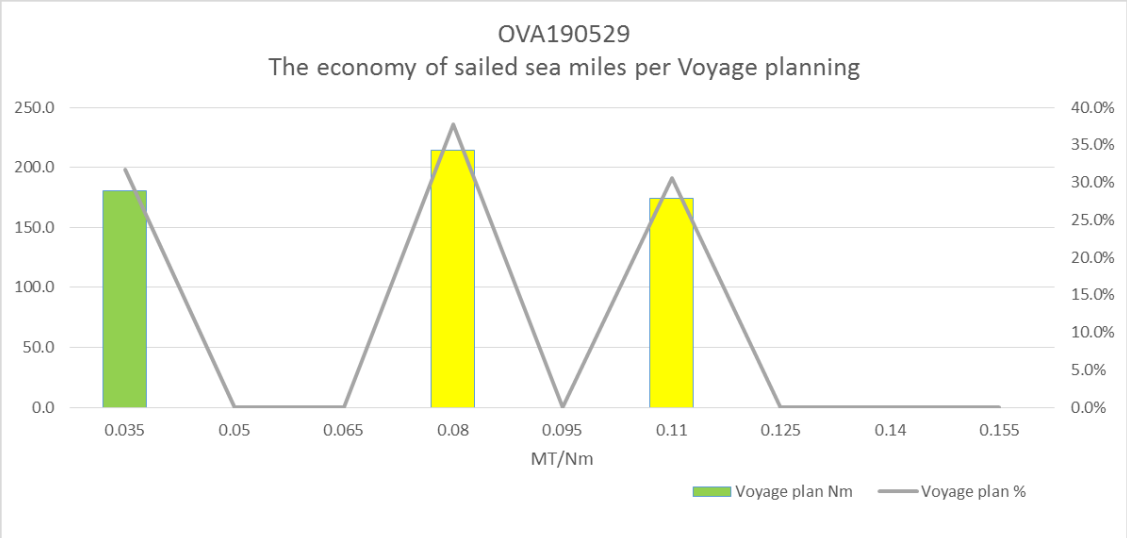

OVA190515
The economy of sailed sea miles per AIS Data
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

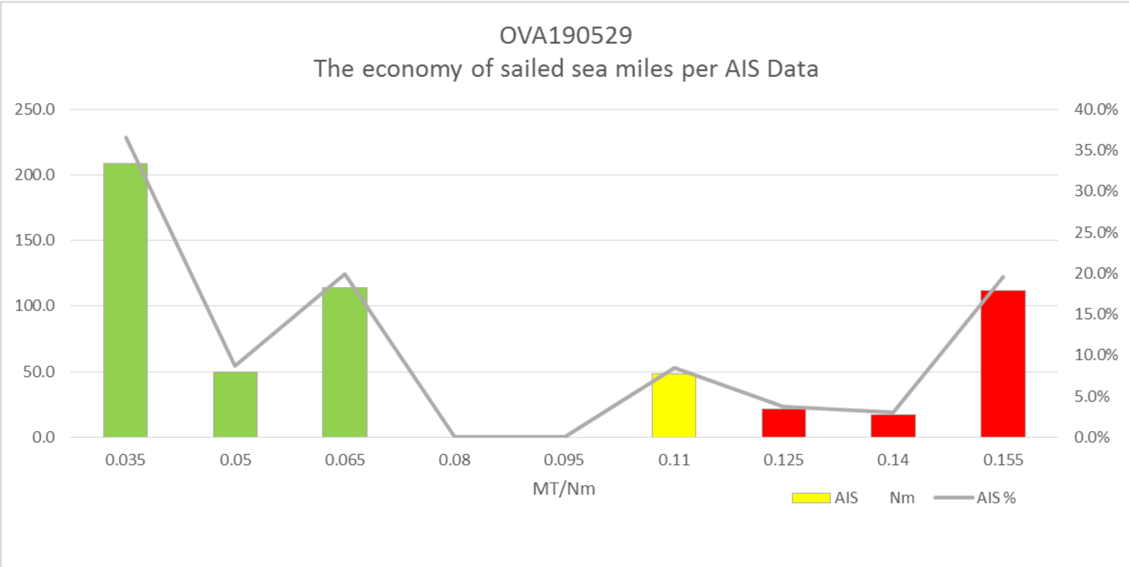

OVA190515
Itinerary profile
Voyage Plan vs AIS distances
600.0
500.0
400.0
300.0
200.0
100.0
0.0
6.0 6.4 6.8 7.2 7.6 8.0 8.4 8.8 9.2 9.6 10.0 10.4 10.8 11.2 11.6 12.0 12.4 12.8 13.2 13.6 14.0 14.4 14.8 15.2 15.6 16.0 16.4 16.8 17.2 17.6 18.0 18.4 18.8
Voyage plan Nm
AIS Nm

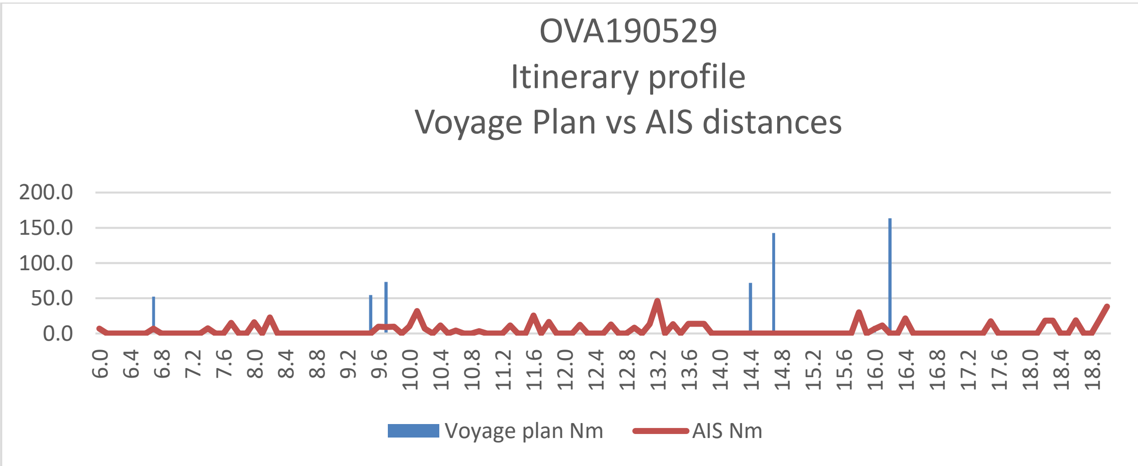


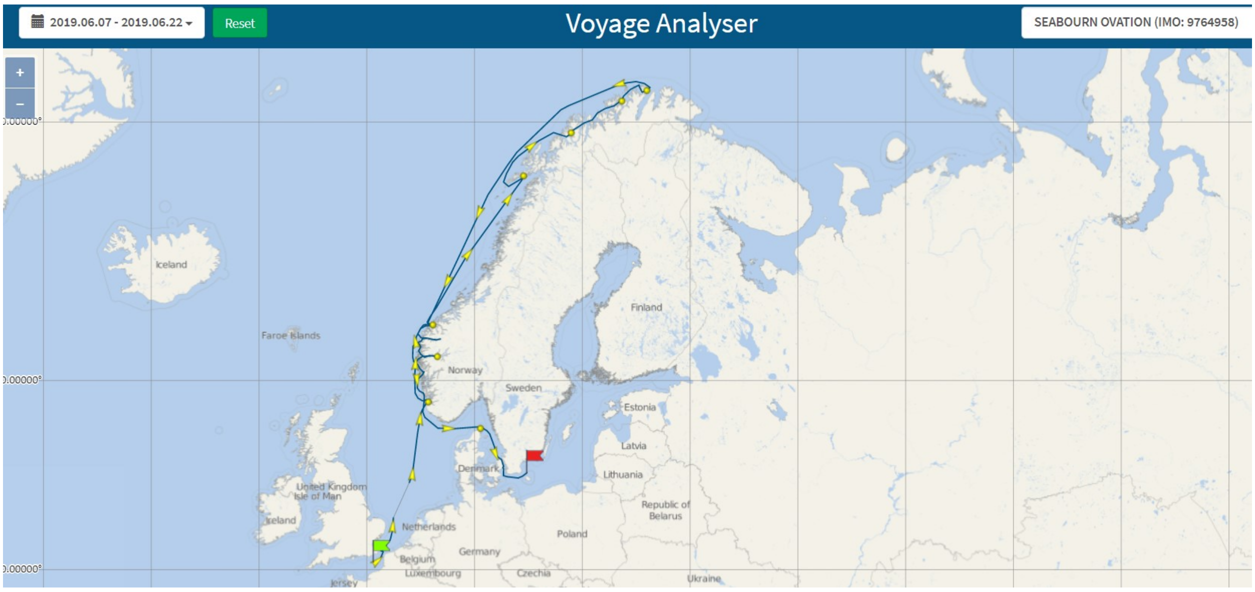


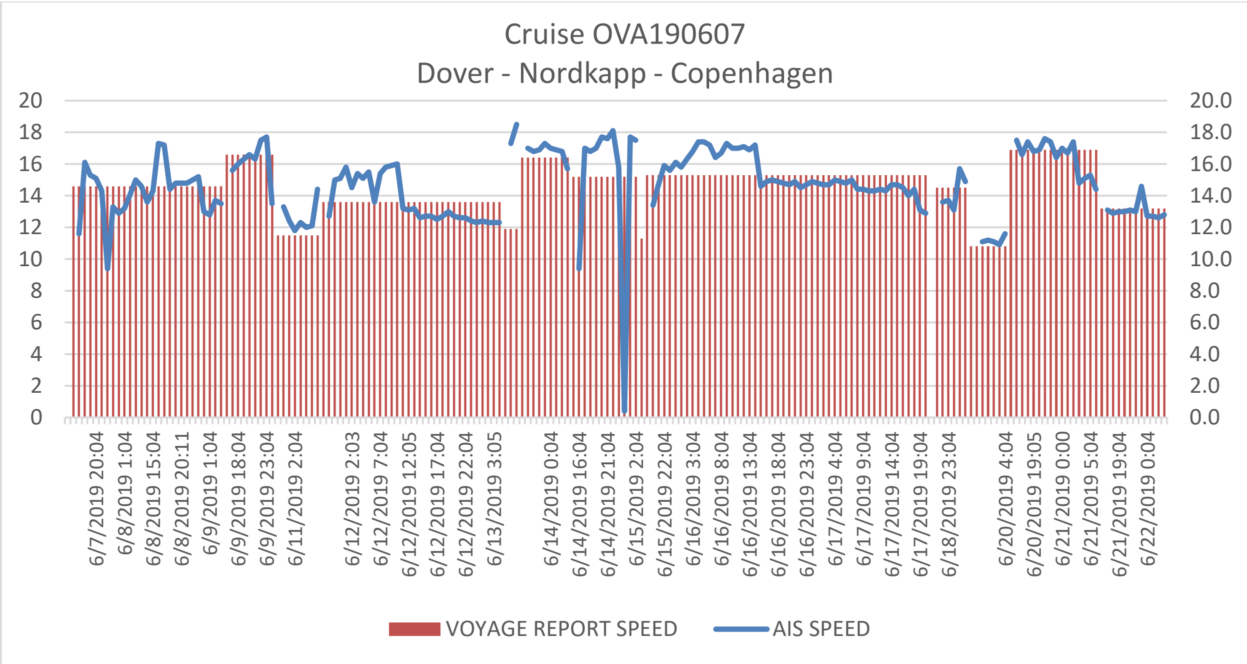
OVA190529												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	180.5	183.6	208.6	31.7%	33.0%	36.5%	4	4	6			
0.05	0.0	8.4	49.6	0.0%	1.5%	8.7%	0	0	2			
0.065	0.0	133.9	113.7	0.0%	24.0%	19.9%	0	8	6	31.7%	58.5%	65.1%
0.08	214.6	72.5	0.0	37.7%	13.0%	0.0%	16	5	0			
0.095	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.11	174.0	158.6	48.3	30.6%	28.5%	8.5%	19	15	5	68.3%	41.5%	8.5%
0.125	0.0	0.0	21.3	0.0%	0.0%	3.7%	0	0	2			
0.14	0.0	0.0	17.5	0.0%	0.0%	3.1%	0	0	2			
0.155	0.0	0.0	111.9	0.0%	0.0%	19.6%	0	0	16	0.0%	0.0%	26.4%
Total	569.1	556.9	570.9	100.0%	100.0%	100.0%	39.5	34.1	40.1	100.0%	100.0%	100.0%
Average	0.0694	0.0612	0.0703	MT/Nm			39.6	34.9	40.1	MT		


OVA190529
The economy of sailed sea miles per Voyage planning
250.0
200.0
150.0
100.0
50.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

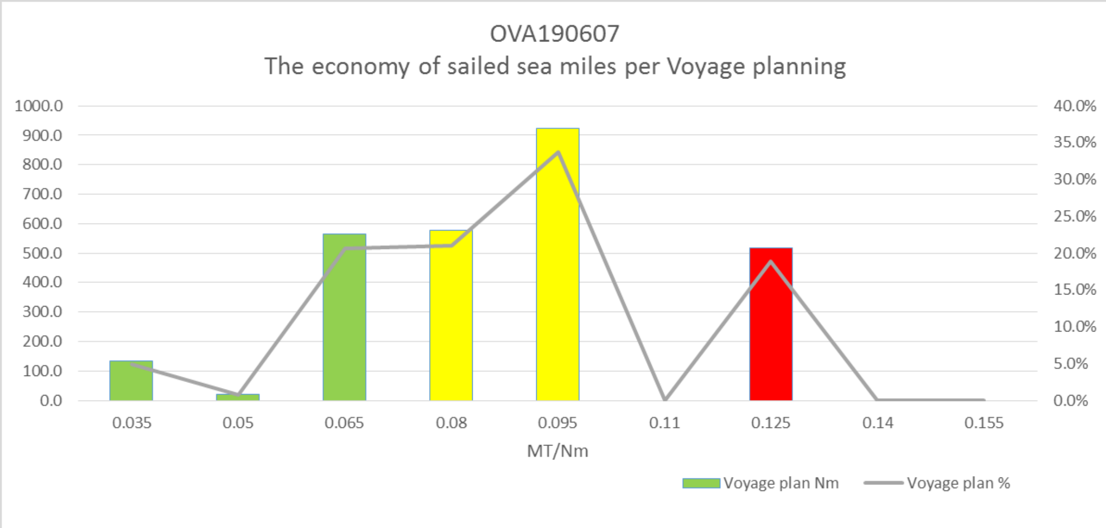

OVA190529
The economy of sailed sea miles per AIS Data
250.0
200.0
150.0
100.0
50.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

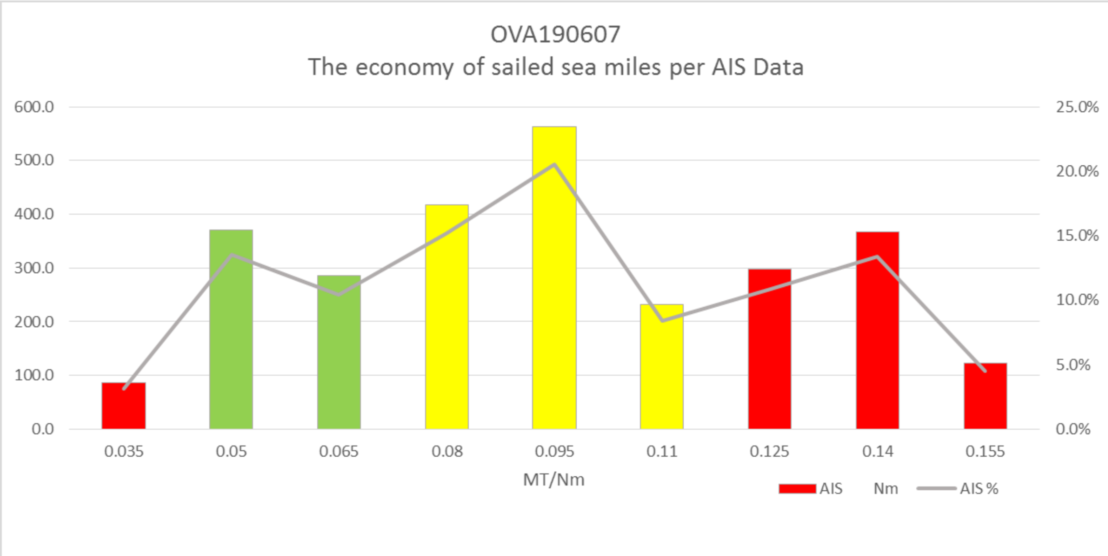

OVA190529
Itinerary profile
Voyage Plan vs AIS distances
200.0
150.0
100.0
50.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

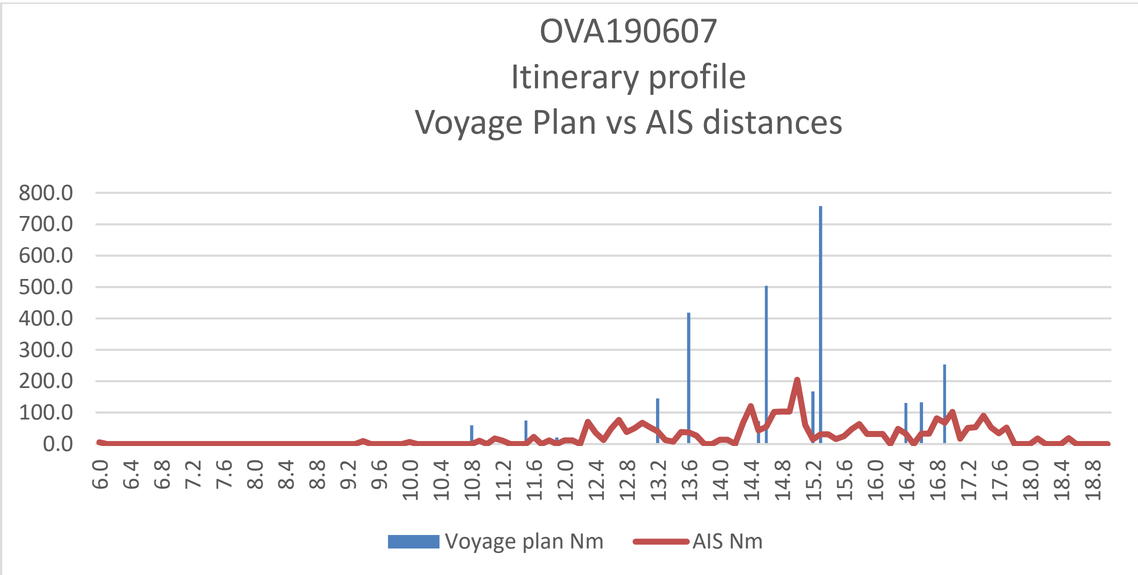


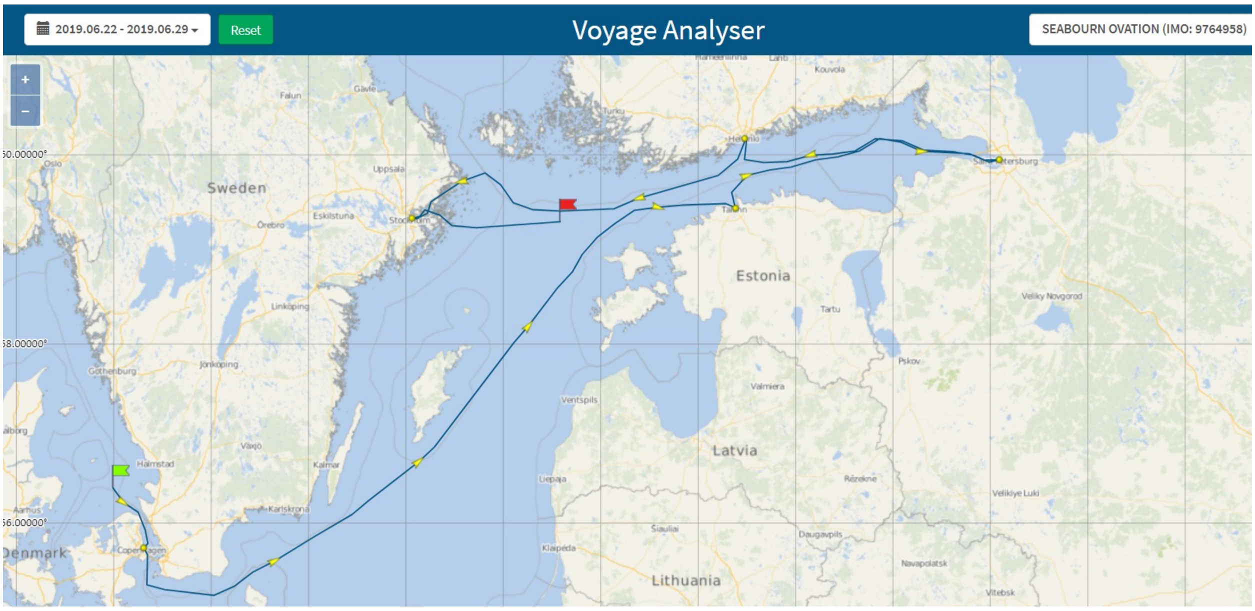


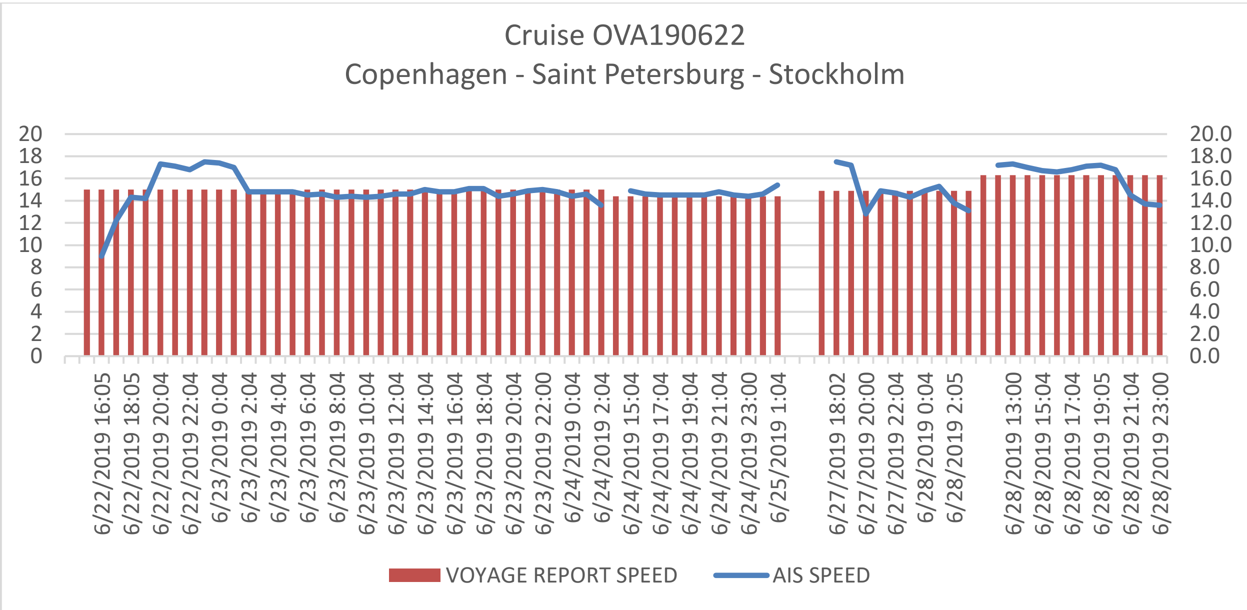
OVA190607												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	134.2	62.2	85.8	4.9%	2.3%	3.1%	4	2	3			
0.05	20.8	83.2	371.4	0.8%	3.1%	13.5%	1	4	17			
0.065	563.6	561.4	285.4	20.6%	20.6%	10.4%	33	32	16	26.3%	26.0%	27.1%
0.08	576.4	561.6	416.9	21.1%	20.6%	15.2%	44	39	31			
0.095	924.6	946.4	563.9	33.8%	34.8%	20.6%	82	83	47			
0.11	0.0	127.2	231.4	0.0%	4.7%	8.4%	0	13	23	54.8%	60.1%	44.2%
0.125	517.5	379.6	298.2	18.9%	13.9%	10.9%	62	44	35			
0.14	0.0	0.0	367.0	0.0%	0.0%	13.4%	0	0	49			
0.155	0.0	0.0	123.2	0.0%	0.0%	4.5%	0	0	18	18.9%	13.9%	28.7%
Total	2737.1	2721.6	2743.2	100.0%	100.0%	100.0%	225.2	216.0	237.8	100.0%	100.0%	100.0%
Average	0.0823	0.0794	0.0867	MT/Nm			225.7	217.8	237.8	MT		


OVA190607
The economy of sailed sea miles per Voyage planning
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

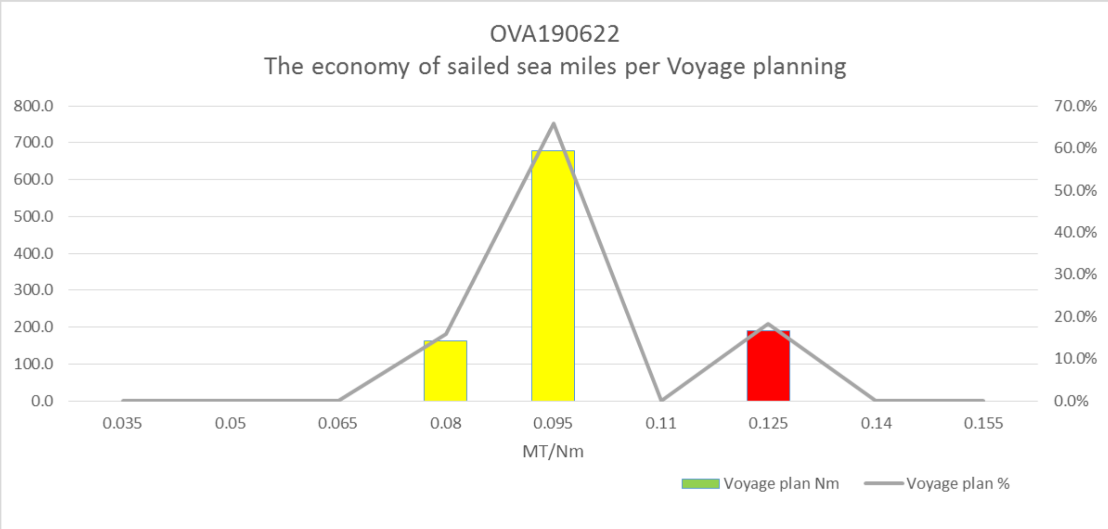

OVA190607
The economy of sailed sea miles per AIS Data
600.0
500.0
400.0
300.0
200.0
100.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %


OVA190607
Itinerary profile
Voyage Plan vs AIS distances
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

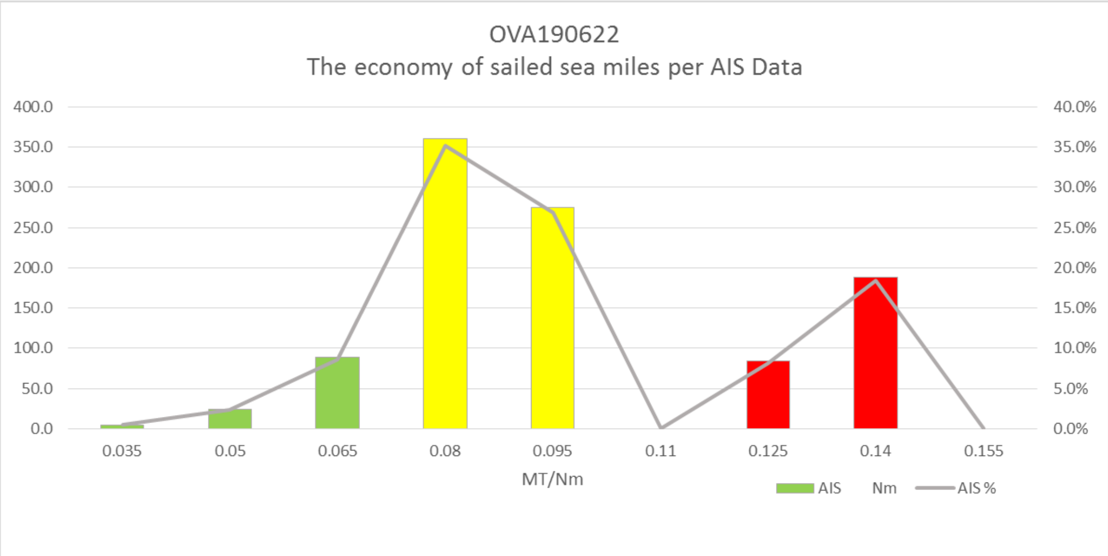




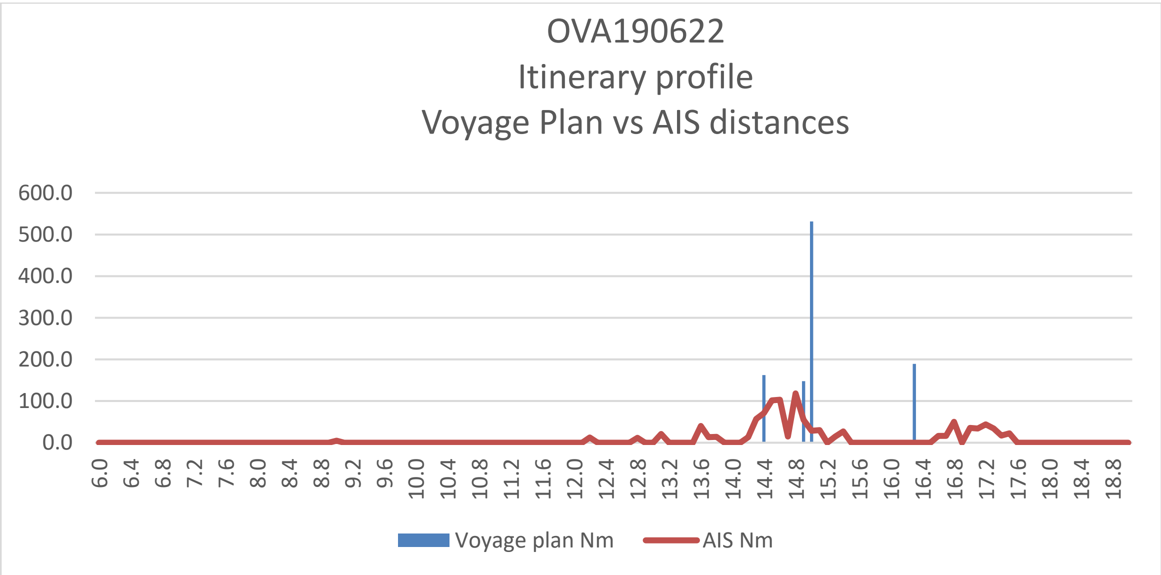
OVA190622												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	5.0	0.0%	0.0%	0.5%	0	0	0			
0.05	0.0	0.0	23.9	0.0%	0.0%	2.3%	0	0	1			
0.065	0.0	0.0	88.5	0.0%	0.0%	8.6%	0	0	5	0.0%	0.0%	11.5%
0.08	162.5	311.9	360.8	15.8%	30.5%	35.2%	12	24	27			
0.095	679.3	524.2	274.6	65.9%	51.3%	26.8%	56	42	23			
0.11	0.0	185.6	0.0	0.0%	18.2%	0.0%	0	19	0	81.7%	100.0%	62.0%
0.125	189.1	0.0	83.7	18.3%	0.0%	8.2%	21	0	10			
0.14	0.0	0.0	188.3	0.0%	0.0%	18.4%	0	0	25			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	18.3%	0.0%	26.5%
Total	1030.8	1021.7	1024.8	100.0%	100.0%	100.0%	89.0	85.3	90.6	100.0%	100.0%	100.0%
Average	0.0863	0.0835	0.0884	MT/Nm			88.5	85.5	90.6	MT		



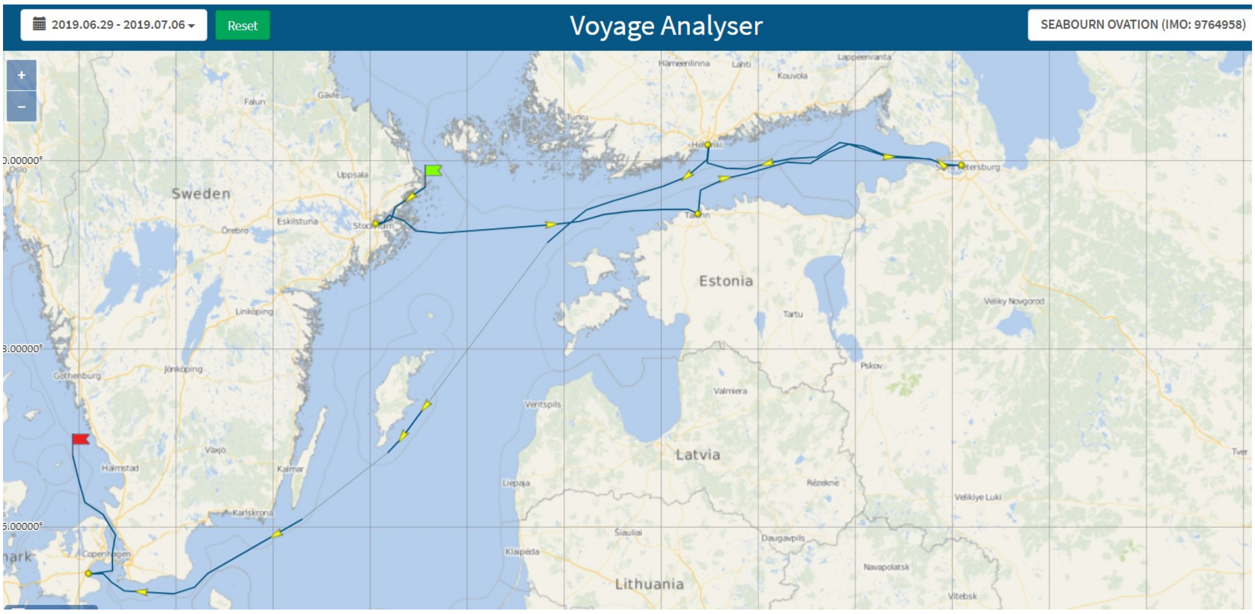
OVA190622
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

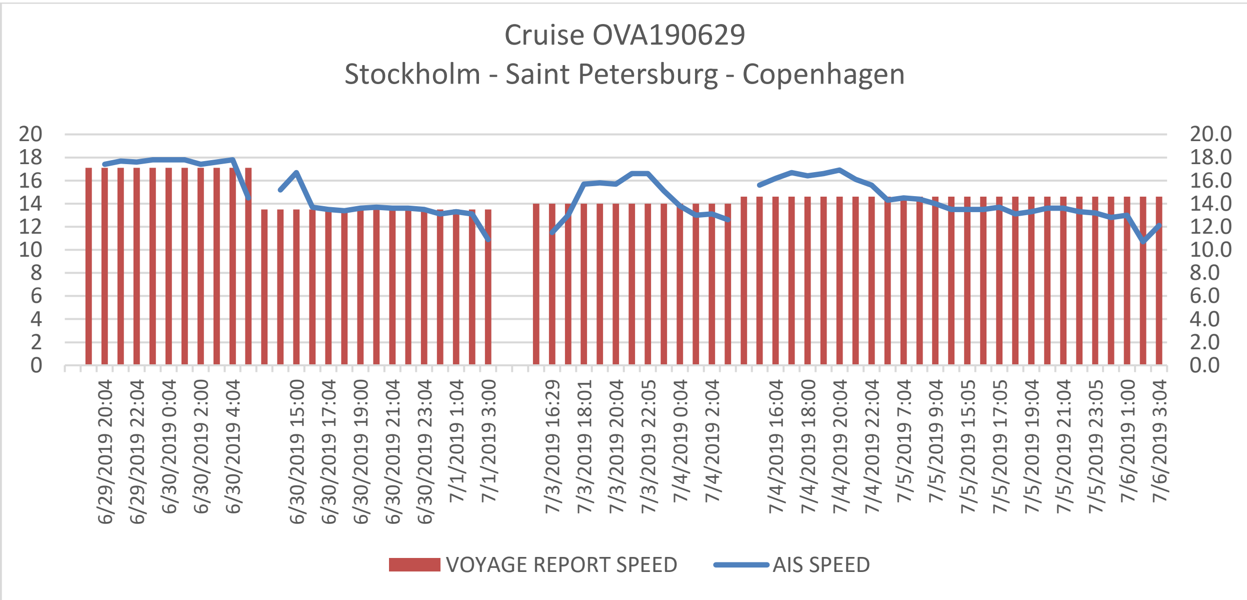


OVA190622
The economy of sailed sea miles per AIS Data
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

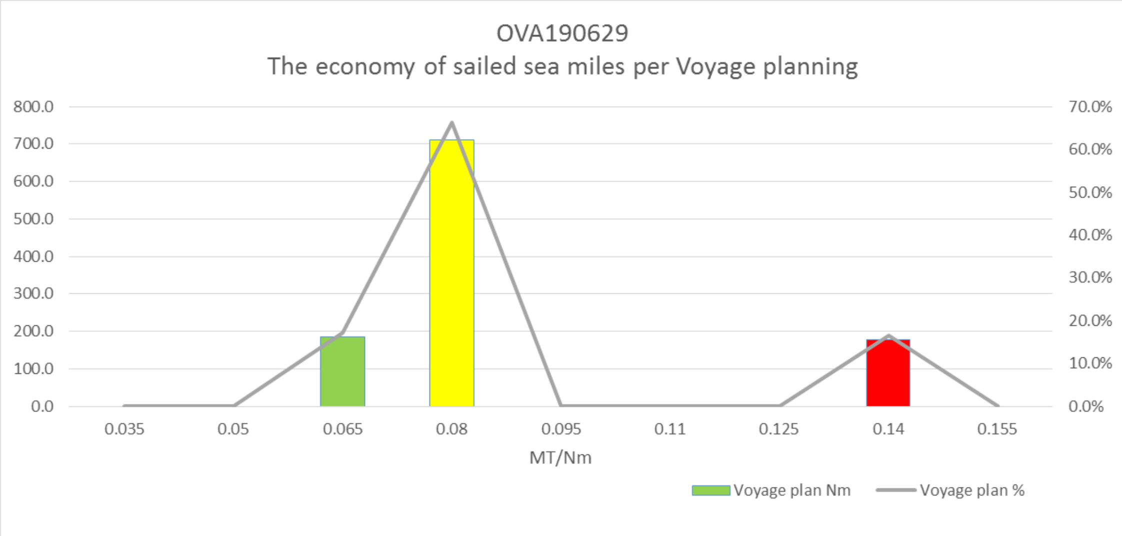


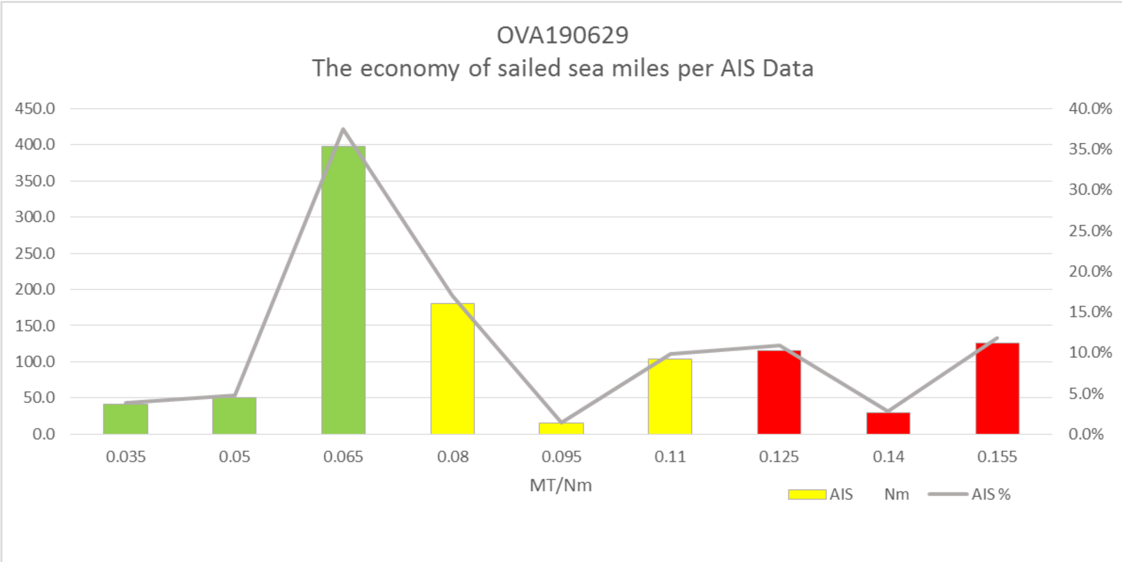
OVA190622
Itinerary profile
Voyage Plan vs AIS distances
600.0
500.0
400.0
300.0
200.0
100.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

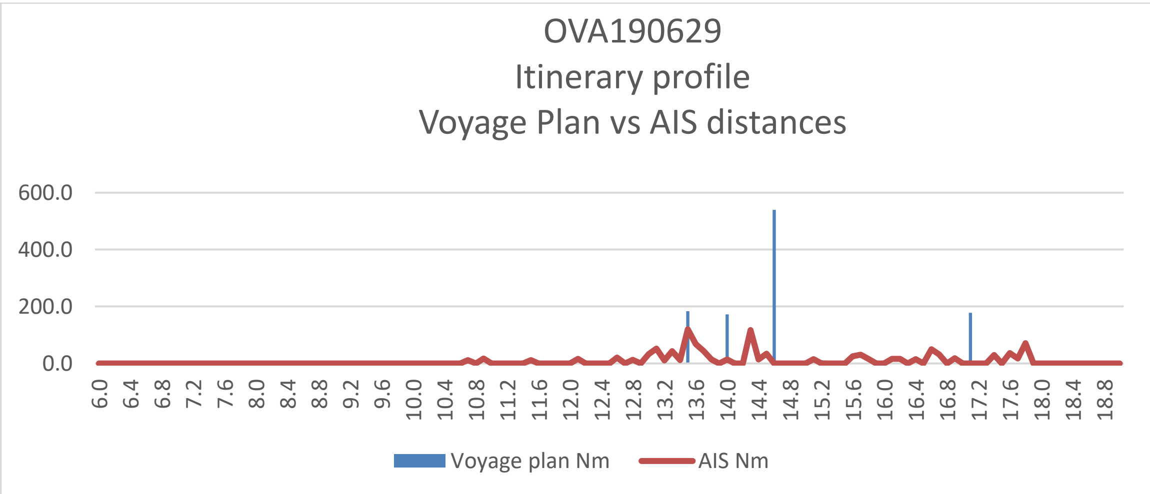


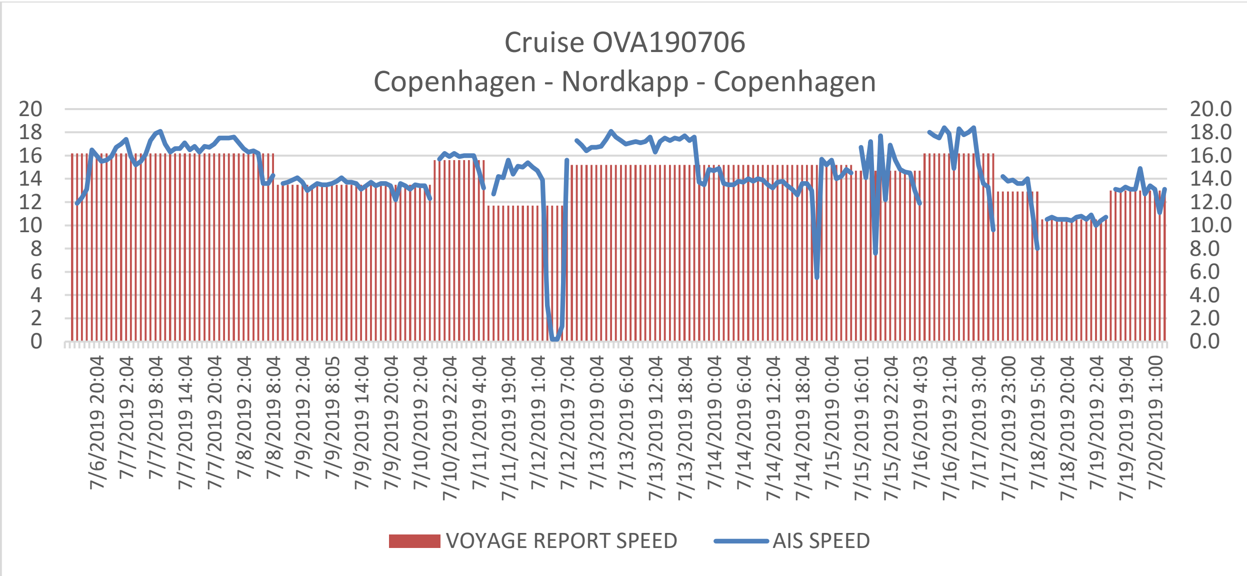


OVA190629												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	41.0	0.0%	0.0%	3.9%	0	0	1			
0.05	0.0	0.0	50.5	0.0%	0.0%	4.8%	0	0	2			
0.065	183.8	183.8	397.1	17.1%	17.3%	37.5%	11	11	22	17.1%	17.3%	46.1%
0.08	712.4	700.1	180.5	66.3%	66.0%	17.0%	52	48	13			
0.095	0.0	0.0	15.5	0.0%	0.0%	1.5%	0	0	1			
0.11	0.0	0.0	104.3	0.0%	0.0%	9.8%	0	0	10	66.3%	66.0%	28.3%
0.125	0.0	0.0	115.4	0.0%	0.0%	10.9%	0	0	14			
0.14	177.6	177.6	29.6	16.5%	16.7%	2.8%	23	23	4			
0.155	0.0	0.0	125.5	0.0%	0.0%	11.8%	0	0	18	16.5%	16.7%	25.5%
Total	1073.8	1061.4	1059.5	100.0%	100.0%	100.0%	85.8	81.8	86.4	100.0%	100.0%	100.0%
Average	0.0799	0.0770	0.0815	MT/Nm			84.7	81.6	86.4	MT		

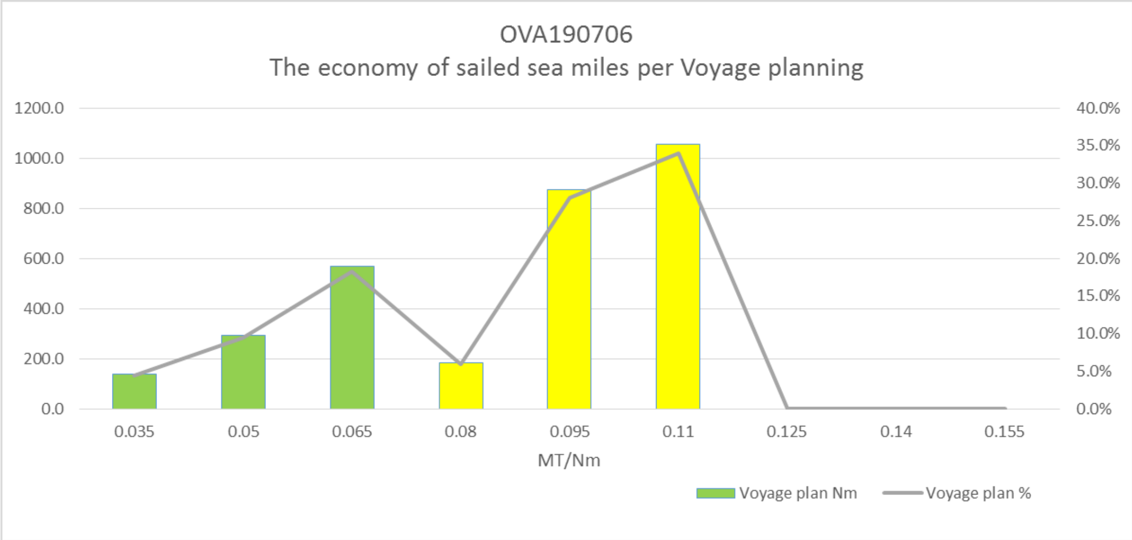

OVA190629
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

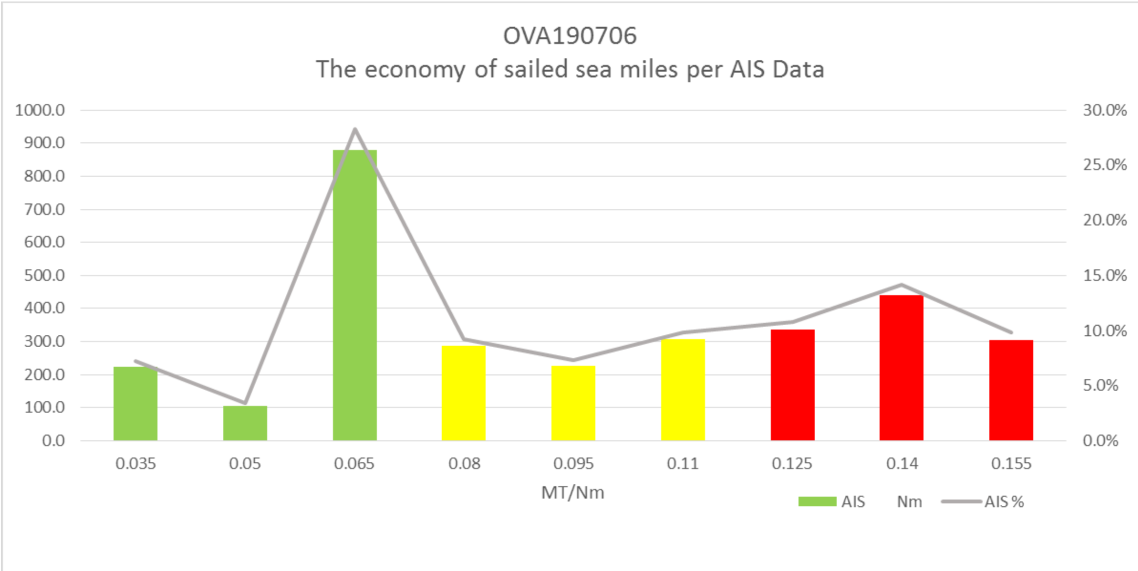

OVA190629
The economy of sailed sea miles per AIS Data
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

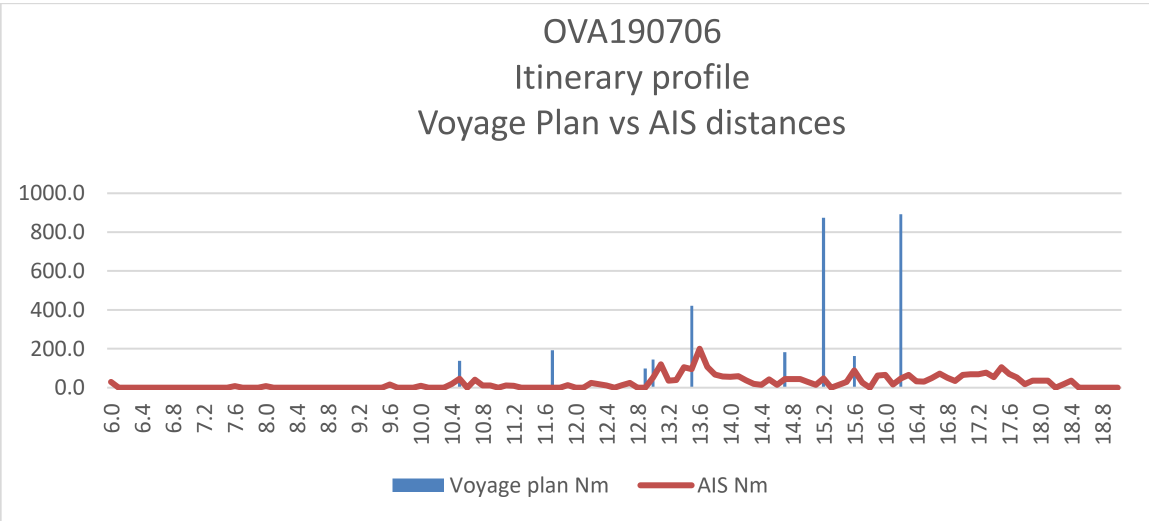

OVA190629
Itinerary profile
Voyage Plan vs AIS distances
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

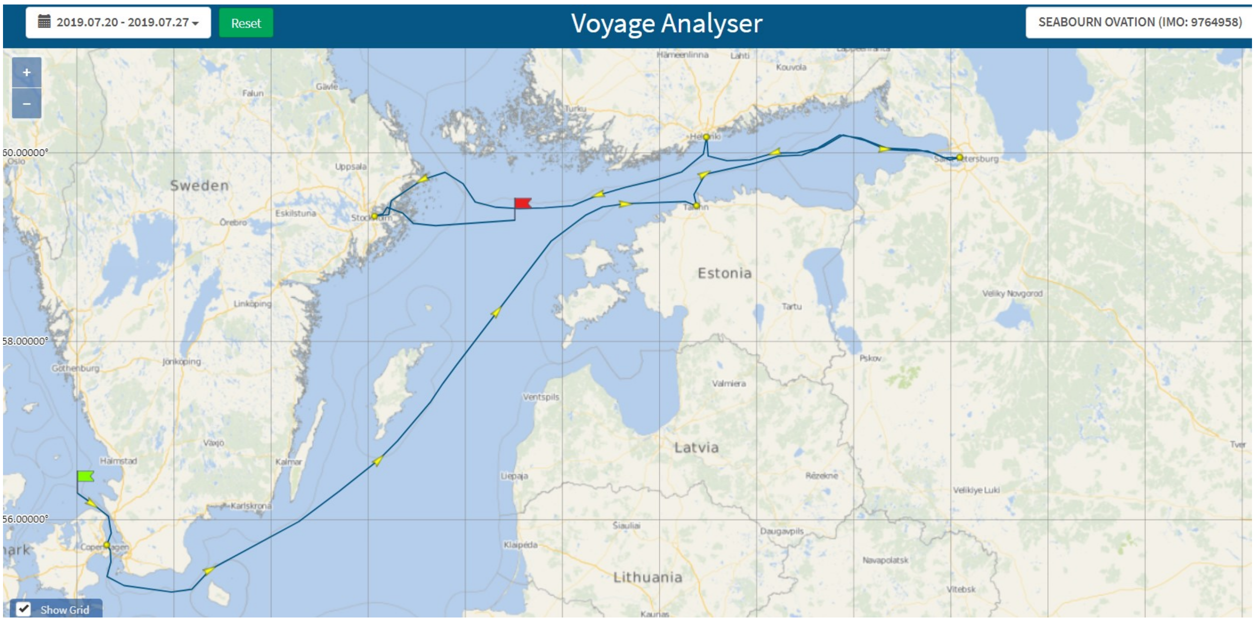


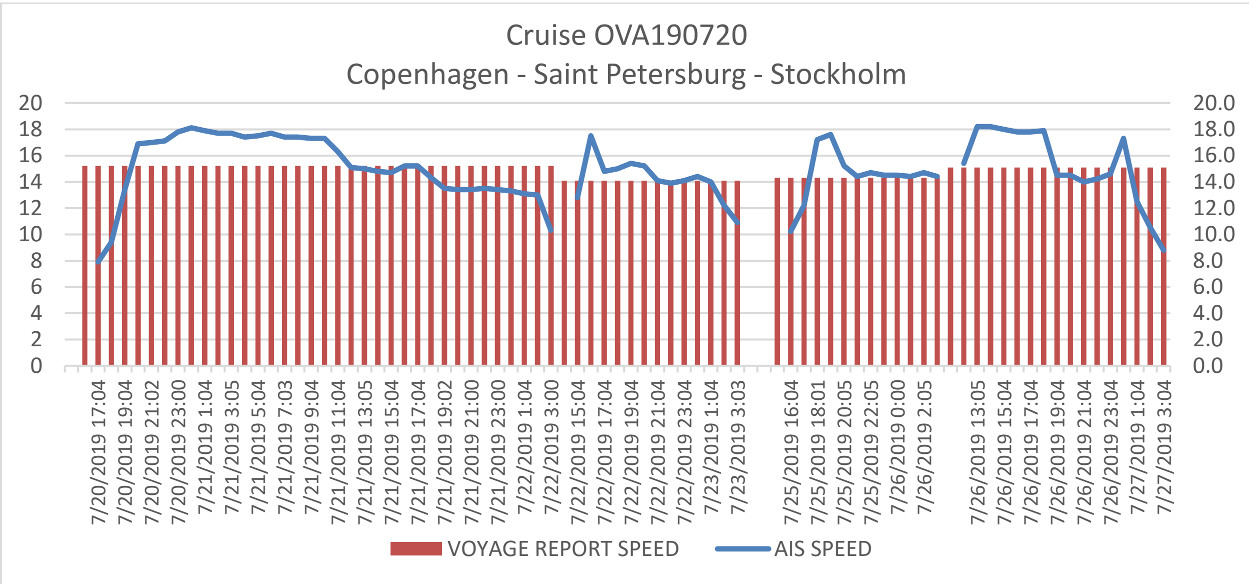
OVA190706												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	138.4	329.5	224.9	4.5%	10.7%	7.2%	4	10	6			
0.05	292.1	94.4	105.0	9.4%	3.1%	3.4%	12	4	4			
0.065	566.8	564.8	879.7	18.2%	18.3%	28.3%	32	31	51	32.1%	32.1%	38.9%
0.08	182.3	176.1	287.9	5.9%	5.7%	9.2%	14	12	20			
0.095	873.7	1034.4	226.8	28.1%	33.5%	7.3%	76	91	19			
0.11	1055.4	884.2	307.1	33.9%	28.7%	9.9%	112	93	31	67.9%	67.9%	26.4%
0.125	0.0	0.0	336.5	0.0%	0.0%	10.8%	0	0	39			
0.14	0.0	0.0	440.7	0.0%	0.0%	14.2%	0	0	59			
0.155	0.0	0.0	304.6	0.0%	0.0%	9.8%	0	0	45	0.0%	0.0%	34.7%
Total	3108.8	3083.4	3113.2	100.0%	100.0%	100.0%	249.5	240.9	274.6	100.0%	100.0%	100.0%
Average	0.0803	0.0781	0.0882	MT/Nm			249.9	243.3	274.6	MT		


OVA190706
The economy of sailed sea miles per Voyage planning
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

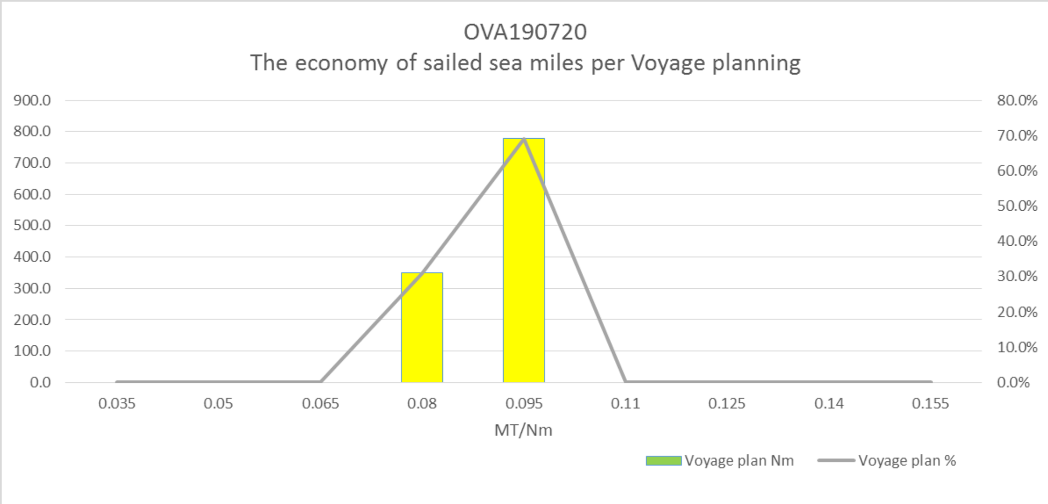

OVA190706
The economy of sailed sea miles per AIS Data
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

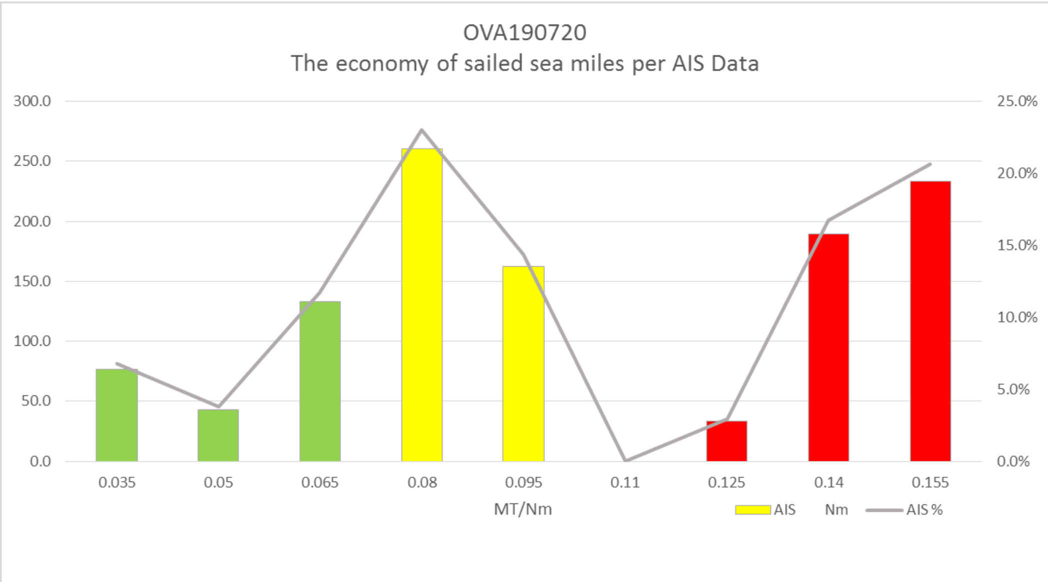

OVA190706
Itinerary profile
Voyage Plan vs AIS distances
1000.0
800.0
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

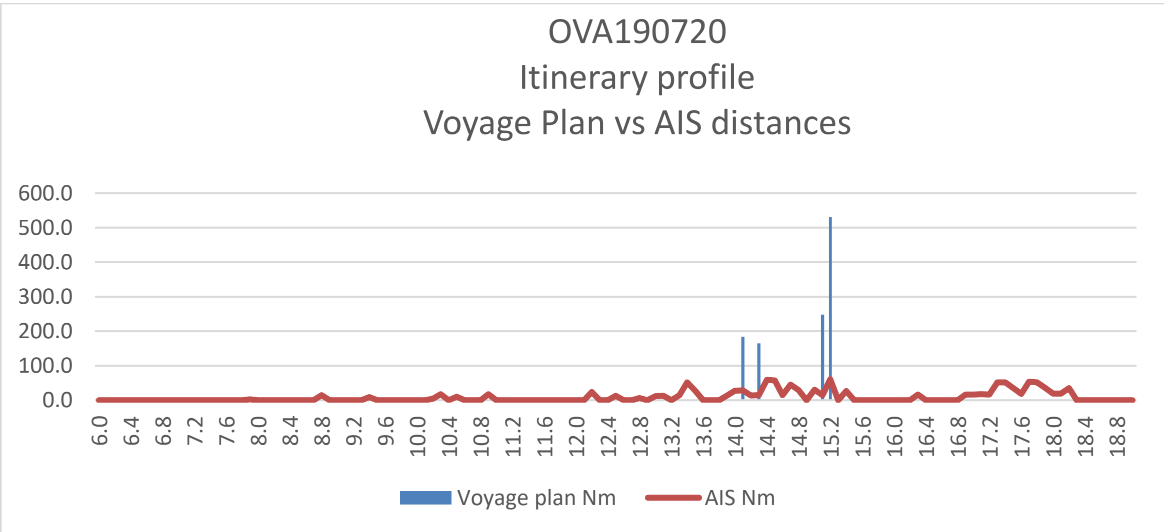


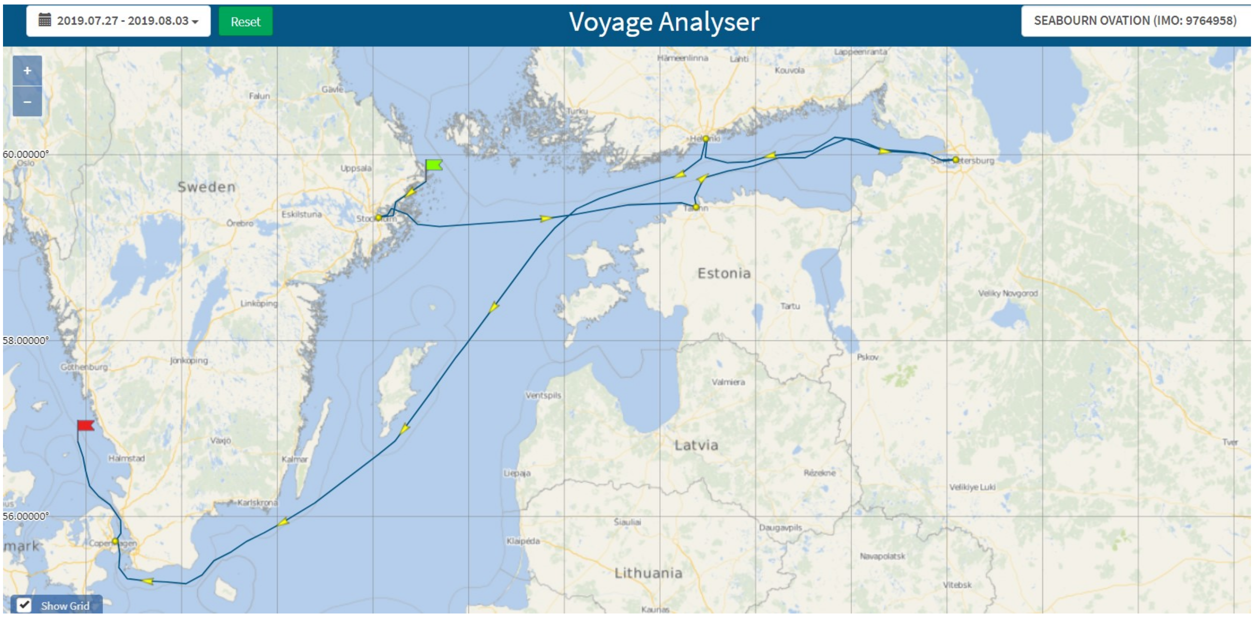


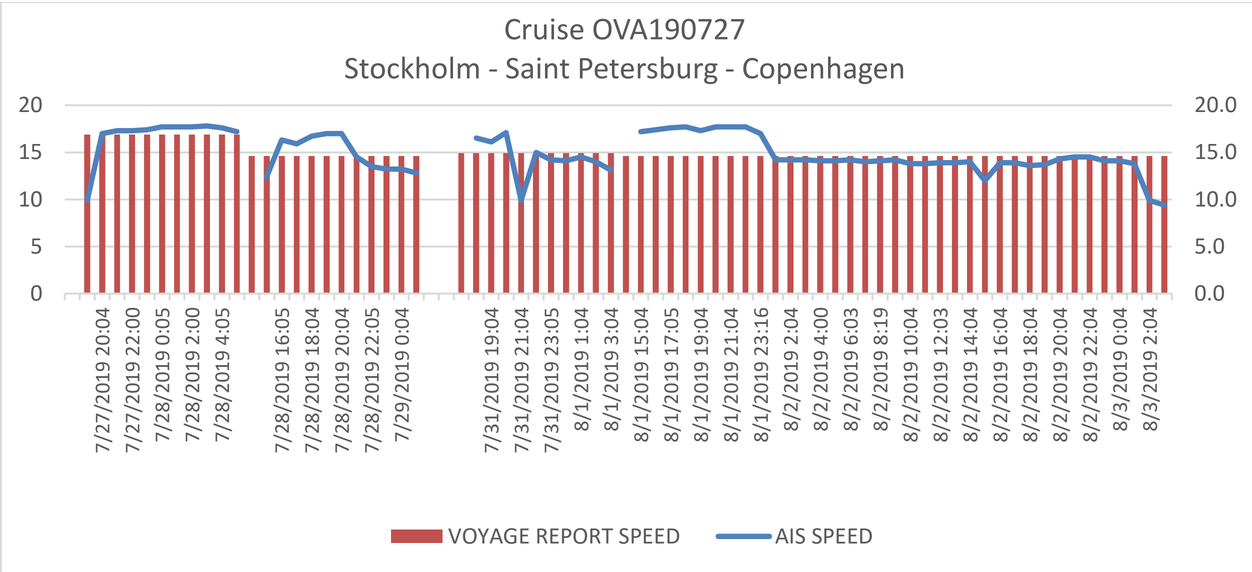
OVA190720												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	76.6	0.0%	0.0%	6.8%	0	0	2			
0.05	0.0	0.0	42.8	0.0%	0.0%	3.8%	0	0	2			
0.065	0.0	182.1	132.9	0.0%	16.3%	11.7%	0	12	7	0.0%	16.3%	22.3%
0.08	349.6	167.2	260.6	31.0%	15.0%	23.0%	24	12	19			
0.095	778.4	768.1	162.4	69.0%	68.7%	14.4%	67	64	14			
0.11	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	100.0%	83.7%	37.4%
0.125	0.0	0.0	33.2	0.0%	0.0%	2.9%	0	0	4			
0.14	0.0	0.0	189.5	0.0%	0.0%	16.7%	0	0	25			
0.155	0.0	0.0	233.2	0.0%	0.0%	20.6%	0	0	34	0.0%	0.0%	40.3%
Total	1128.0	1117.4	1131.2	100.0%	100.0%	100.0%	91.5	87.6	107.7	100.0%	100.0%	100.0%
Average	0.0811	0.0784	0.0953	MT/Nm			91.8	88.7	107.7	MT		


OVA190720
The economy of sailed sea miles per Voyage planning
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

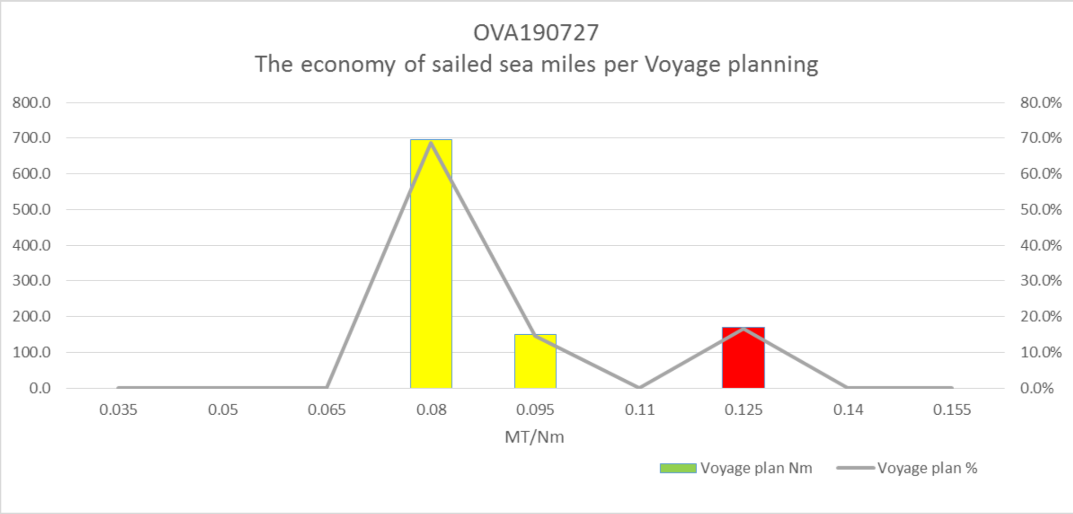

OVA190720
The economy of sailed sea miles per AIS Data
300.0
250.0
200.0
150.0
100.0
50.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

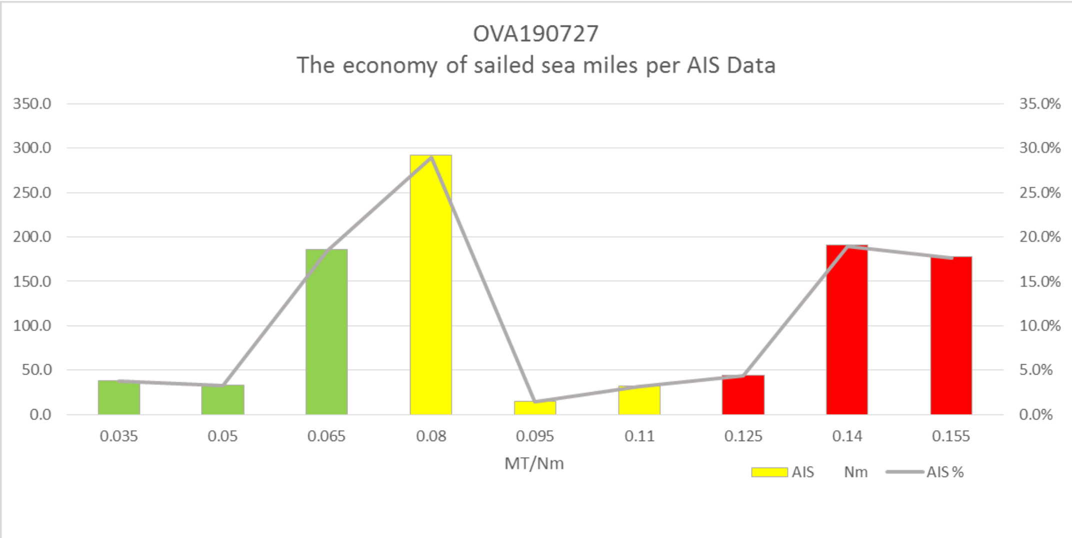

OVA190720
Itinerary profile
Voyage Plan vs AIS distances
600.0
500.0
400.0
300.0
200.0
100.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

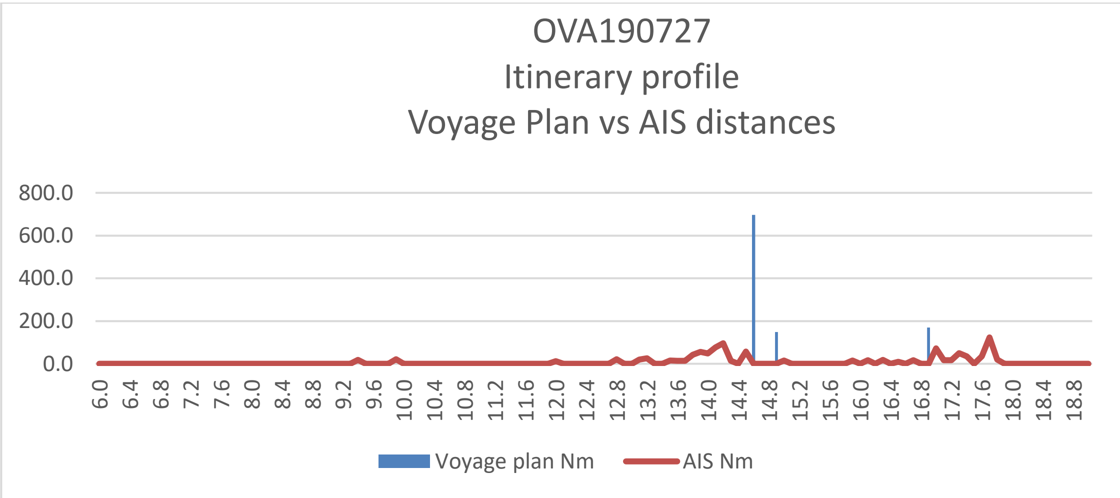


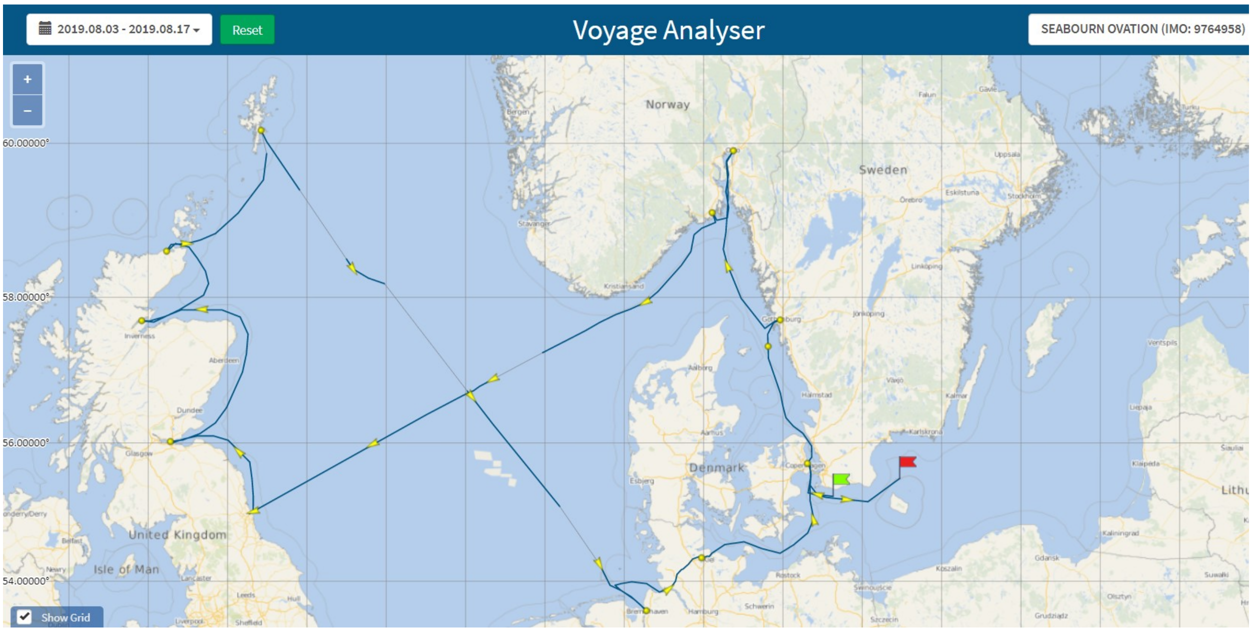


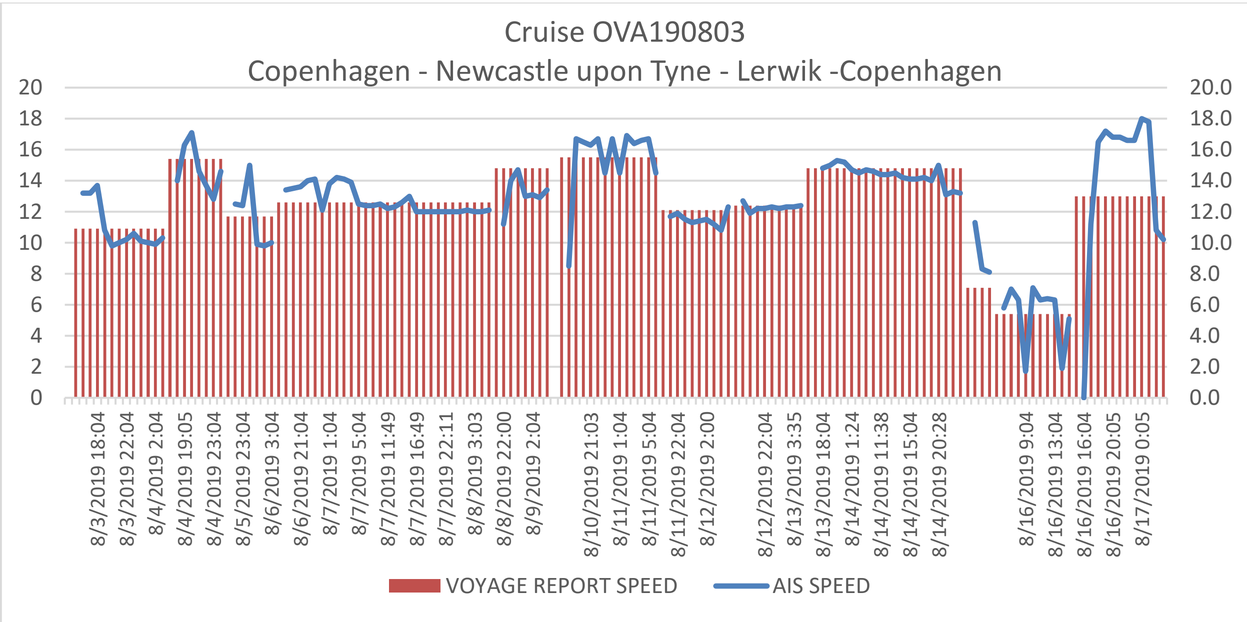
OVA190727												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	38.6	0.0%	0.0%	3.8%	0	0	1			
0.05	0.0	0.0	33.4	0.0%	0.0%	3.3%	0	0	1			
0.065	0.0	0.0	186.0	0.0%	0.0%	18.4%	0	0	11	0.0%	0.0%	25.5%
0.08	697.1	836.4	292.1	68.7%	83.3%	28.9%	53	62	20			
0.095	149.0	0.0	15.1	14.7%	0.0%	1.5%	12	0	1			
0.11	0.0	0.0	32.0	0.0%	0.0%	3.2%	0	0	3	83.4%	83.3%	33.6%
0.125	169.0	168.0	43.9	16.6%	16.7%	4.3%	21	20	5			
0.14	0.0	0.0	191.3	0.0%	0.0%	18.9%	0	0	25			
0.155	0.0	0.0	177.9	0.0%	0.0%	17.6%	0	0	26	16.6%	16.7%	40.9%
Total	1015.2	1004.5	1010.3	100.0%	100.0%	100.0%	86.1	82.3	93.9	100.0%	100.0%	100.0%
Average	0.0848	0.0819	0.0930	MT/Nm			85.7	82.8	93.9	MT		


OVA190727
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

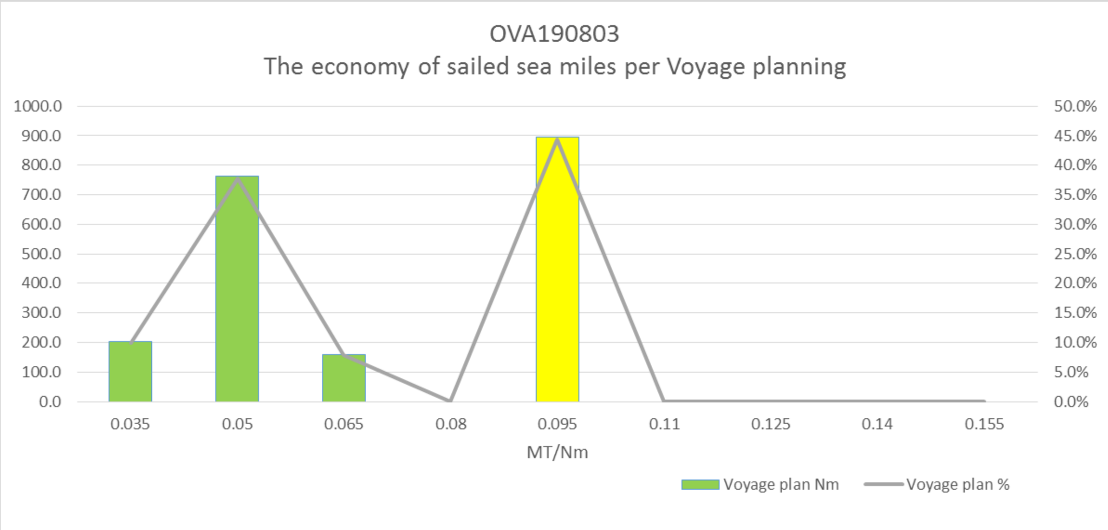

OVA190727
The economy of sailed sea miles per AIS Data
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

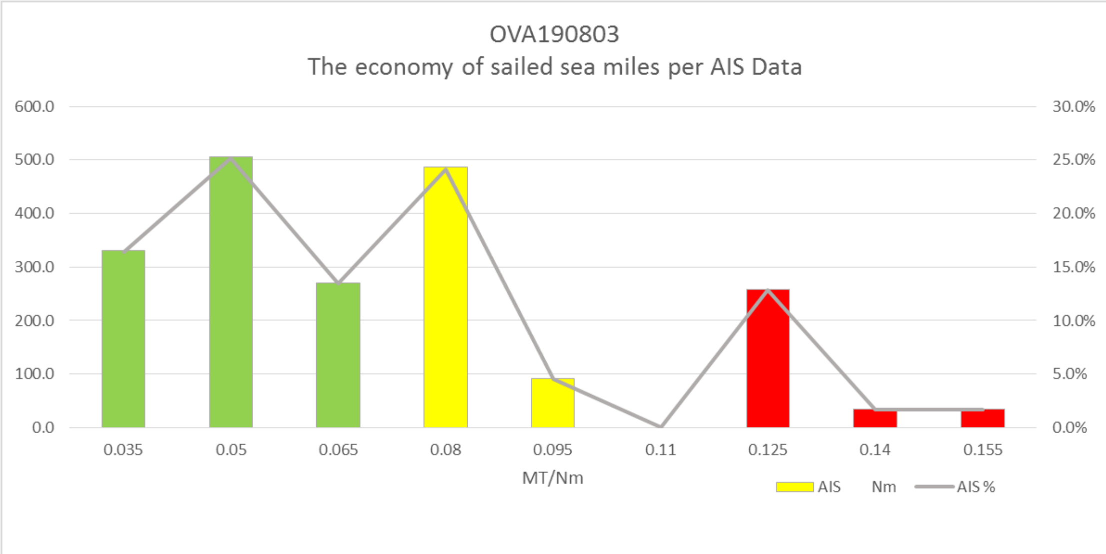

OVA190727
Itinerary profile
Voyage Plan vs AIS distances
800.0
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

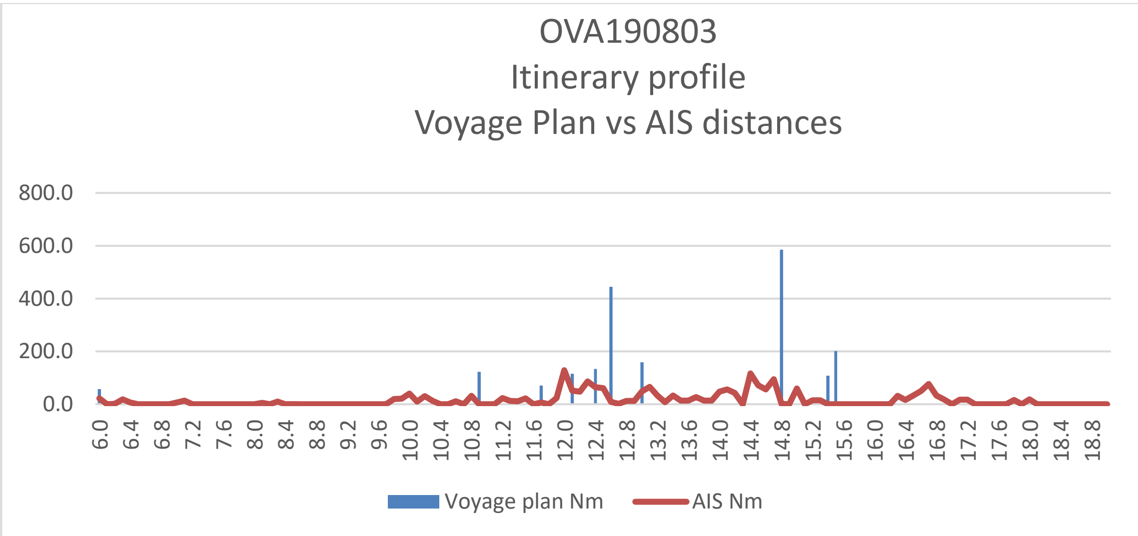


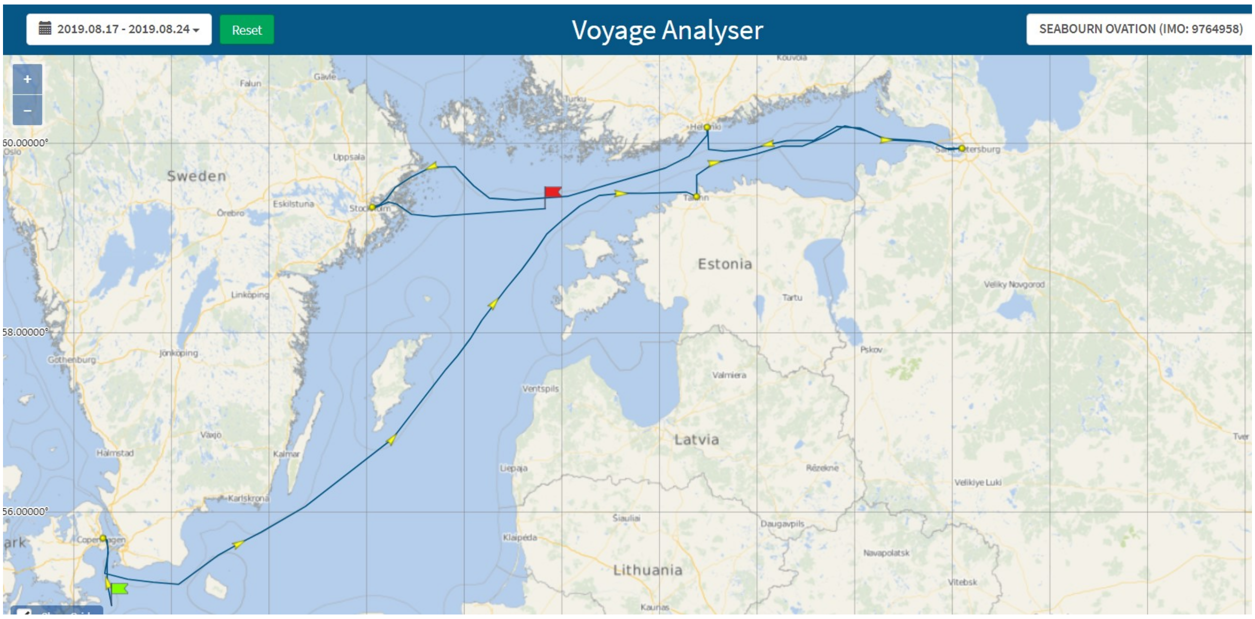


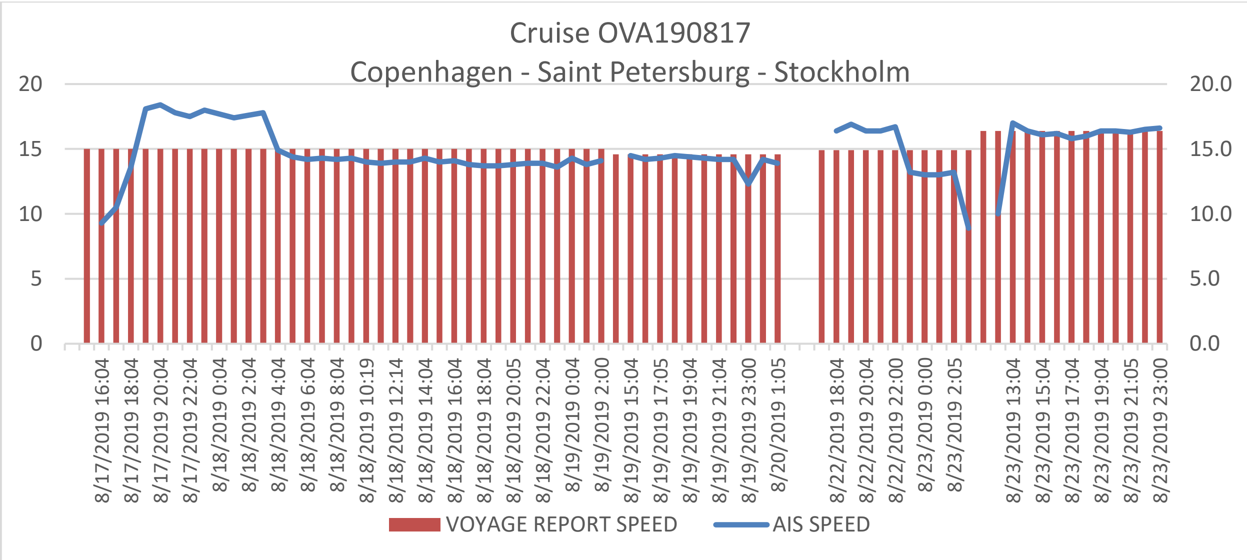
OVA190803												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	201.5	385.1	330.8	10.0%	19.3%	16.4%	6	12	9			
0.05	762.8	579.9	505.4	37.8%	29.0%	25.1%	33	26	21			
0.065	159.2	92.4	270.3	7.9%	4.6%	13.4%	8	5	15	55.7%	52.9%	55.0%
0.08	0.0	741.6	486.1	0.0%	37.1%	24.2%	0	53	35			
0.095	893.9	200.2	91.5	44.3%	10.0%	4.5%	75	18	8			
0.11	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	44.3%	47.1%	28.7%
0.125	0.0	0.0	258.6	0.0%	0.0%	12.9%	0	0	30			
0.14	0.0	0.0	34.3	0.0%	0.0%	1.7%	0	0	4			
0.155	0.0	0.0	34.6	0.0%	0.0%	1.7%	0	0	5	0.0%	0.0%	16.3%
Total	2017.5	1999.2	2011.4	100.0%	100.0%	100.0%	121.7	114.1	127.7	100.0%	100.0%	100.0%
Average	0.0603	0.0571	0.0635	MT/Nm			121.3	114.8	127.7	MT		


OVA190803
The economy of sailed sea miles per Voyage planning
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

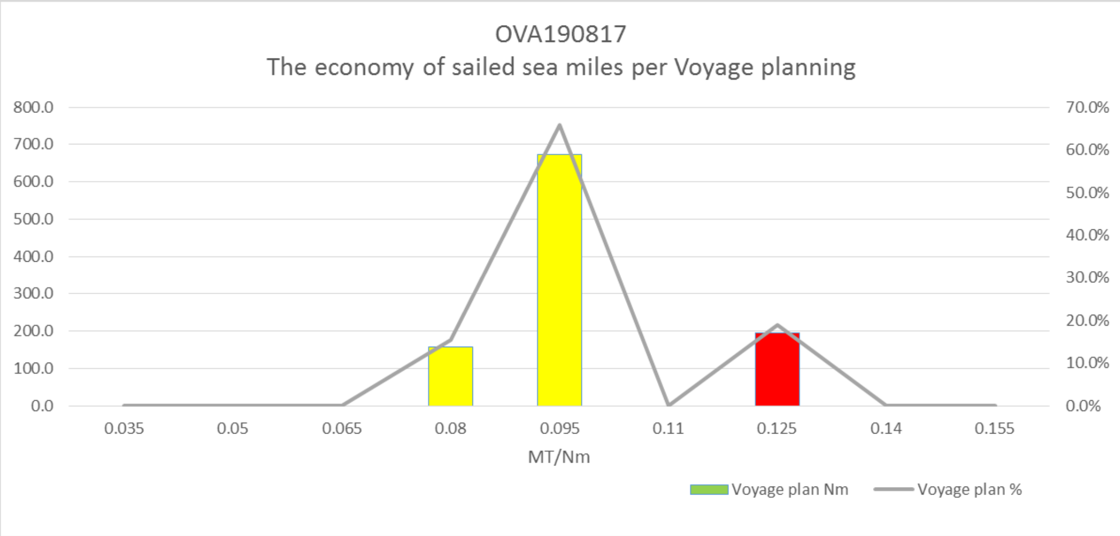

OVA190803
The economy of sailed sea miles per AIS Data
600.0
500.0
400.0
300.0
200.0
100.0
0.0
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS
Nm
AIS %

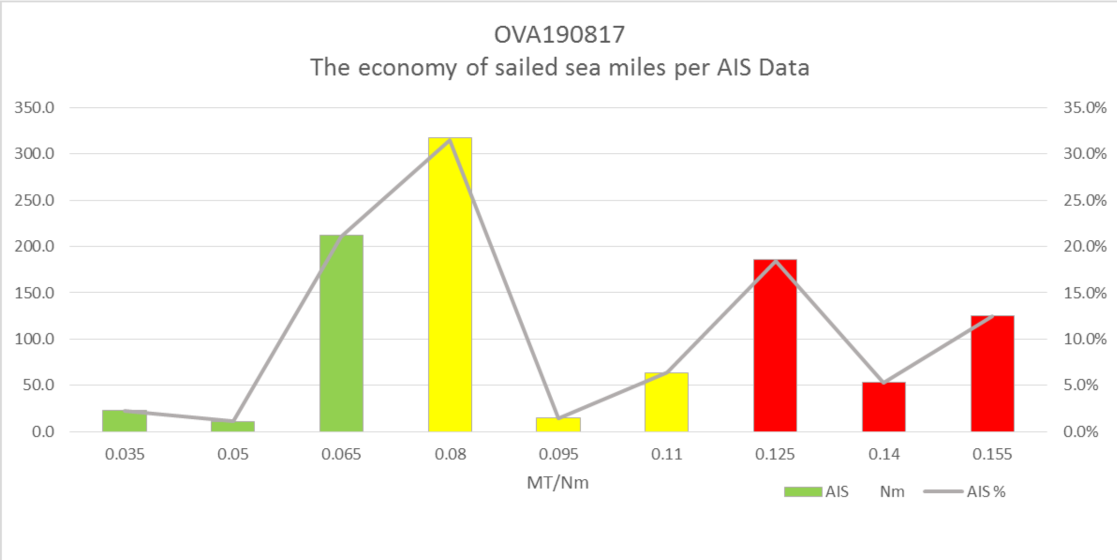

OVA190803
Itinerary profile
Voyage Plan vs AIS distances
800.0
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

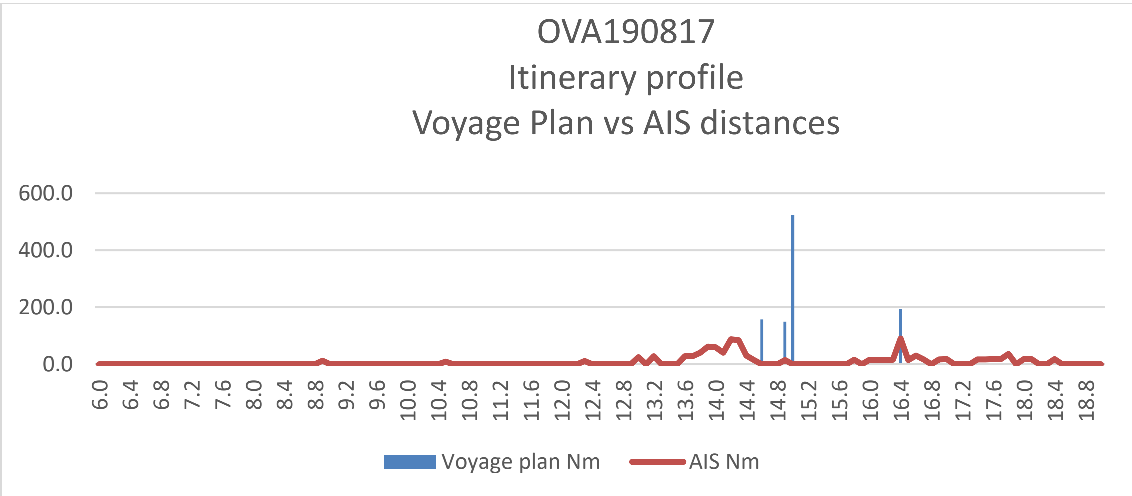


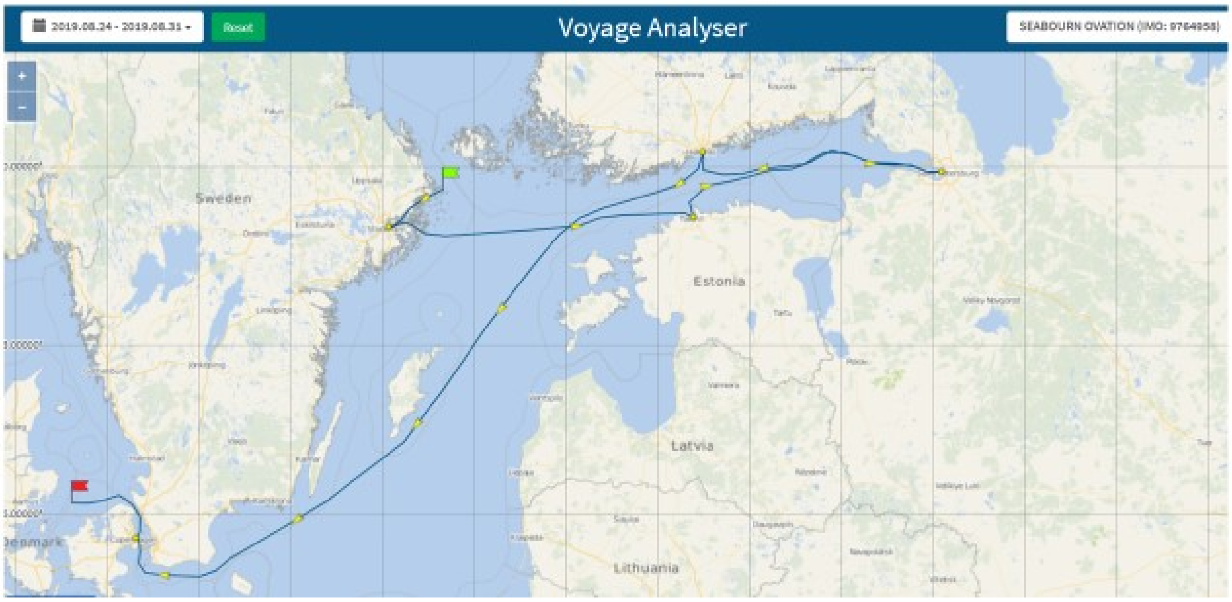


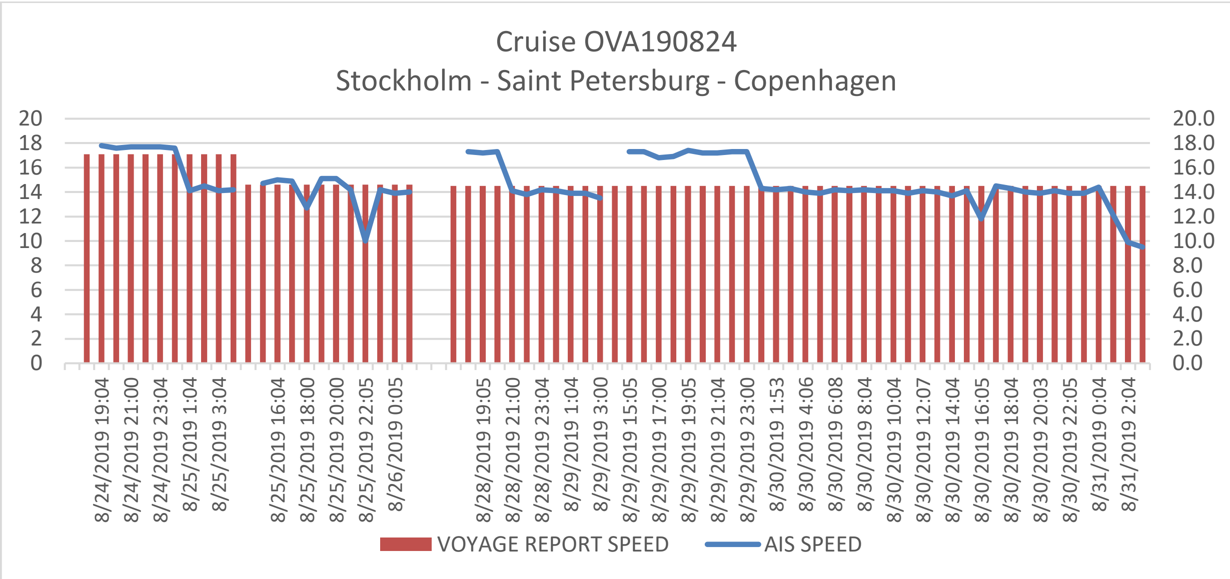
OVA190817												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	23.0	0.0%	0.0%	2.3%	0	0	1			
0.05	0.0	0.0	11.3	0.0%	0.0%	1.1%	0	0	0			
0.065	0.0	139.0	212.2	0.0%	13.9%	21.1%	0	9	13	0.0%	13.9%	24.5%
0.08	156.9	151.6	317.1	15.3%	15.2%	31.5%	12	10	22			
0.095	674.0	518.0	14.9	65.8%	52.0%	1.5%	56	41	1			
0.11	0.0	188.1	64.0	0.0%	18.9%	6.4%	0	19	7	81.1%	86.1%	39.3%
0.125	194.1	0.0	185.8	18.9%	0.0%	18.5%	22	0	21			
0.14	0.0	0.0	53.3	0.0%	0.0%	5.3%	0	0	7			
0.155	0.0	0.0	125.4	0.0%	0.0%	12.4%	0	0	18	18.9%	0.0%	36.2%
Total	1025.0	996.7	1007.0	100.0%	100.0%	100.0%	89.7	79.4	90.5	100.0%	100.0%	100.0%
Average	0.0875	0.0797	0.0898	MT/Nm			88.1	80.3	90.5	MT		


OVA190817
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %


OVA190817
The economy of sailed sea miles per AIS Data
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

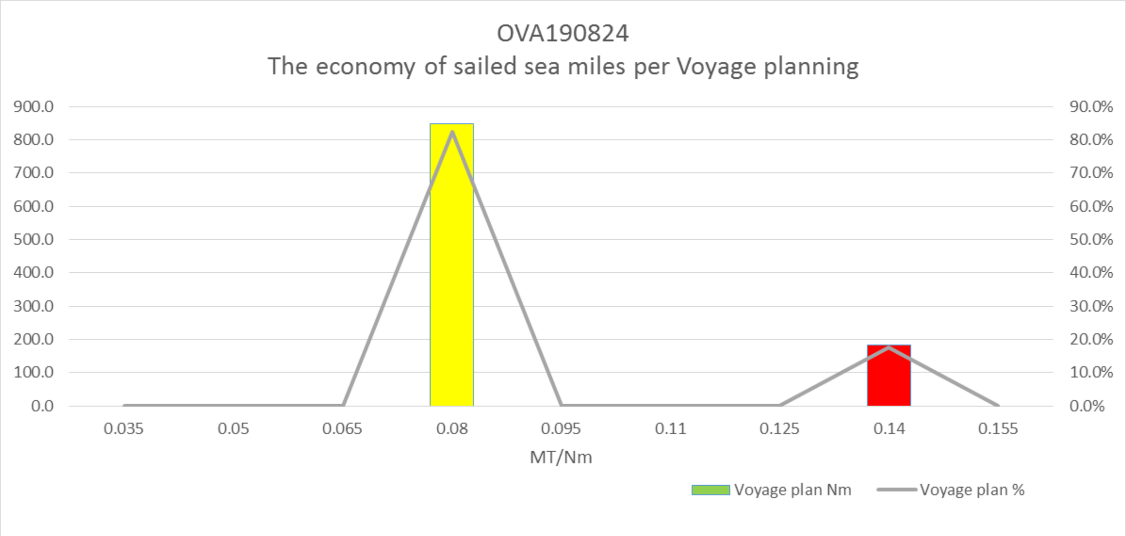

OVA190817
Itinerary profile
Voyage Plan vs AIS distances
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm



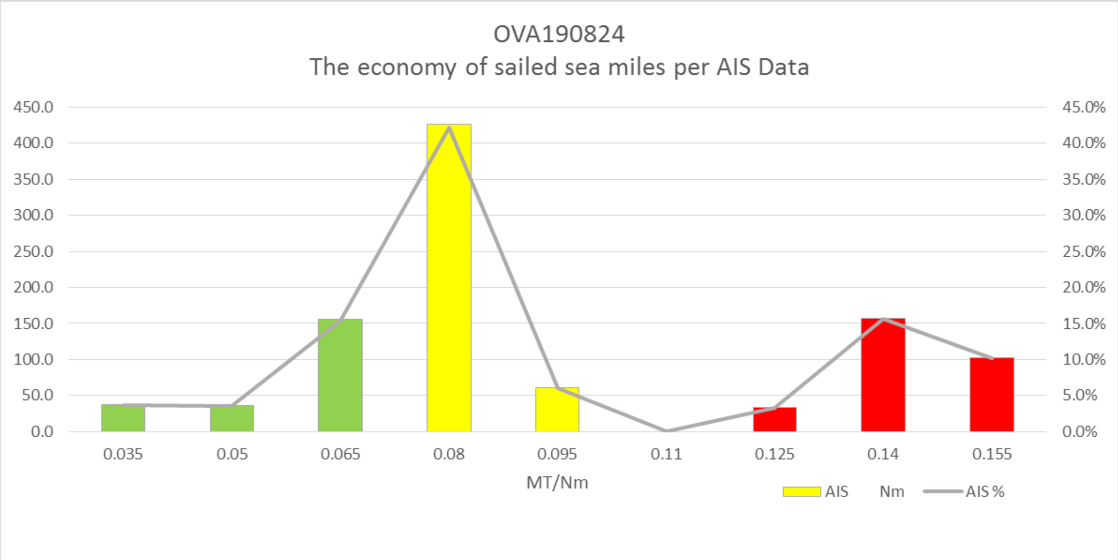


OVA190824

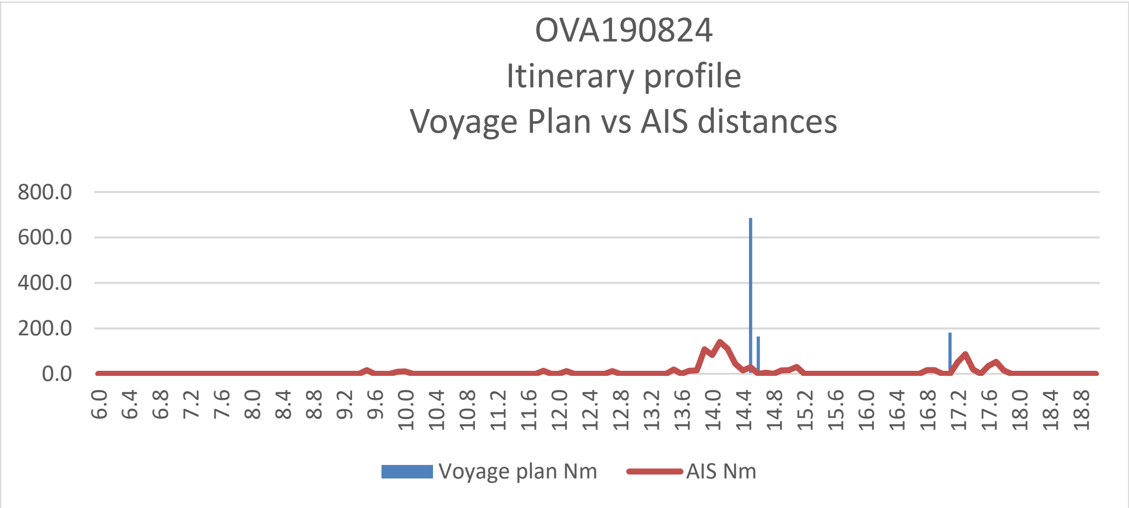
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	0.0	0.0	37.4	0.0%	0.0%	3.7%	0	0	1			
0.05	0.0	0.0	36.6	0.0%	0.0%	3.6%	0	0	1			
0.065	0.0	0.0	155.5	0.0%	0.0%	15.4%	0	0	10	0.0%	0.0%	22.7%
0.08	849.4	693.9	425.7	82.4%	68.5%	42.1%	63	49	29			
0.095	0.0	148.0	61.3	0.0%	14.6%	6.1%	0	12	5			
0.11	0.0	171.2	0.0	0.0%	16.9%	0.0%	0	18	0	82.4%	100.0%	48.2%
0.125	0.0	0.0	33.7	0.0%	0.0%	3.3%	0	0	4			
0.14	181.8	0.0	157.6	17.6%	0.0%	15.6%	23	0	21			
0.155	0.0	0.0	102.5	0.0%	0.0%	10.1%	0	0	15	17.6%	0.0%	29.1%
Total	1031.2	1013.1	1010.3	100.0%	100.0%	100.0%	86.7	79.1	86.3	100.0%	100.0%	100.0%
Average	0.0841	0.0781	0.0854	MT/Nm			85.0	78.9	86.3	MT		



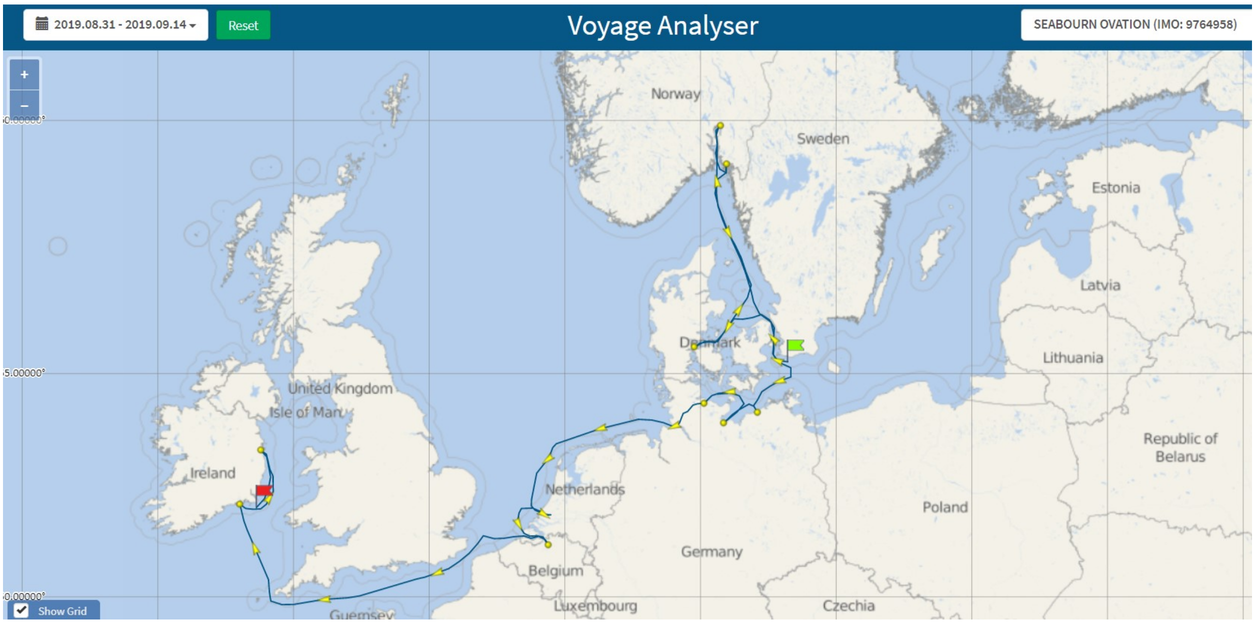
OVA190824
The economy of sailed sea miles per Voyage planning
MT/Nm
Voyage plan Nm
Voyage plan %

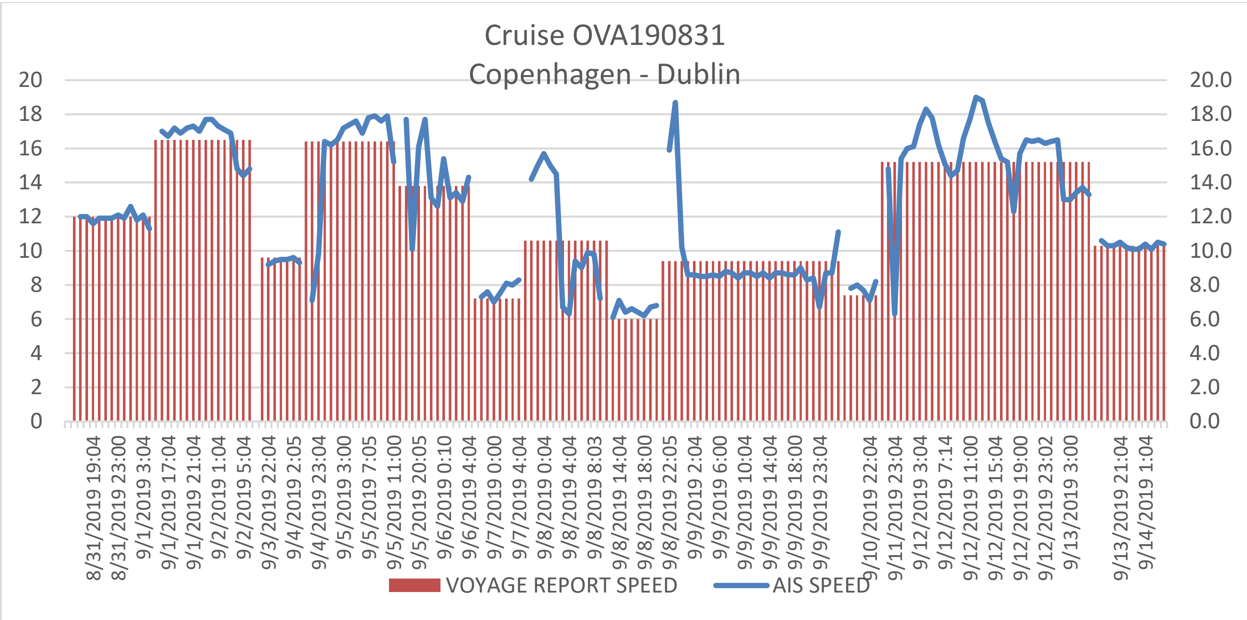


OVA190824
The economy of sailed sea miles per AIS Data
MT/Nm
AIS Nm
AIS %

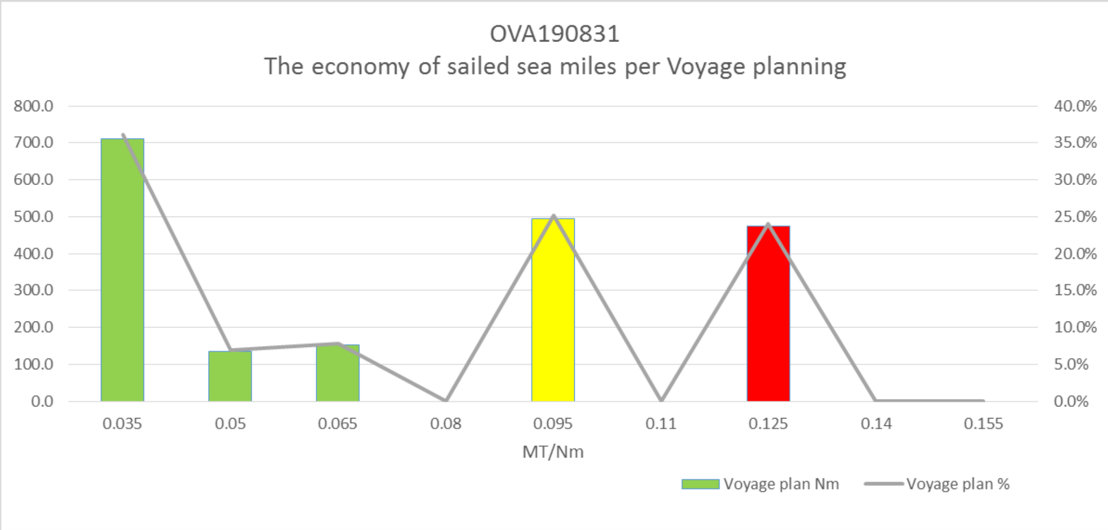


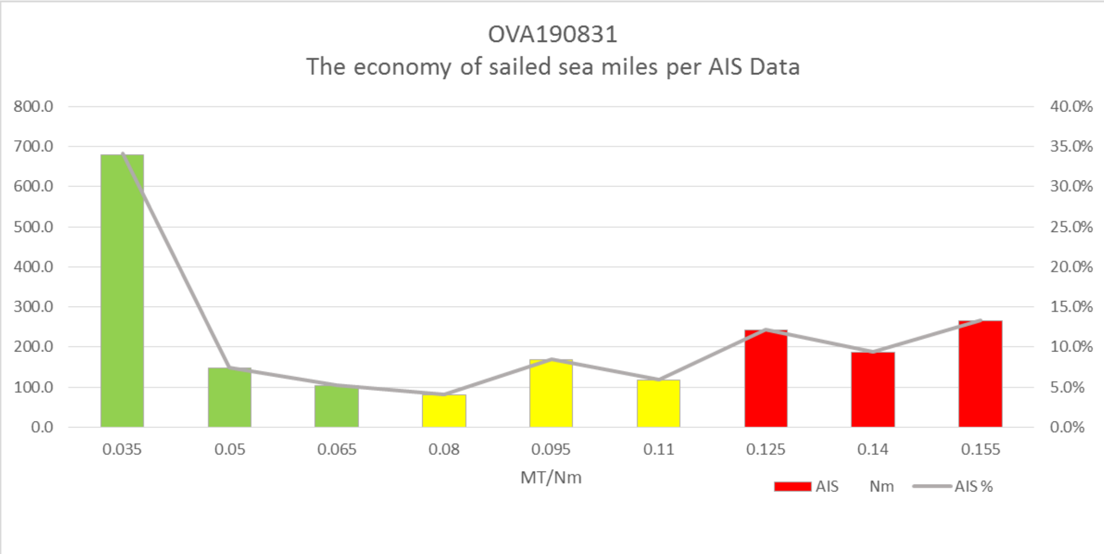
OVA190824
Itinerary profile
Voyage Plan vs AIS distances
Voyage plan Nm
AIS Nm

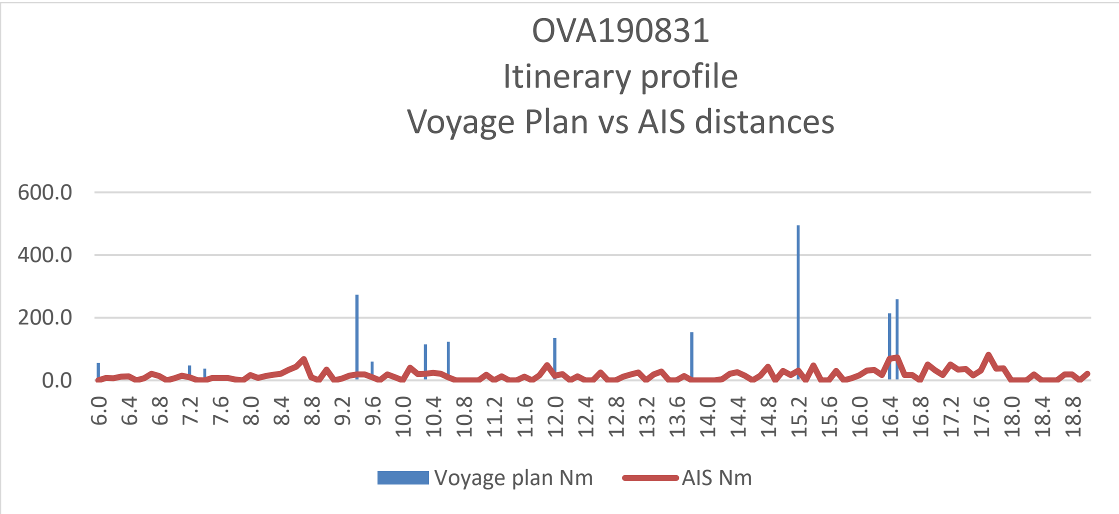


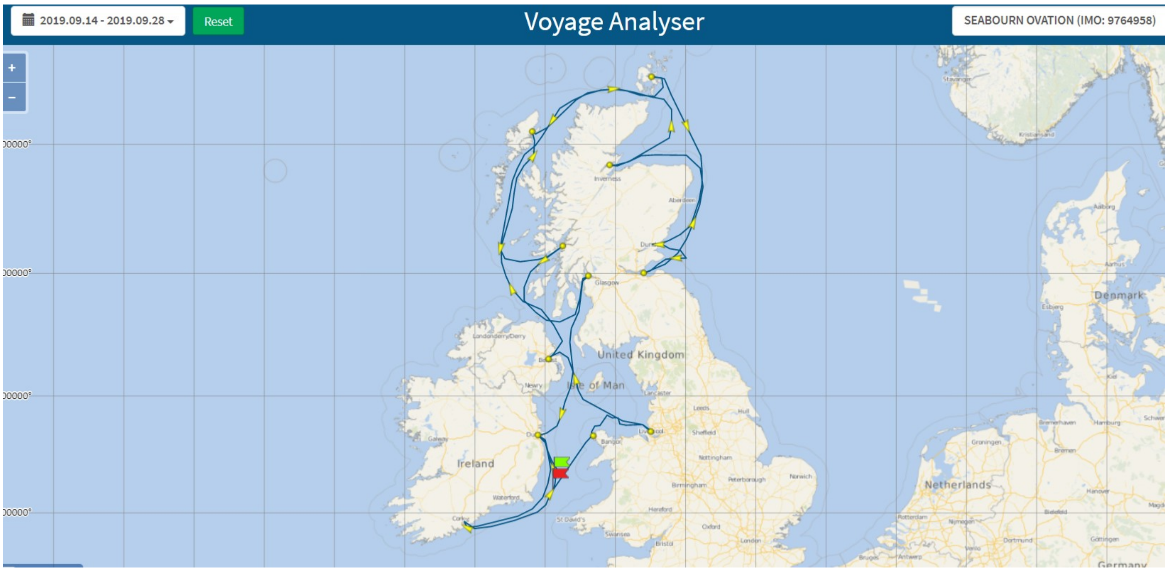


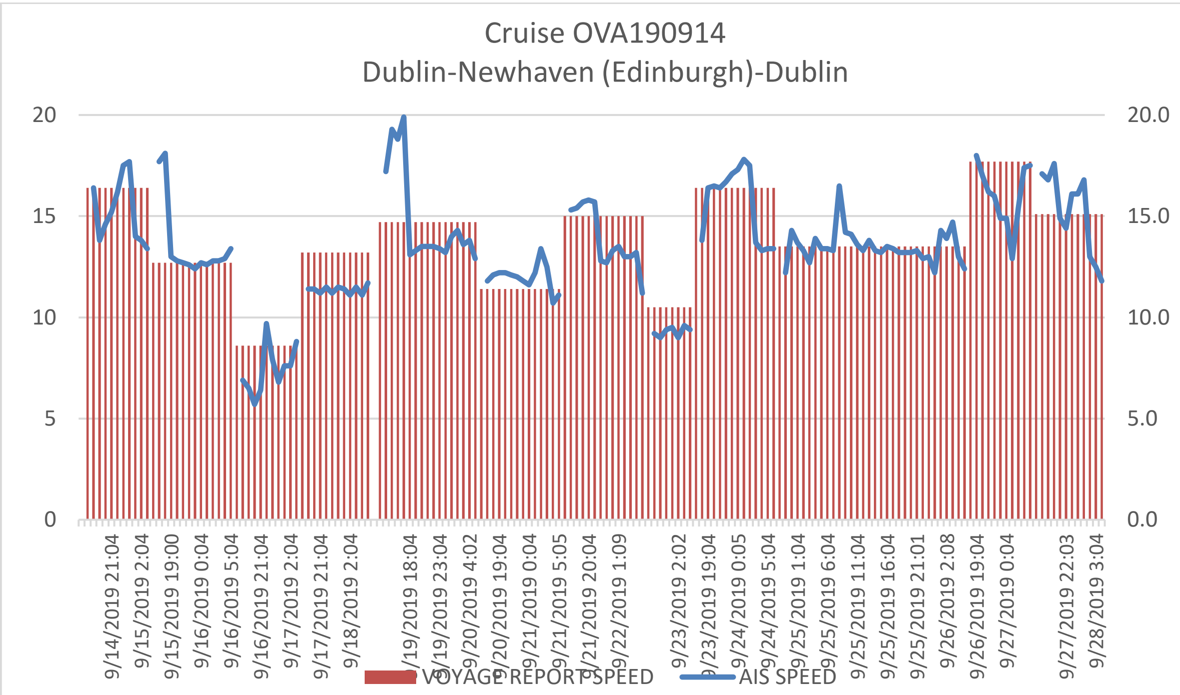
OVA190831												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	710.2	719.9	678.5	36.1%	36.3%	34.1%	18	18	17			
0.05	135.8	134.7	147.0	6.9%	6.8%	7.4%	5	5	6			
0.065	153.4	0.0	104.1	7.8%	0.0%	5.2%	10	0	6	50.8%	43.1%	46.7%
0.08	0.0	157.9	80.5	0.0%	8.0%	4.0%	0	11	6			
0.095	494.5	504.3	168.7	25.1%	25.4%	8.5%	43	47	14			
0.11	0.0	206.2	117.4	0.0%	10.4%	5.9%	0	21	12	25.1%	43.8%	18.4%
0.125	473.3	260.9	242.5	24.1%	13.2%	12.2%	54	31	28			
0.14	0.0	0.0	186.8	0.0%	0.0%	9.4%	0	0	25			
0.155	0.0	0.0	264.5	0.0%	0.0%	13.3%	0	0	38	24.1%	13.2%	34.9%
Total	1967.3	1983.7	1990.0	100.0%	100.0%	100.0%	129.6	132.2	152.8	100.0%	100.0%	100.0%
Average	0.0659	0.0666	0.0768	MT/Nm			131.1	132.6	152.8	MT		


OVA190831
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

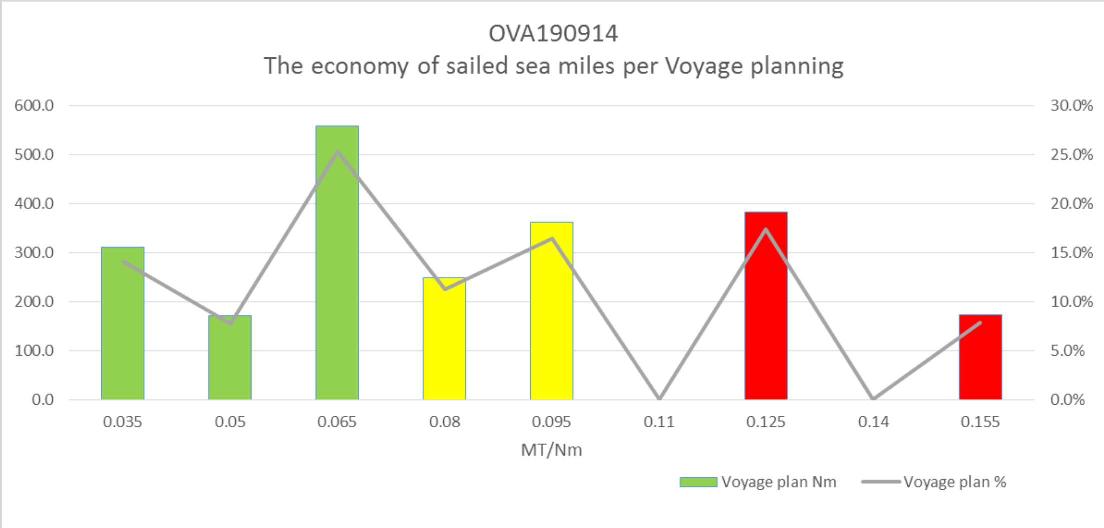

OVA190831
The economy of sailed sea miles per AIS Data
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

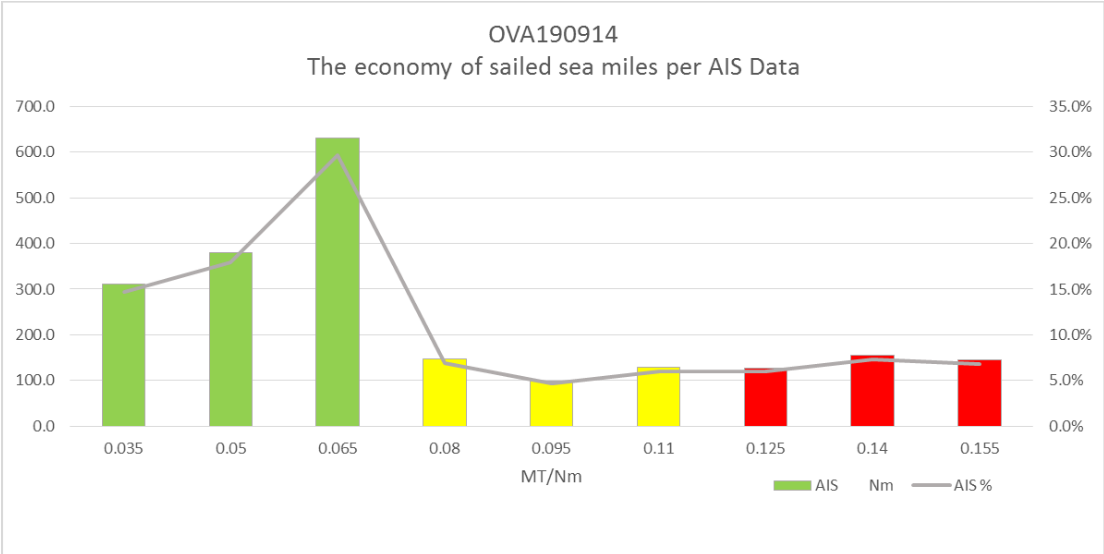

OVA190831
Itinerary profile
Voyage Plan vs AIS distances
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

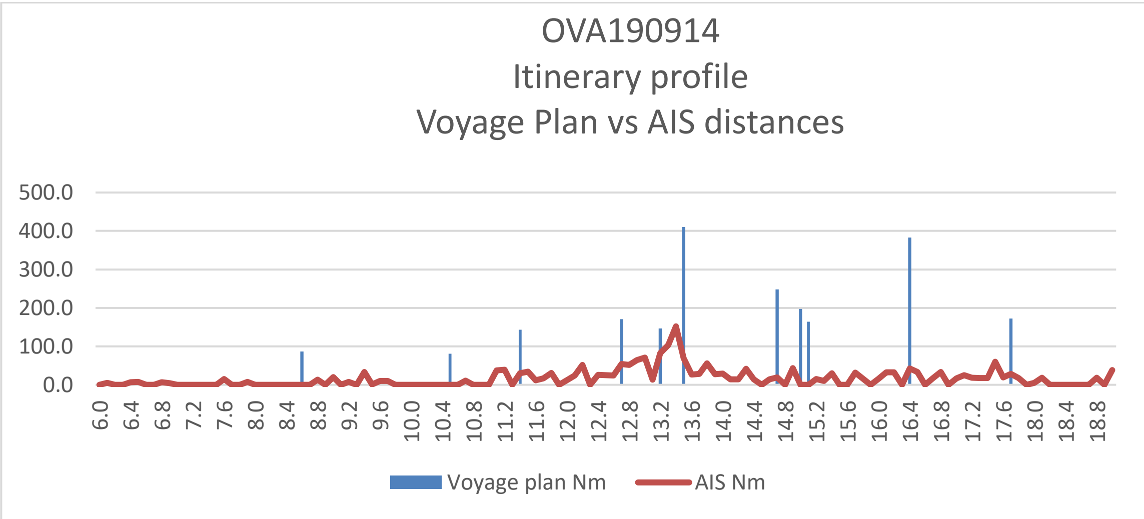


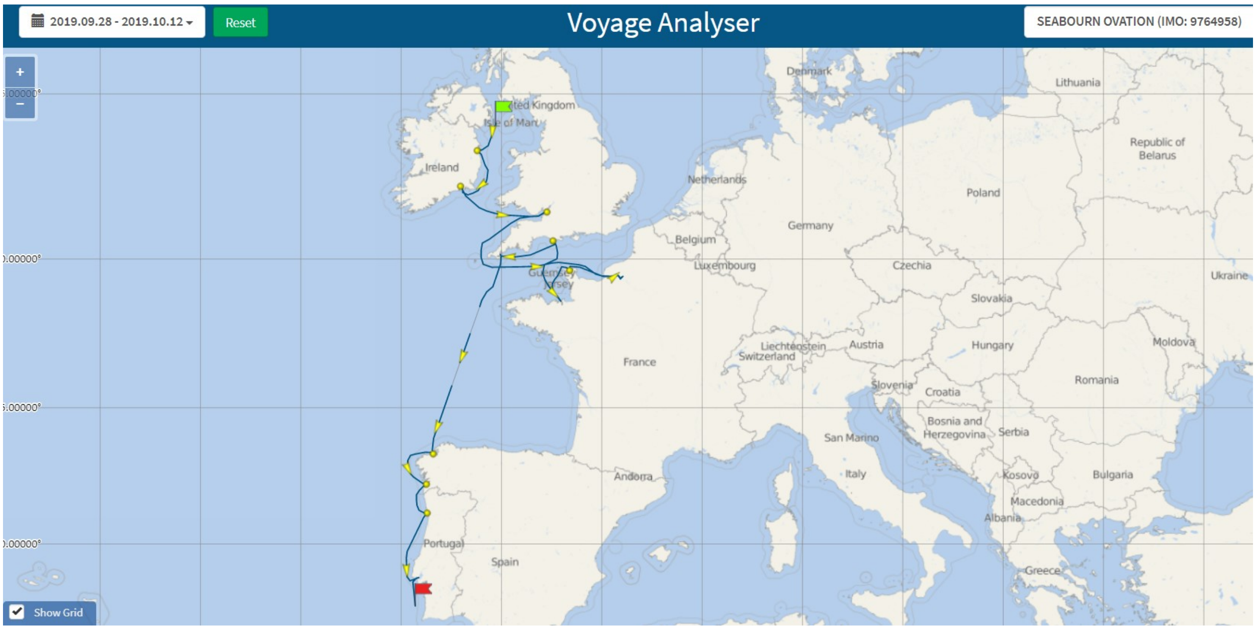


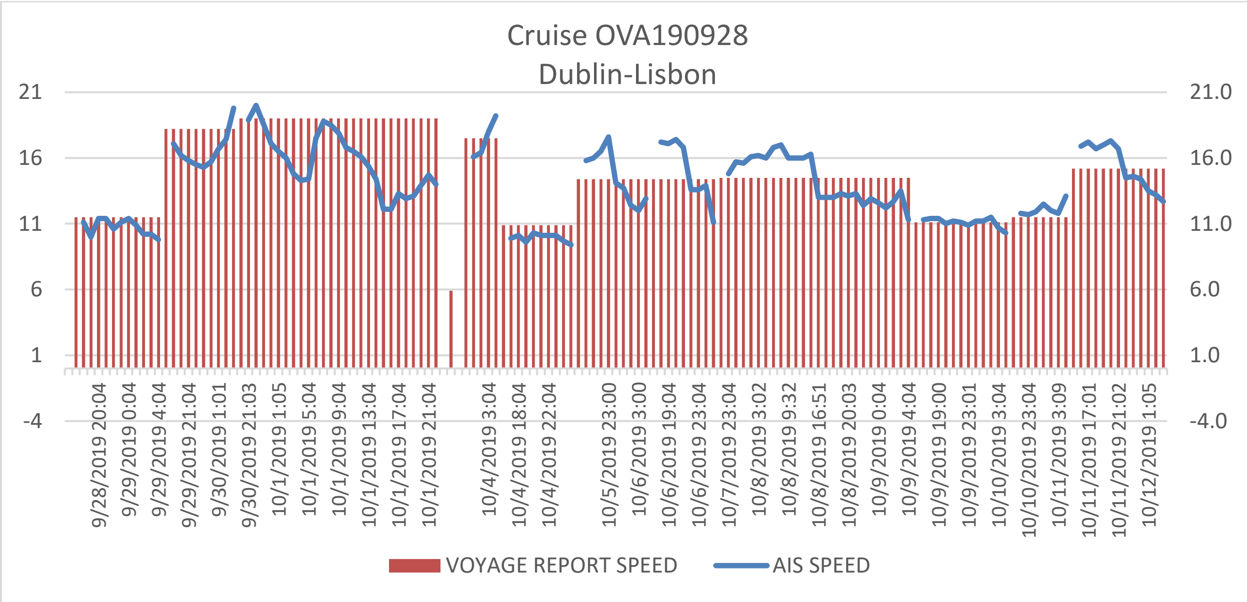
OVA190914												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	310.9	275.6	311.8	14.1%	13.0%	14.7%	9	8	9			
0.05	170.8	149.1	379.7	7.8%	7.0%	17.9%	8	6	17			
0.065	557.1	773.2	629.9	25.3%	36.4%	29.7%	31	45	35	47.1%	56.5%	62.2%
0.08	248.2	246.5	146.5	11.3%	11.6%	6.9%	19	19	10			
0.095	361.3	520.0	99.2	16.4%	24.5%	4.7%	30	45	9			
0.11	0.0	157.7	128.1	0.0%	7.4%	6.0%	0	17	13	27.7%	43.5%	17.6%
0.125	383.2	0.0	126.6	17.4%	0.0%	6.0%	43	0	15			
0.14	0.0	0.0	155.6	0.0%	0.0%	7.3%	0	0	21			
0.155	172.3	0.0	145.3	7.8%	0.0%	6.8%	25	0	21	25.2%	0.0%	20.1%
Total	2203.9	2122.1	2122.7	100.0%	100.0%	100.0%	166.1	139.9	149.8	100.0%	100.0%	100.0%
Average	0.0754	0.0659	0.0706	MT/Nm			160.0	140.0	149.8	MT		


OVA190914
The economy of sailed sea miles per Voyage planning
600.0
500.0
400.0
300.0
200.0
100.0
0.0
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

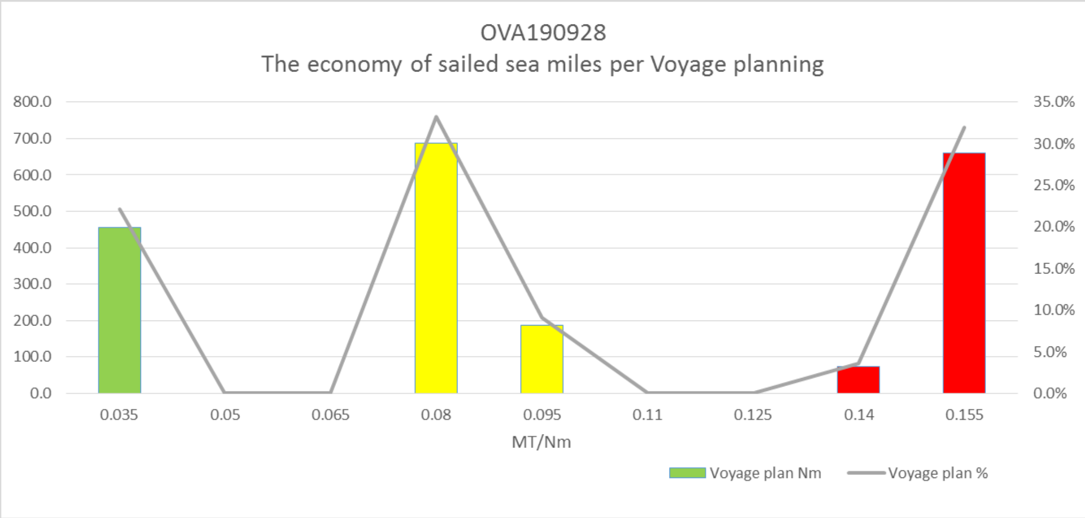

OVA190914
The economy of sailed sea miles per AIS Data
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

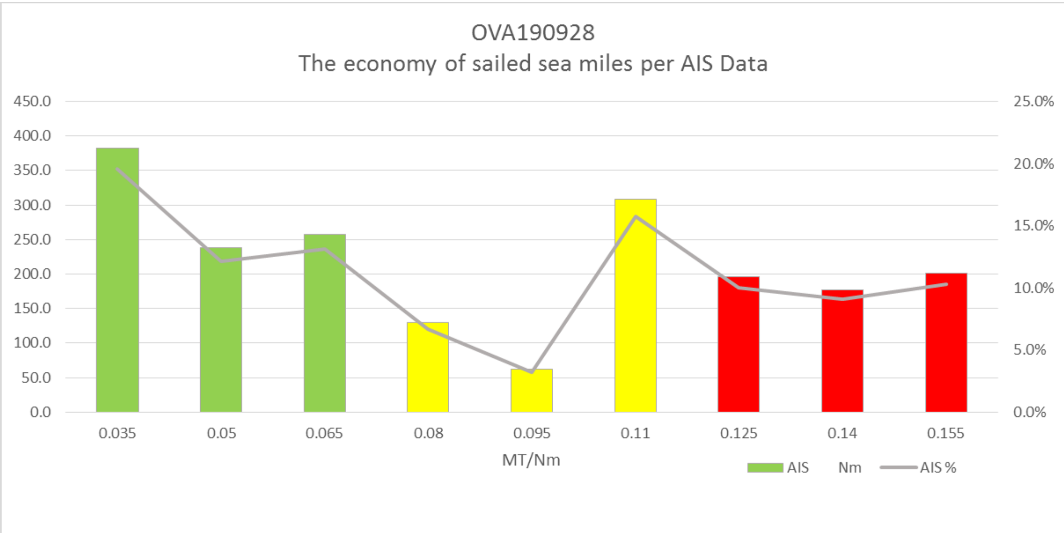

OVA190914
Itinerary profile
Voyage Plan vs AIS distances
500.0
400.0
300.0
200.0
100.0
0.0
6.0 6.4 6.8 7.2 7.6 8.0 8.4 8.8 9.2 9.6 10.0 10.4 10.8 11.2 11.6 12.0 12.4 12.8 13.2 13.6 14.0 14.4 14.8 15.2 15.6 16.0 16.4 16.8 17.2 17.6 18.0 18.4 18.8
Voyage plan Nm
AIS Nm

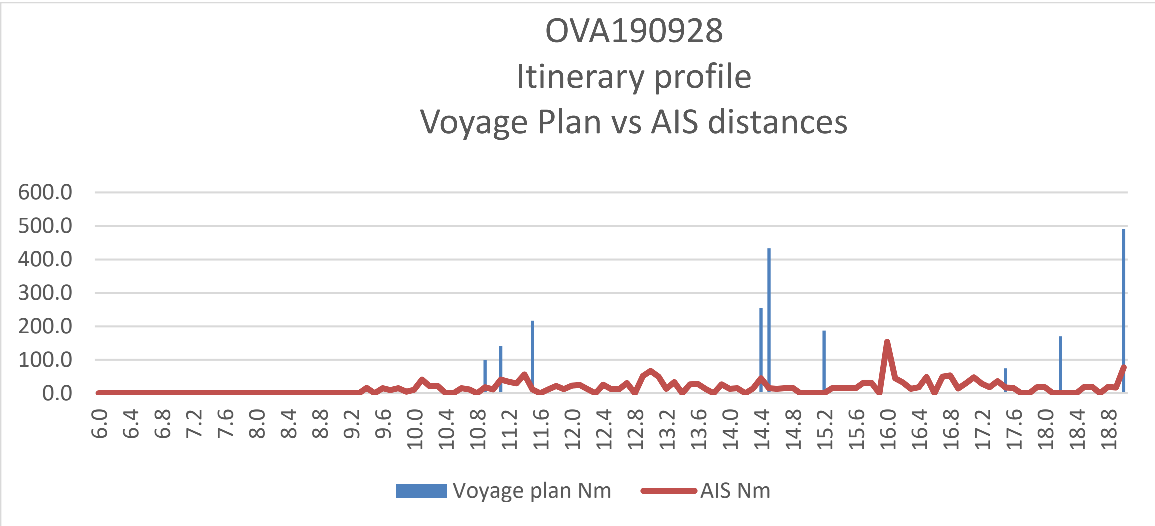


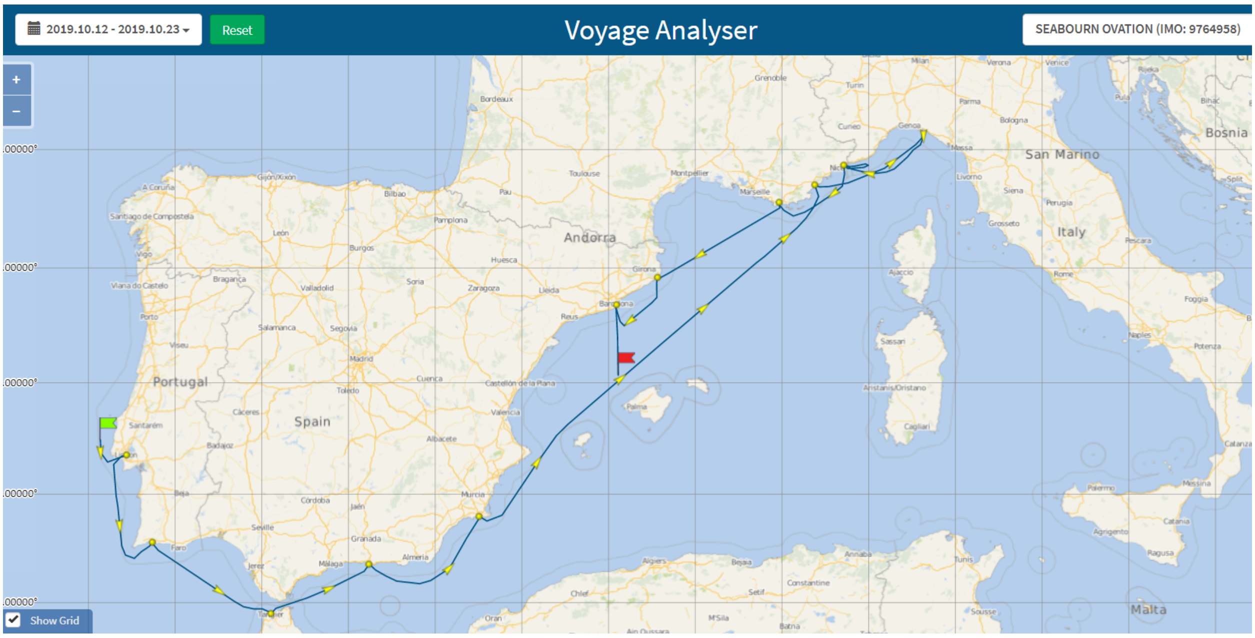


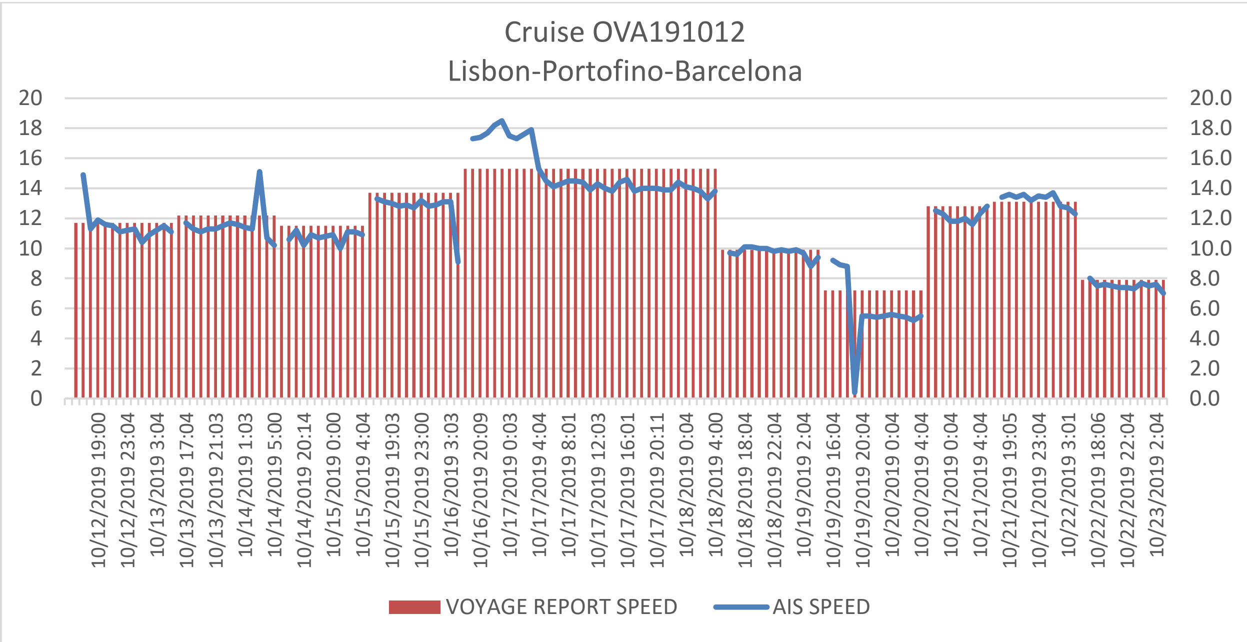
OVA190928												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	456.9	349.8	382.7	22.1%	18.0%	19.6%	14	10	11			
0.05	0.0	91.6	237.8	0.0%	4.7%	12.2%	0	4	10			
0.065	0.0	0.0	257.0	0.0%	0.0%	13.2%	0	0	14	22.1%	22.7%	44.9%
0.08	687.7	680.3	130.1	33.3%	35.0%	6.7%	51	48	9			
0.095	187.5	187.5	62.4	9.1%	9.6%	3.2%	16	16	6			
0.11	0.0	403.3	308.4	0.0%	20.7%	15.8%	0	38	32	42.3%	65.4%	25.6%
0.125	0.0	156.8	196.3	0.0%	8.1%	10.0%	0	19	23			
0.14	74.7	0.0	177.4	3.6%	0.0%	9.1%	10	0	23			
0.155	661.0	75.5	201.9	32.0%	3.9%	10.3%	96	11	29	35.6%	11.9%	29.5%
Total	2067.8	1944.7	1953.9	100.0%	100.0%	100.0%	187.8	146.1	157.8	100.0%	100.0%	100.0%
Average	0.0908	0.0751	0.0808	MT/Nm			177.5	146.8	157.8	MT		


OVA190928
The economy of sailed sea miles per Voyage planning
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

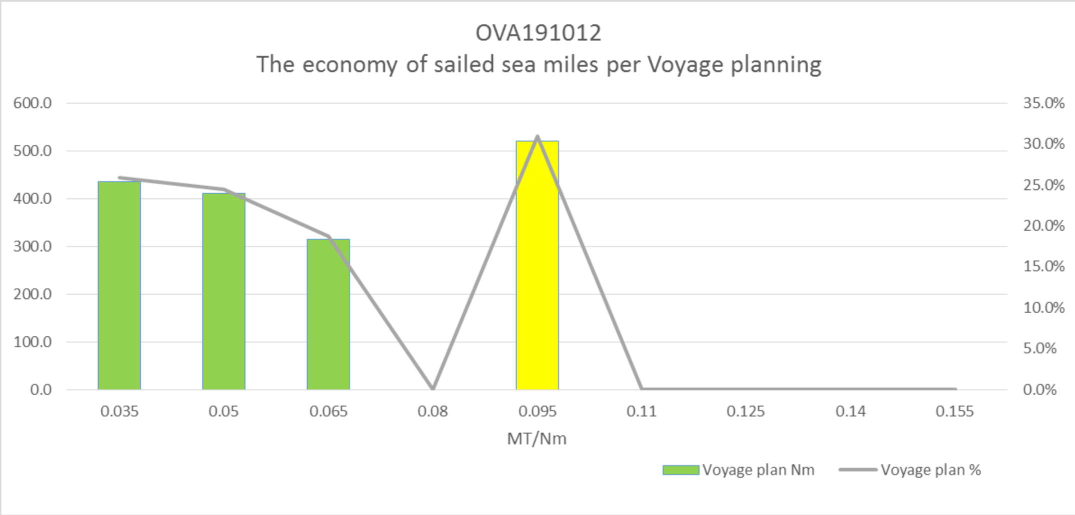

OVA190928
The economy of sailed sea miles per AIS Data
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

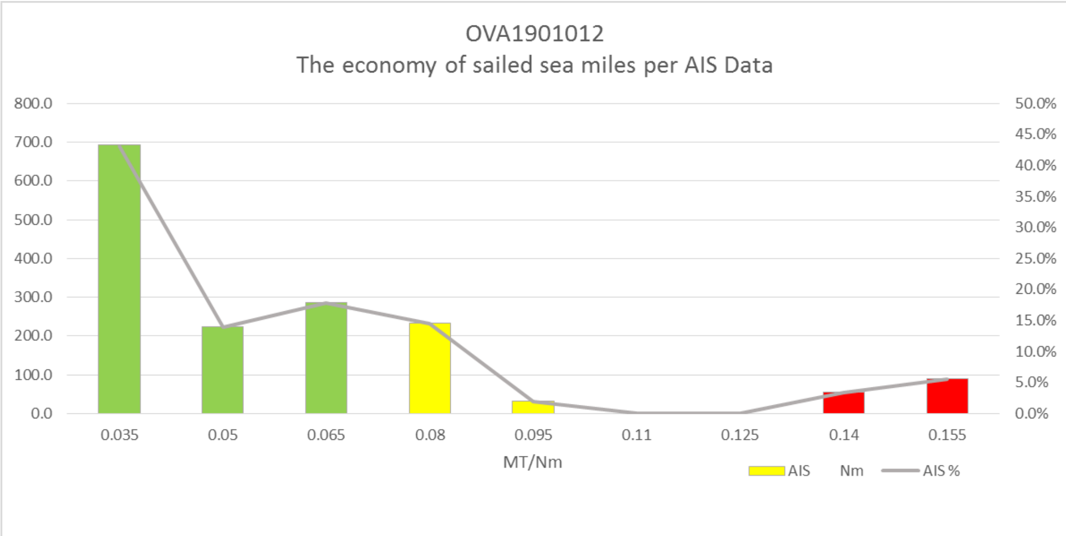

OVA190928
Itinerary profile
Voyage Plan vs AIS distances
600.0
500.0
400.0
300.0
200.0
100.0
0.0
6.0 6.4 6.8 7.2 7.6 8.0 8.4 8.8 9.2 9.6 10.0 10.4 10.8 11.2 11.6 12.0 12.4 12.8 13.2 13.6 14.0 14.4 14.8 15.2 15.6 16.0 16.4 16.8 17.2 17.6 18.0 18.4 18.8
Voyage plan Nm
AIS Nm

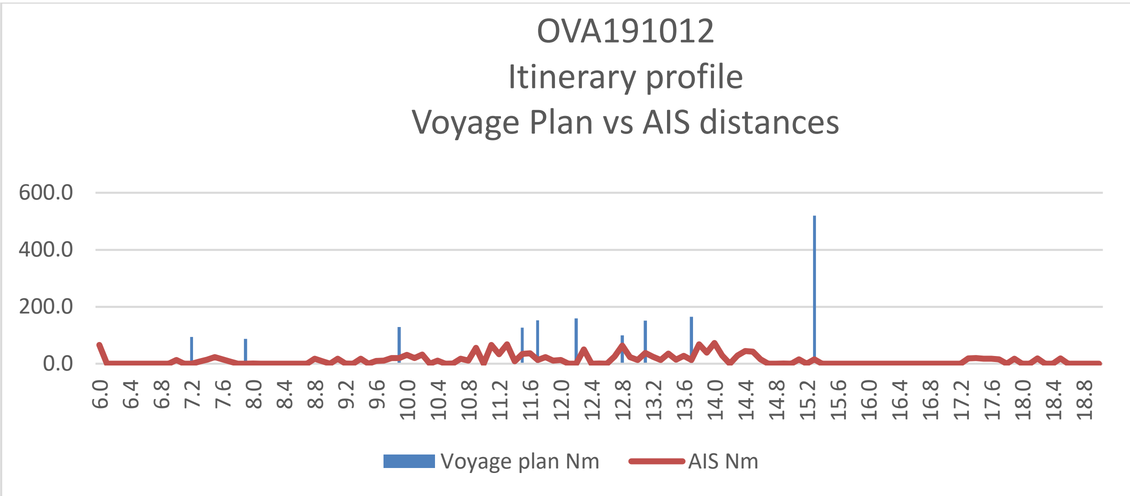


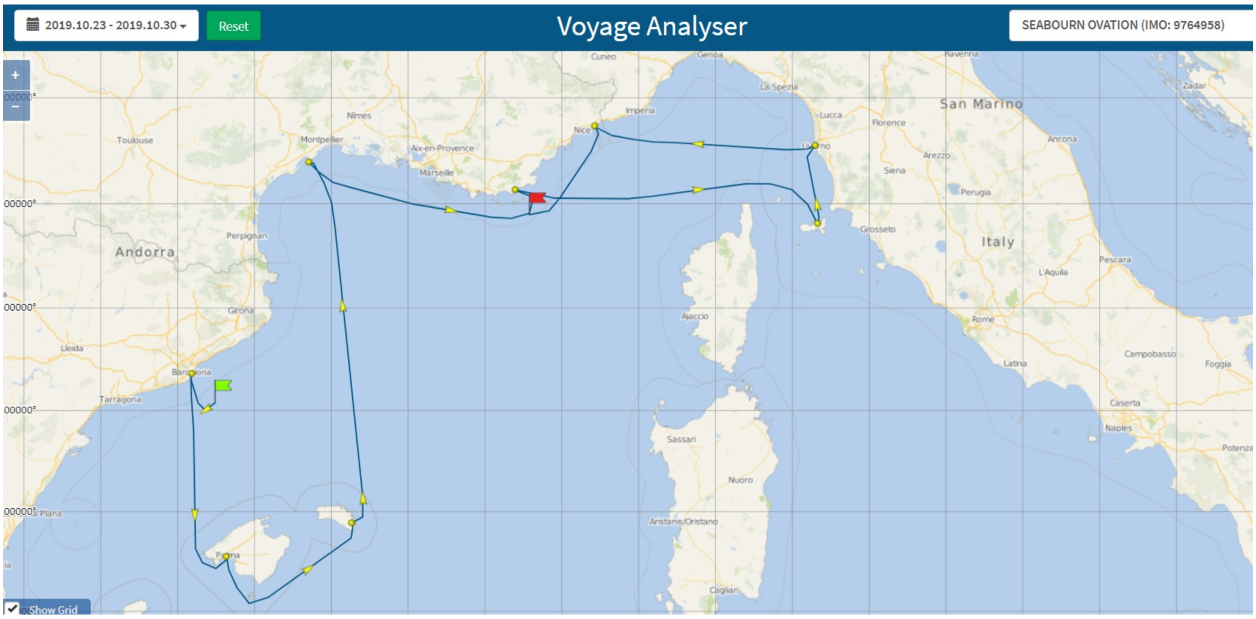


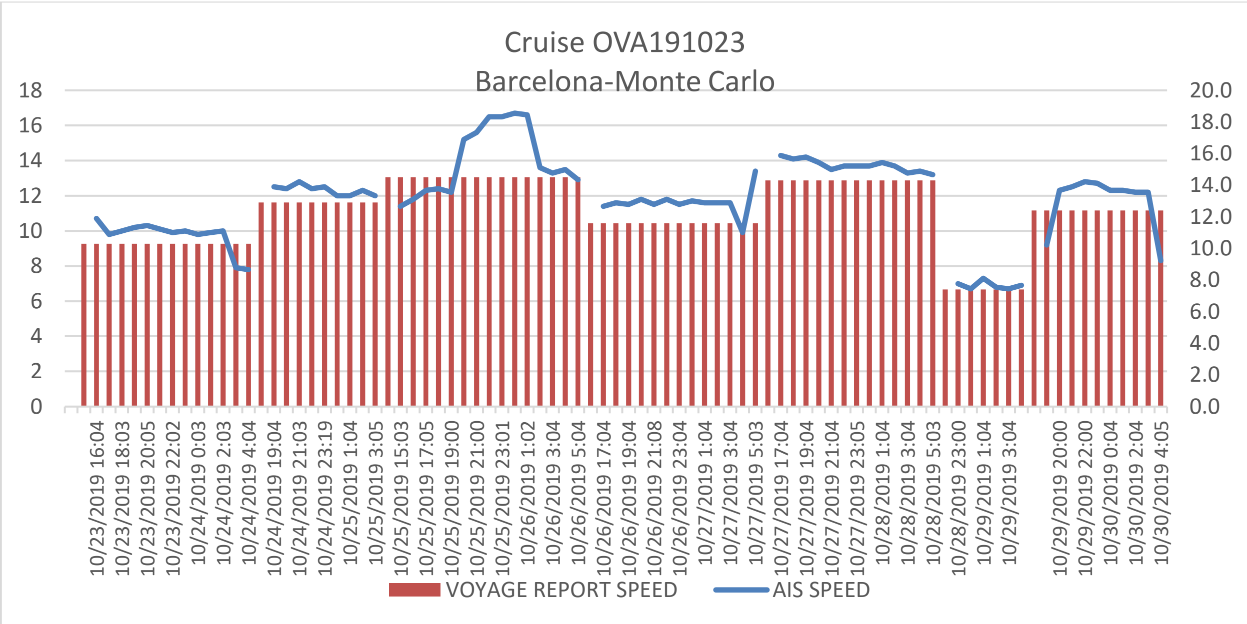
OVA191012												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	435.7	704.4	693.2	25.9%	43.7%	43.1%	12	21	19			
0.05	410.1	243.6	223.2	24.4%	15.1%	13.9%	17	10	10			
0.065	315.1	151.8	285.7	18.7%	9.4%	17.7%	18	8	17	69.1%	68.2%	74.7%
0.08	0.0	0.0	232.1	0.0%	0.0%	14.4%	0	0	16			
0.095	520.2	513.4	32.0	30.9%	31.8%	2.0%	46	44	3			
0.11	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	30.9%	31.8%	16.4%
0.125	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.14	0.0	0.0	54.6	0.0%	0.0%	3.4%	0	0	7			
0.155	0.0	0.0	88.7	0.0%	0.0%	5.5%	0	0	13	0.0%	0.0%	8.9%
Total	1681.1	1613.2	1609.5	100.0%	100.0%	100.0%	92.7	82.7	85.2	100.0%	100.0%	100.0%
Average	0.0552	0.0513	0.0529	MT/Nm			88.8	82.5	85.2	MT		


OVA191012
The economy of sailed sea miles per Voyage planning
600.0
500.0
400.0
300.0
200.0
100.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

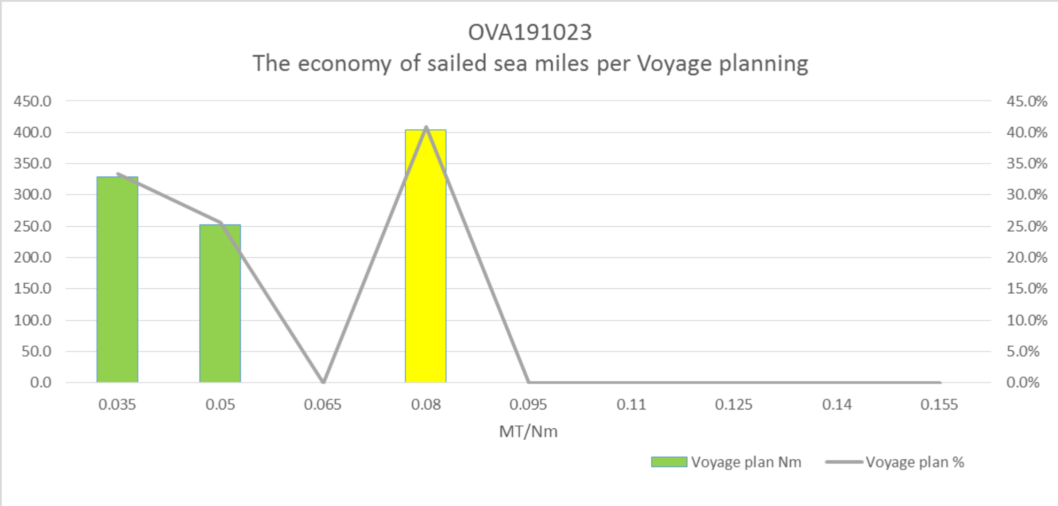

OVA1901012
The economy of sailed sea miles per AIS Data
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
50.0%
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

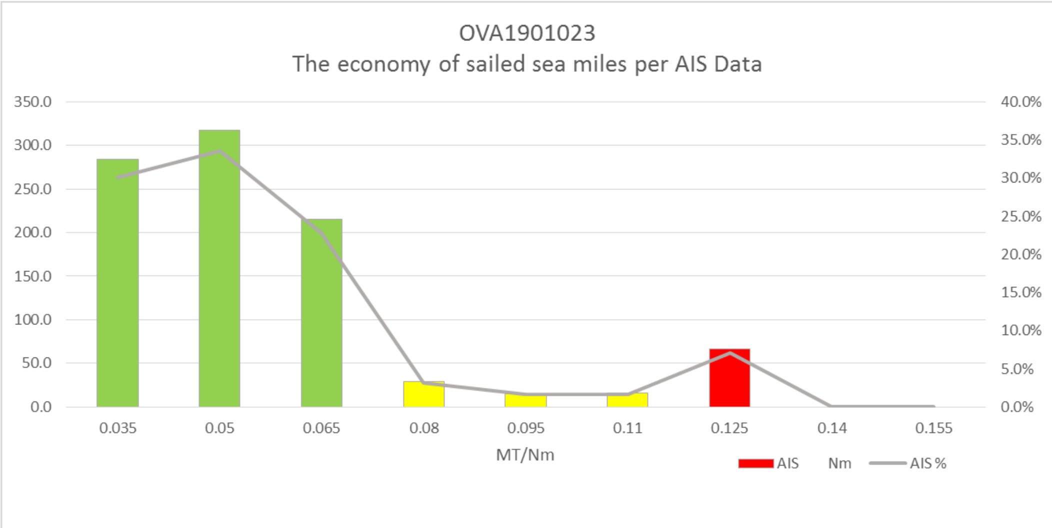

OVA191012
Itinerary profile
Voyage Plan vs AIS distances
600.0
400.0
200.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

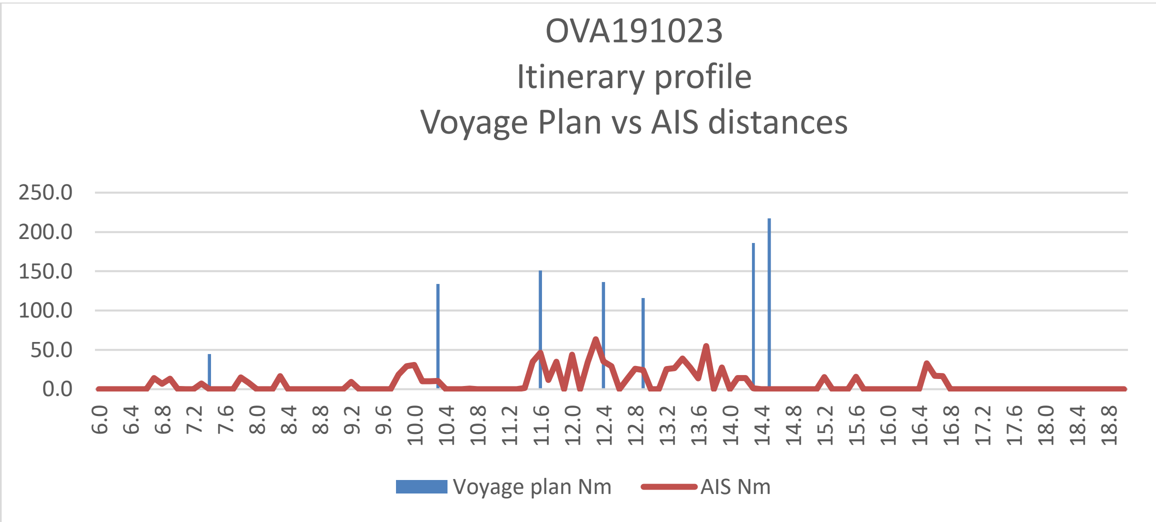


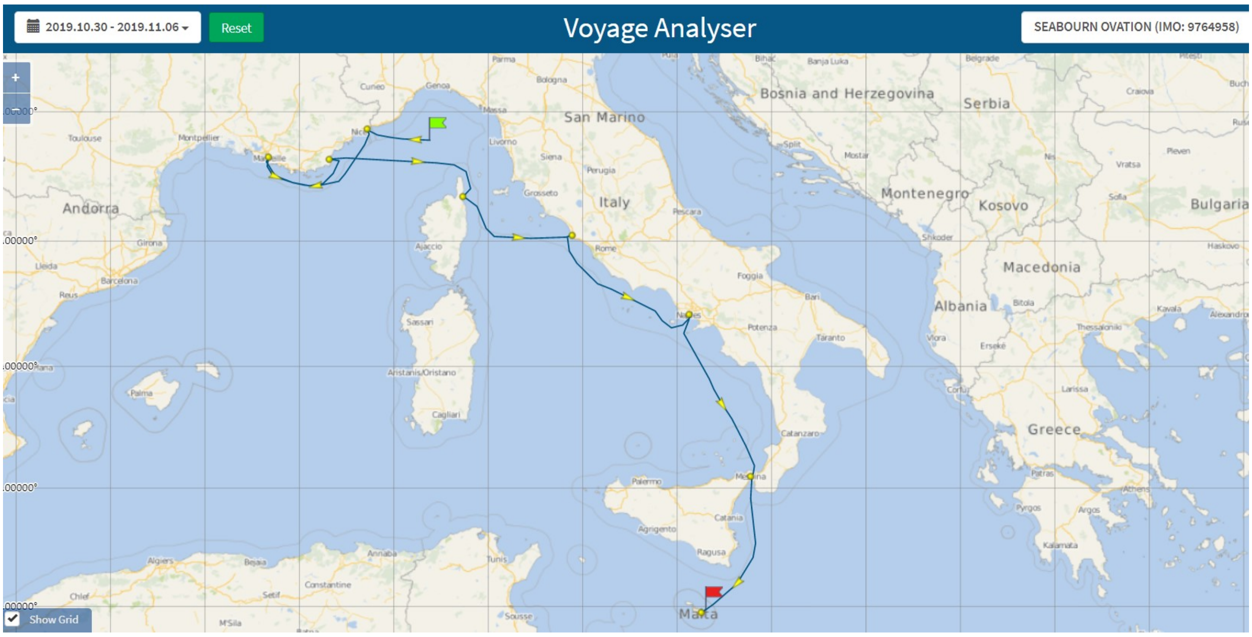


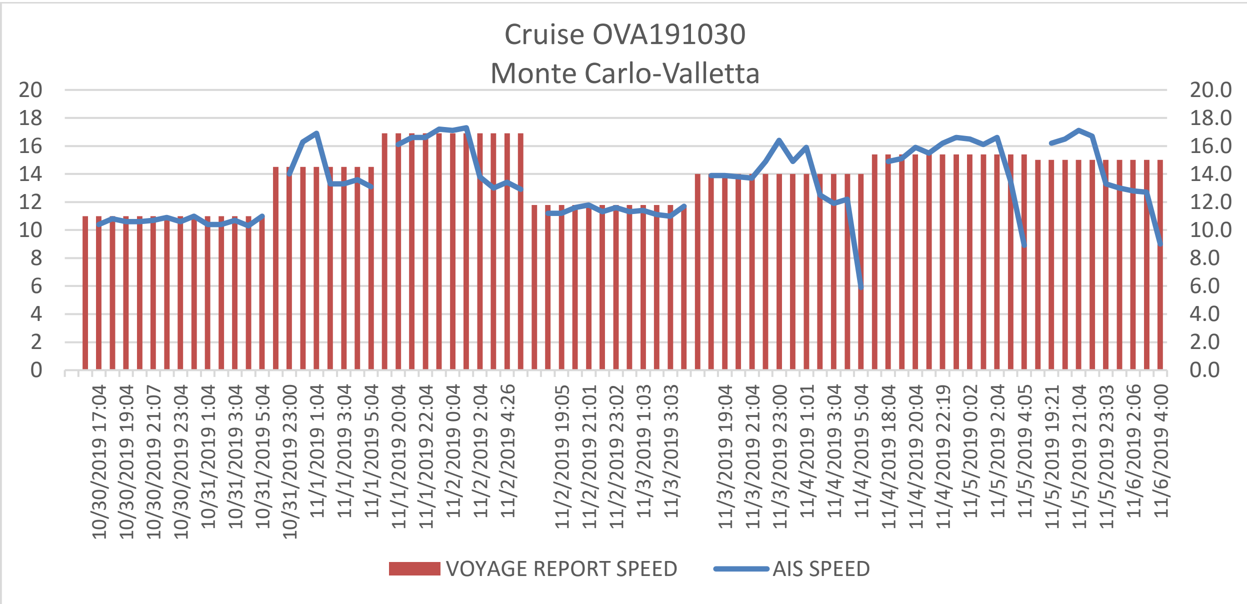
OVA191023												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	329.2	291.7	283.9	33.4%	30.9%	30.1%	10	8	8			
0.05	252.5	262.8	317.0	25.6%	27.9%	33.6%	12	10	13			
0.065	0.0	178.1	215.2	0.0%	18.9%	22.8%	0	11	13	59.1%	77.7%	86.5%
0.08	403.4	210.0	29.5	40.9%	22.3%	3.1%	29	14	2			
0.095	0.0	0.0	15.2	0.0%	0.0%	1.6%	0	0	1			
0.11	0.0	0.0	15.6	0.0%	0.0%	1.7%	0	0	1	40.9%	22.3%	6.4%
0.125	0.0	0.0	66.8	0.0%	0.0%	7.1%	0	0	8			
0.14	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	0.0%	0.0%	7.1%
Total	985.1	942.6	943.2	100.0%	100.0%	100.0%	50.6	42.7	46.3	100.0%	100.0%	100.0%
Average	0.0513	0.0453	0.0490	MT/Nm			48.4	42.8	46.3	MT		


OVA191023
The economy of sailed sea miles per Voyage planning
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

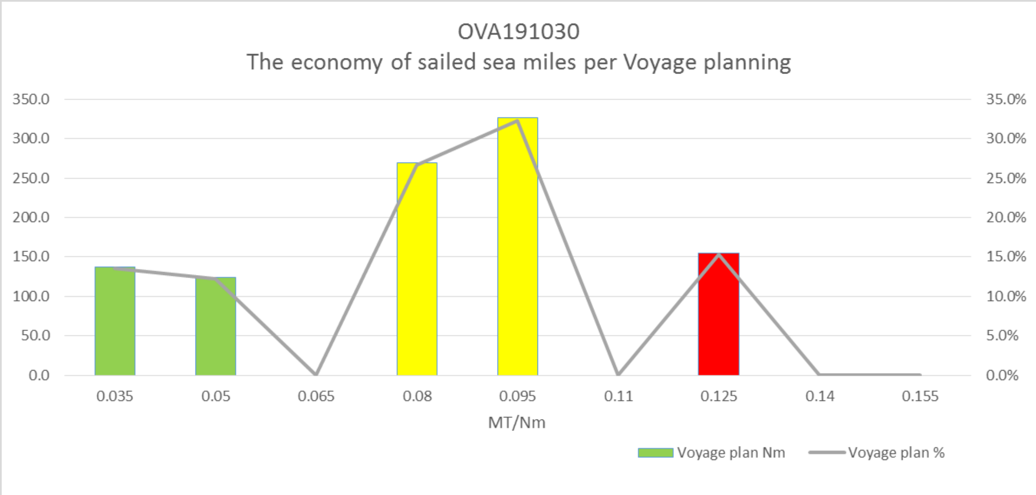

OVA1901023
The economy of sailed sea miles per AIS Data
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

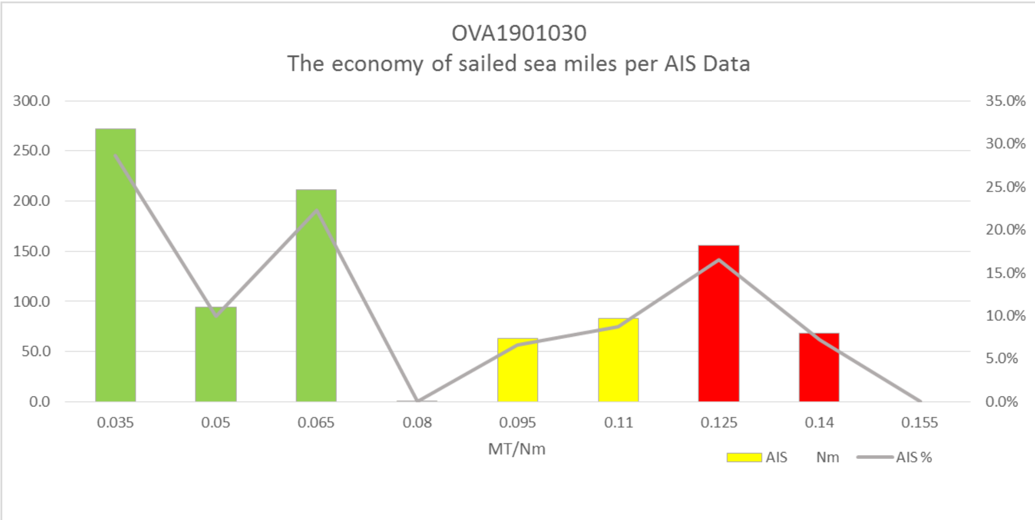

OVA191023
Itinerary profile
Voyage Plan vs AIS distances
250.0
200.0
150.0
100.0
50.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

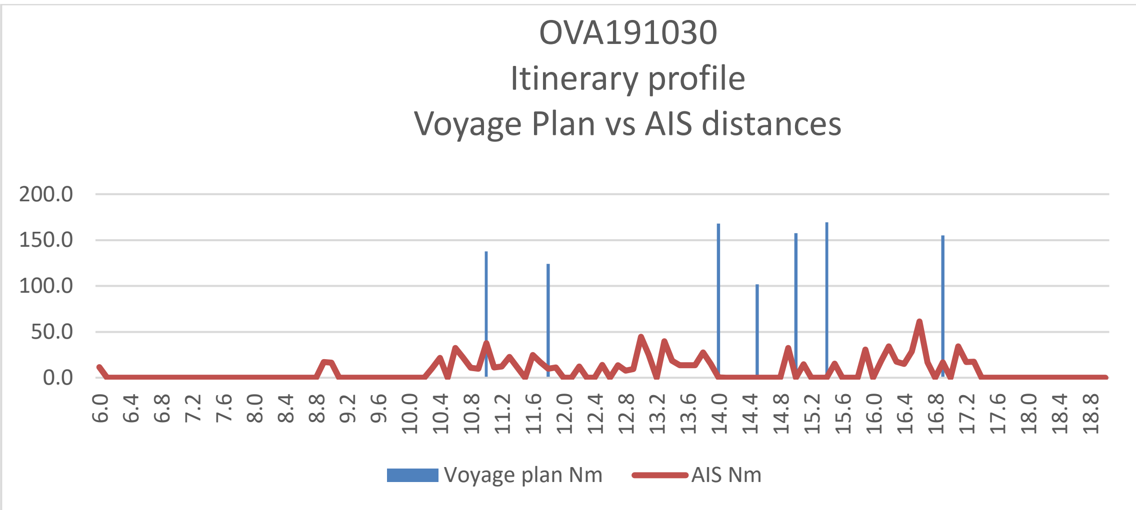


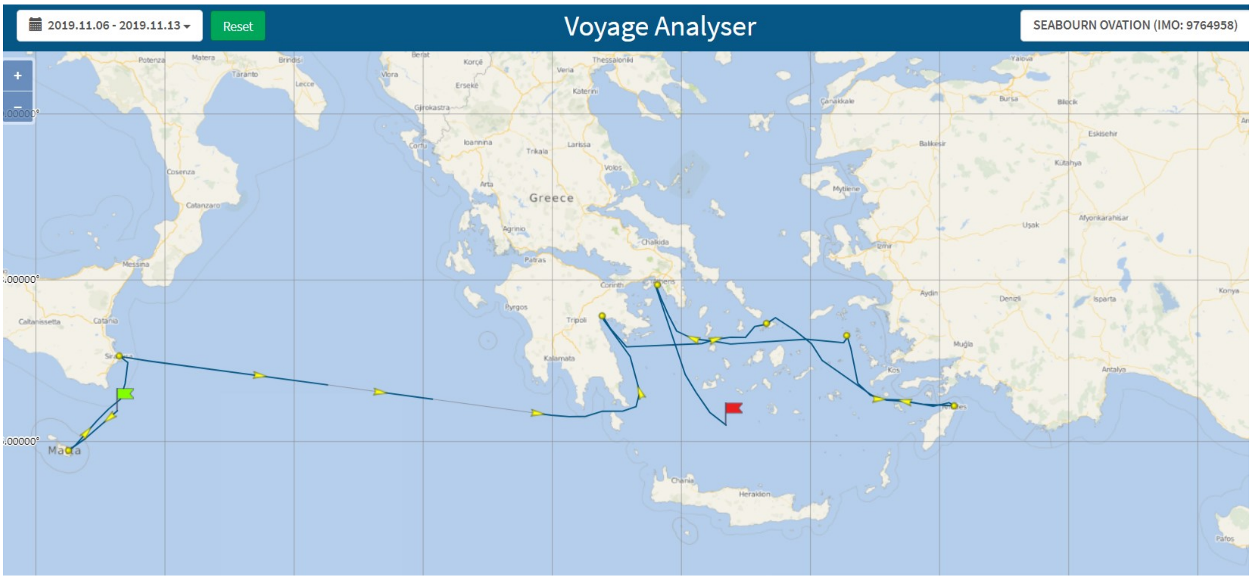


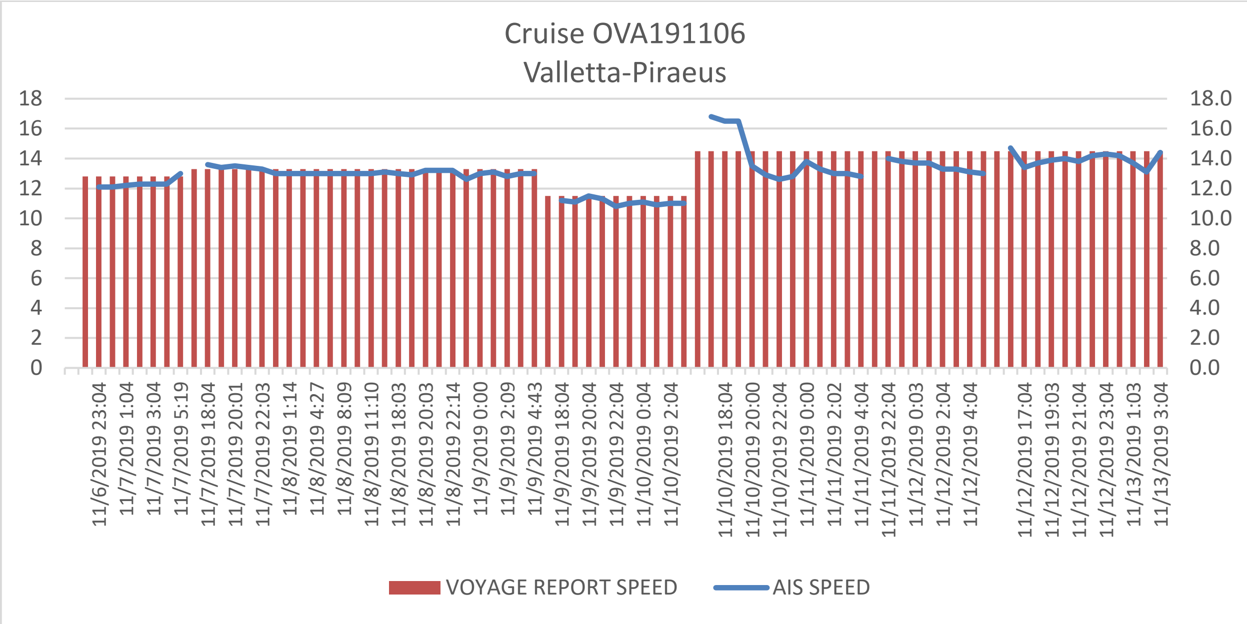
OVA191030												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	137.5	253.4	271.7	13.6%	26.7%	28.6%	4	8	8			
0.05	123.9	153.6	94.5	12.2%	16.2%	10.0%	5	7	4			
0.065	0.0	142.8	211.1	0.0%	15.0%	22.3%	0	8	12	25.8%	57.9%	60.9%
0.08	269.7	260.2	0.3	26.6%	27.4%	0.0%	19	19	0			
0.095	326.9	139.3	62.9	32.3%	14.7%	6.6%	29	12	5			
0.11	0.0	0.0	82.9	0.0%	0.0%	8.7%	0	0	9	58.9%	42.1%	15.4%
0.125	154.9	0.0	156.2	15.3%	0.0%	16.5%	19	0	18			
0.14	0.0	0.0	68.8	0.0%	0.0%	7.2%	0	0	9			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	15.3%	0.0%	23.7%
Total	1013.0	949.4	948.5	100.0%	100.0%	100.0%	75.0	54.6	64.9	100.0%	100.0%	100.0%
Average	0.0740	0.0576	0.0684	MT/Nm			70.2	54.6	64.9	MT		


OVA191030
The economy of sailed sea miles per Voyage planning
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

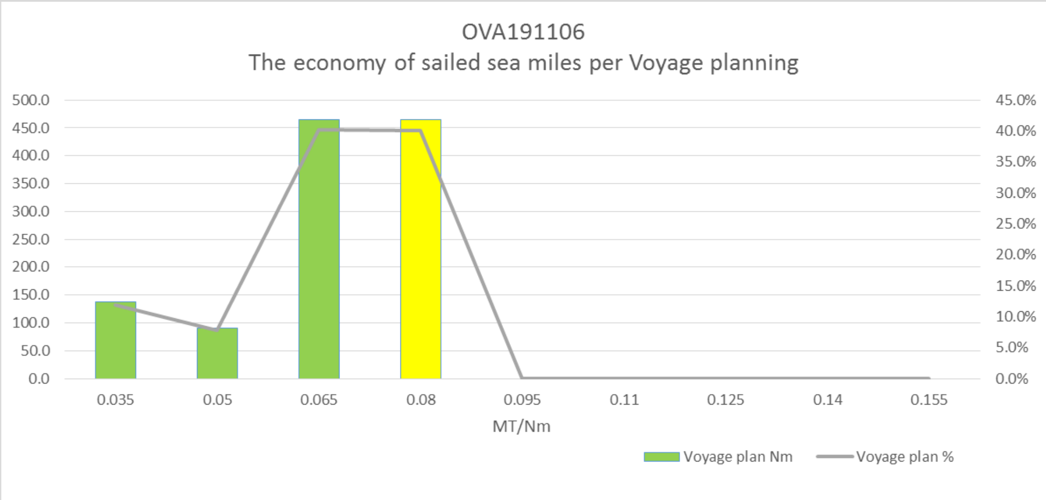

OVA1901030
The economy of sailed sea miles per AIS Data
300.0
250.0
200.0
150.0
100.0
50.0
0.0
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

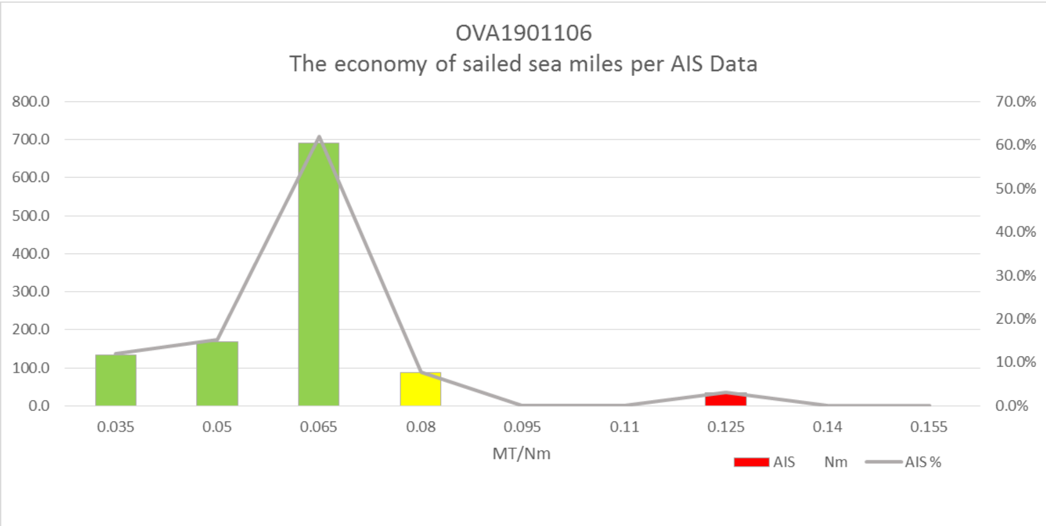

OVA191030
Itinerary profile
Voyage Plan vs AIS distances
200.0
150.0
100.0
50.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

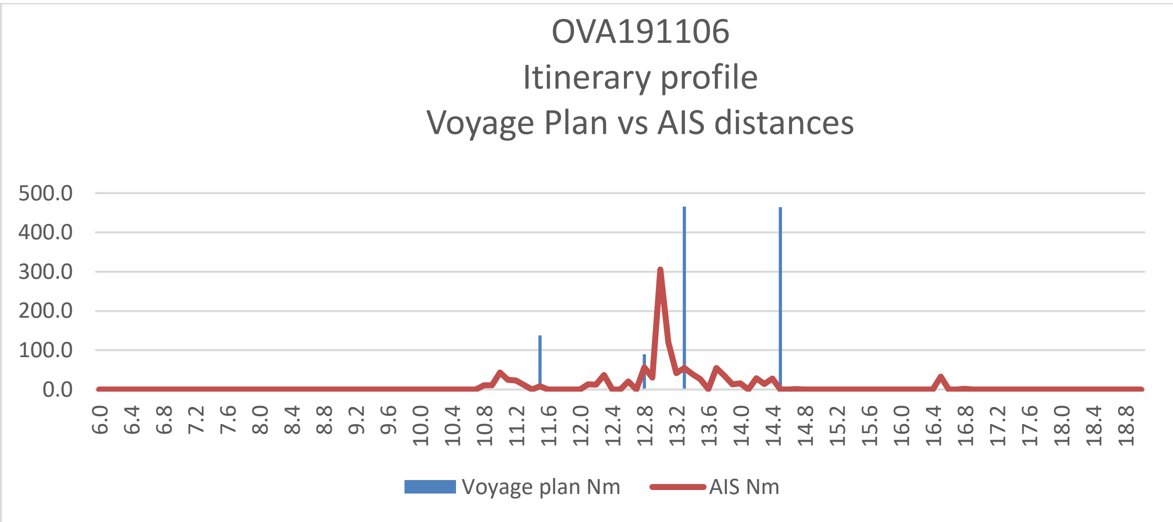


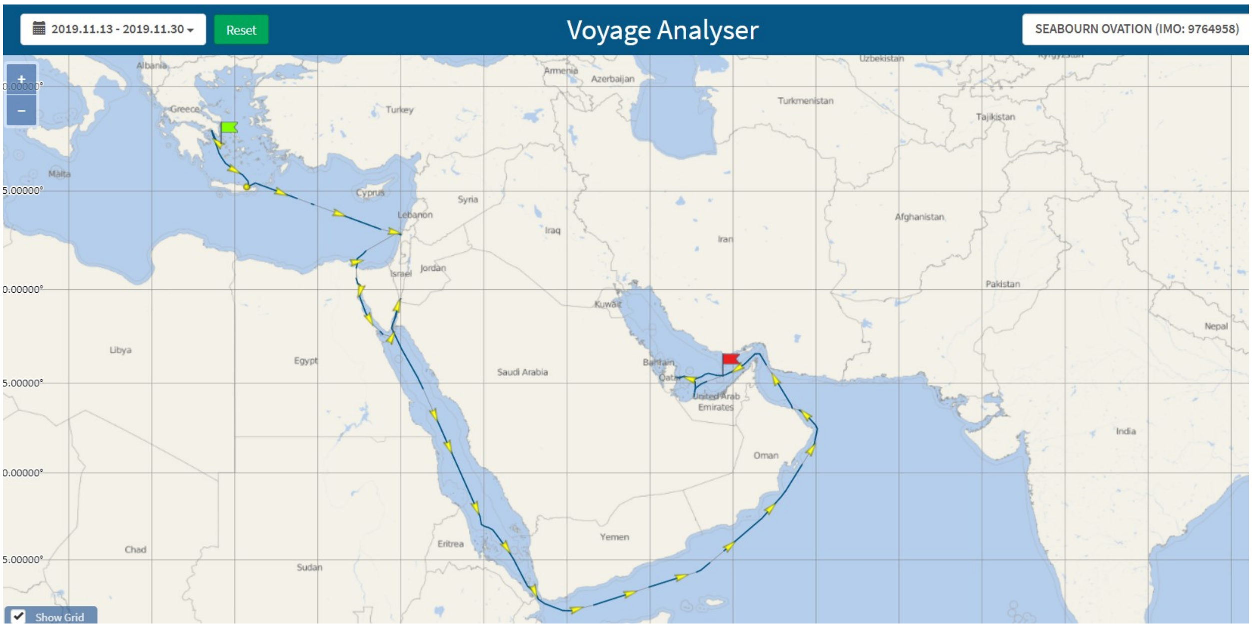


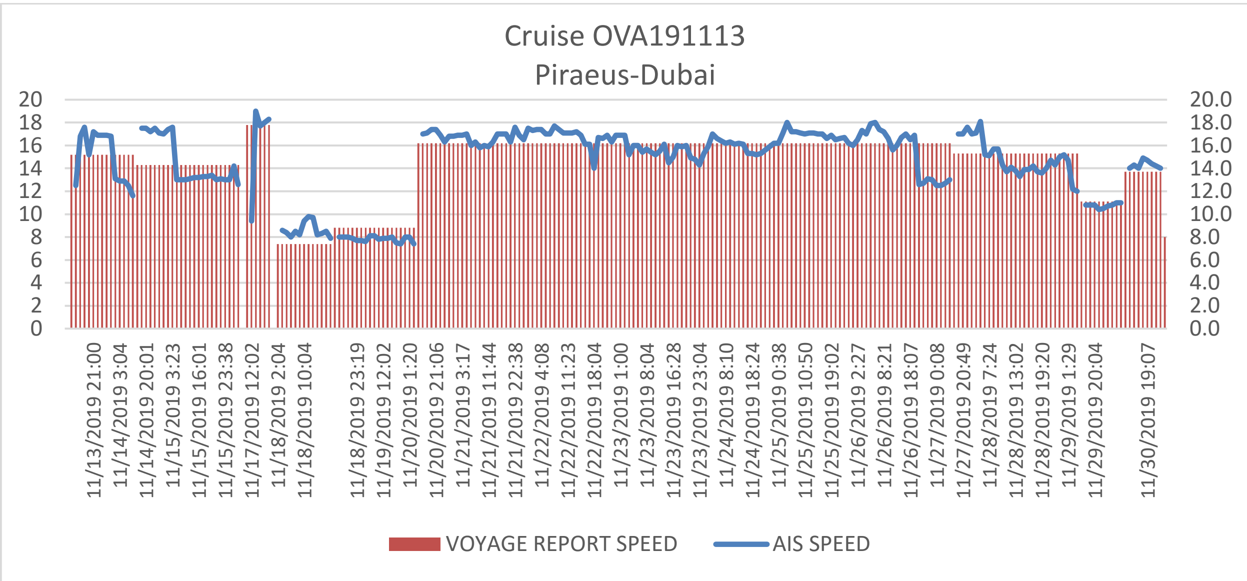
OVA191106												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	138.0	133.2	133.0	11.9%	11.9%	11.9%	5	4	4			
0.05	89.8	87.0	169.3	7.8%	7.8%	15.2%	4	4	8			
0.065	465.5	732.7	691.5	40.2%	65.4%	62.0%	25	40	37	59.9%	85.0%	89.1%
0.08	464.2	168.0	87.3	40.1%	15.0%	7.8%	34	11	6			
0.095	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.11	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	40.1%	15.0%	7.8%
0.125	0.0	0.0	34.4	0.0%	0.0%	3.1%	0	0	4			
0.14	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0			
0.155	0.0	0.0	0.0	0.0%	0.0%	0.0%	0	0	0	0.0%	0.0%	3.1%
Total	1157.6	1120.9	1115.5	100.0%	100.0%	100.0%	68.8	59.3	58.7	100.0%	100.0%	100.0%
Average	0.0594	0.0529	0.0527	MT/Nm			66.3	59.0	58.7	MT		


OVA191106
The economy of sailed sea miles per Voyage planning
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
45.0%
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %

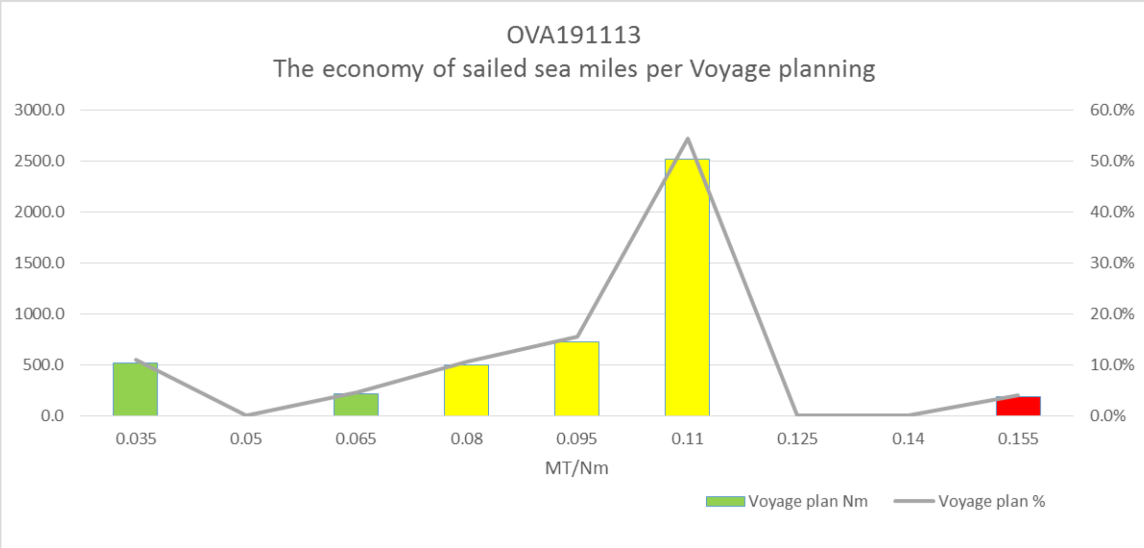

OVA1901106
The economy of sailed sea miles per AIS Data
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %

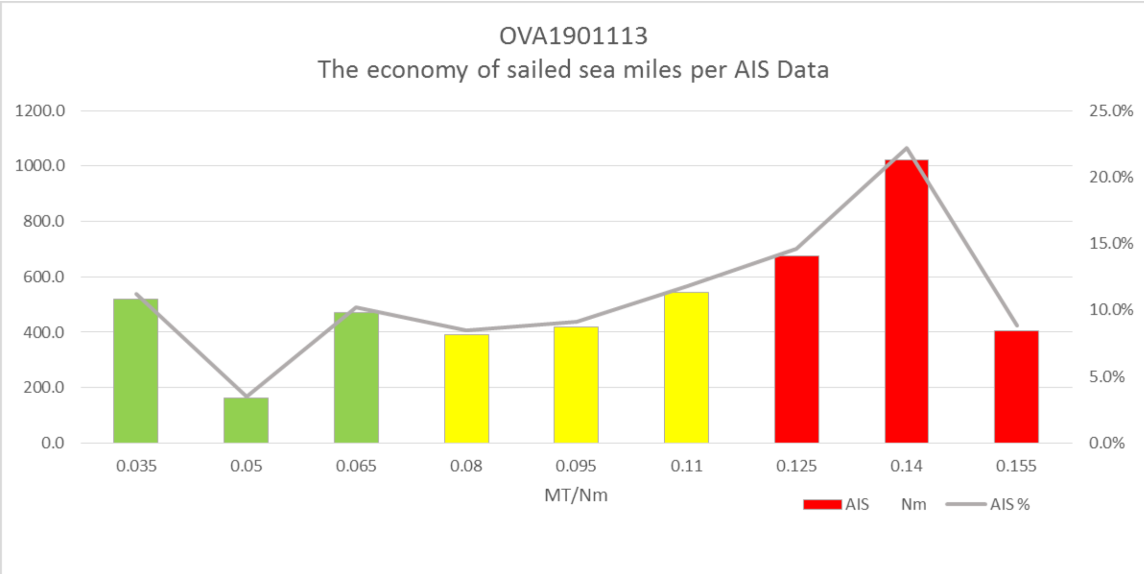

OVA191106
Itinerary profile
Voyage Plan vs AIS distances
500.0
400.0
300.0
200.0
100.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm

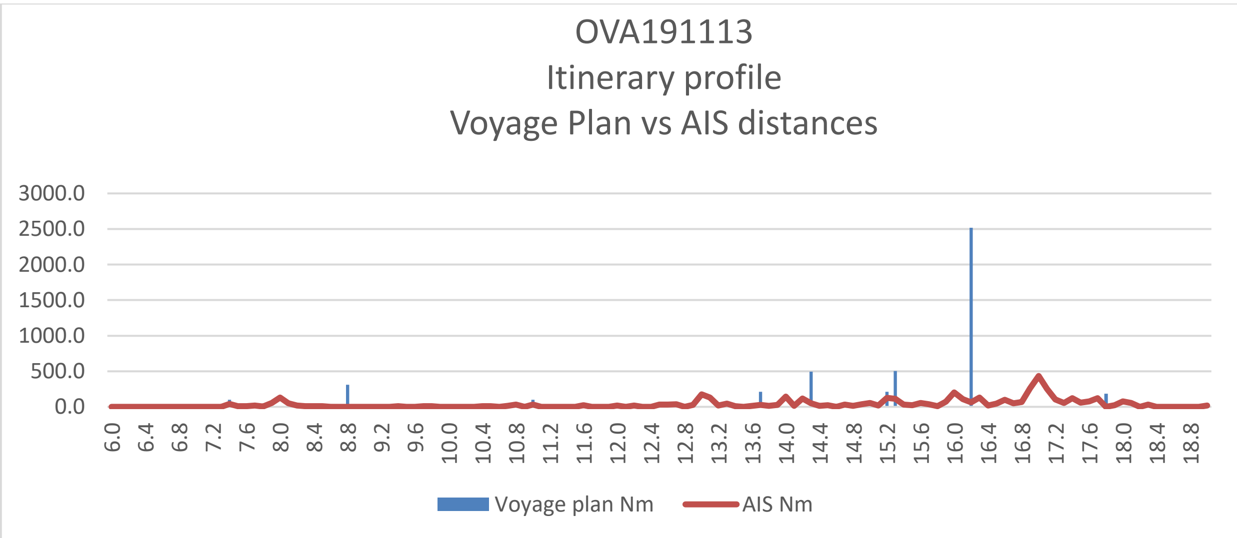




OVA191113												
MT/NM	Voyage plan Nm	AIS Average Nm	AIS Nm	Voyage plan %	AIS Av. %	AIS %	Voyage plan MT	AIS Av. of legs MT	AIS MT	Voyage plan %	AIS Av. %	AIS %
0.035	511.3	490.2	517.9	11.0%	10.6%	11.2%	13	13	13			
0.05	0.0	0.0	162.3	0.0%	0.0%	3.5%	0	0	7			
0.065	212.4	0.0	470.6	4.6%	0.0%	10.2%	13	0	25	15.6%	10.6%	25.0%
0.08	493.4	721.9	390.1	10.6%	15.7%	8.5%	35	53	27			
0.095	717.7	695.6	418.8	15.5%	15.1%	9.1%	64	55	36			
0.11	2519.1	2519.1	542.3	54.3%	54.7%	11.8%	273	273	56	80.4%	85.5%	29.3%
0.125	0.0	176.1	674.2	0.0%	3.8%	14.6%	0	21	80			
0.14	0.0	0.0	1023.5	0.0%	0.0%	22.2%	0	0	133			
0.155	186.6	0.0	405.9	4.0%	0.0%	8.8%	27	0	60	4.0%	3.8%	45.7%
Total	4640.4	4602.9	4605.6	100.0%	100.0%	100.0%	424.4	414.7	438.0	100.0%	100.0%	100.0%
Average	0.0915	0.0901	0.0951	MT/Nm			421.2	414.9	438.0	MT		


OVA191113
The economy of sailed sea miles per Voyage planning
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
Voyage plan Nm
Voyage plan %


OVA1901113
The economy of sailed sea miles per AIS Data
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
0.035
0.05
0.065
0.08
0.095
0.11
0.125
0.14
0.155
MT/Nm
AIS Nm
AIS %


OVA191113
Itinerary profile
Voyage Plan vs AIS distances
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
6.0
6.4
6.8
7.2
7.6
8.0
8.4
8.8
9.2
9.6
10.0
10.4
10.8
11.2
11.6
12.0
12.4
12.8
13.2
13.6
14.0
14.4
14.8
15.2
15.6
16.0
16.4
16.8
17.2
17.6
18.0
18.4
18.8
Voyage plan Nm
AIS Nm