Title:
Prevention of Air Pollution from Shipping - Implementation of Directive 2012/33/EU

IA No: DfT00301

Lead department or agency:
Department for Transport / Maritime and Coastguard Agency

Other departments or agencies:
Defra

Impact Assessment (IA)

Date: 03 September 2014

Stage: Final

Source of intervention: EU

Type of measure: Secondary legislation

Contact for enquiries:
Jonathan Simpson
Head Environmental Policy, MCA

Summary: Intervention and Options

RPC Opinion: Green

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present**	**Net cost to business per year** (EANCB on 2009	**In scope of One-In, Two-**	**Measure qualifies as**
-£2,946m	-£4,258m	£407m	No	**NA**

What is the problem under consideration? Why is government intervention necessary?

Air pollution seriously impacts on human health, the environment and the economy. Despite significant improvements, air pollution from shipping remains problematic (e.g. analysis published in 2005 indicated that sulphur emissions from shipping would exceed the sulphur emissions from all land-based sources at the EU level by 2020 without further regulation). As a result the EU has agreed new limits for the sulphur content of marine fuels. To ensure UK vessels and other vessels operating in UK waters adhere to the new requirements, UK legislation must be amended. Government intervention is necessary as air pollution from shipping is an externality that imposes costs that are not incurred by those that generate the emissions and sufficient voluntary action has not occurred to-date despite continued growth of emissions.

What are the policy objectives and the intended effects?

The objective is to reduce the sulphur emissions and emissions of particulate matter that result from the combustion of marine fuels. This shall be achieved by imposing limits on the sulphur content of such fuels or permitting alternative technology that delivers at least the same reduction in sulphur emissions. This will ensure that sulphur emissions from UK ships and other ships in UK waters will fall, which will also produce health and environmental benefits for those residing in the UK, especially within the locality of a maritime hub. Emissions of Particulate Matter (including Black Carbon) released into the atmosphere are also expected to fall resulting in a number of health benefits.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Five options and additionally a further option suggested by consultees were given initial consideration (see Annex 1), then reduced to two - full transposition and a 'Do Nothing' option. The preferred option is full transposition of the Directive without 'gold plating' with maximum use of the flexibility provided in the Directive to minimise costs on industry where possible. The text of the Directive does not allow for alternatives to regulation but the transposition will be as 'light-touch' as possible while retaining the benefits. While 'Do Nothing' was investigated, the growing emissions burden from the sector compared to other emitters renders this option difficult to defend.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 07/2018

Does implementation go beyond minimum EU requirements?			**No**		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	Micro Yes	< 20 **Yes**	Small Yes	Medium Yes	Large **Yes**
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded:** NQ	**Non-traded:** NQ	

I have read the Impact Assessment and I am satisfied that (a) it represents a fair and reasonable view of the expected costs, benefits and impact of the policy, and (b) that the benefits justify the costs.

Signed by the responsible Minister John Hayes **Date:** 22nd October 2014

Summary: Analysis & Evidence

Policy Option 1

Description: Transposition of EC Directive 2012/33

Full Implementation

Price Base Year 2013	PV Base Year 2014	Time Period Years 10	Net Benefit (Present Value (PV)) (£m)		
			Low: - £4,694	**High: - £1,383**	**Best Estimate: - £2,946**

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	0	NA	£374m	£3,082m
High	0		£694m	£5,711m
Best Estimate	0		£523m	£4,302m

Description and scale of key monetised costs by 'main affected groups'

1.) The direct costs are to the shipping industry. The costs to vessels operating in the UK Exclusive Economic Zone (EEZ) are estimated in this IA. The estimated costs consist of the costs to businesses from the cost of installing or retrofitting abatement systems and/or additional cost of fuel. 2.) There will be an increase in greenhouse gas emissions driven by switching to fuel with higher overall greenhouse gas emissions per tonne of fuel consumed or increased fuel consumption associated with the installation of scrubber technology (and hence increased fuel consumption overall) which has an associated rise in greenhouse gas emissions.

Other key non-monetised costs by 'main affected groups'

Indirect impacts to the UK refining industry as the balance of demand for low and high sulphur fuels shifts. Administrative and enforcement costs to the Maritime and Coastguard Agency.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	0	NA	£126m	£1,018m
High	0		£210m	£1,698m
Best Estimate	0		£168m	£1,356m

Description and scale of key monetised benefits by 'main affected groups'

The regulations are identified to generate benefits for human health and also to generate benefits from reduced building and material damage, from reductions in air pollutants resulting from the requirements for use of low sulphur fuel or use of emissions abatement technology. Health benefits are from reduction in life years lost and respiratory and cardiovascular hospital admissions due to reduced emissions of air pollutants.

Other key non-monetised benefits by 'main affected groups'

Benefits to the environment due to a reduction in atmospheric pollution. Improvement in the (non-health) quality of life from an improvement in air quality. There may benefits to the agricultural sector as soils and water courses recover from the impact of air pollution. There may be benefits to UK technology manufacturers developing and producing equipment that could be used to meet the requirements of the regulations.

Key assumptions/sensitivities/risks **Discount rate** 3.5%

The estimated costs and benefits presented in the IA are very sensitive to the data sources that have been used in this analysis and the assumptions that have been made (e.g. future fuel consumption, the average sulphur content of fuel currently used by ships, the price differential for lower sulphur fuel, the costs of emissions abatement technology etc). Therefore, these estimates should be interpreted as indicative estimates of the order of magnitude of these costs and benefits.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			In scope of	Measure
Cost: £407m	**Benefits:** 0	**Net: -** £407m	No	**NA**

1. Problem Under Consideration

Air Pollution

The main concern arising from the current sulphur content of marine fuels is air pollution and its associated impact on human health and the environment. Air pollution means the introduction by humans, directly or indirectly, of substances into the air resulting in harmful effects of such a nature as to endanger human health, harm living resources and ecosystems and material property[1]. Pollutants of particular concern include particulate matter (PM), oxides of sulphur (SO_X), oxides of nitrogen (NO_X), and ozone.

When sulphur is released into the atmosphere (usually through combustion) oxides are produced that result in acids being formed within the atmosphere. The sulphur dioxide (SO_2) that forms is an acidic gas that can then combine with water to form acid rain (wet deposition). When the particles remain dry (do not bond with water) dry deposition can occur as the particles remain in the atmosphere. The 'release' of the acid from the atmosphere can have a range of effects including acidification.

Additionally there is a growing body of evidence[2] linking sulphur dioxides with serious health problems, in particular in worsening pre-existing medical conditions and in causing long term, chronic, health issues associated with reduced lung function and cardiovascular system impairment.

Health Impacts

As well as being emitted directly, particulates can be formed in the atmosphere from reactions between other pollutants, of which SO_2, NOx, non-methane volatile organic compounds (NMVOCs) and ammonia (NH3) are the most important. Health effects of PM are caused after their inhalation and penetration into the lungs. The smaller the particles, the deeper they penetrate into the lungs. Emissions of NOx, SO_2, and NMVOCs can react together to form low level ozone which at higher levels can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases. Several European studies have reported that current ozone concentrations in Europe have health effects, especially in the summer, and that daily mortality rises with increases in ozone exposure.[3]

The health impacts of sulphur as a pollutant occur when tiny airborne particles are inhaled and then pass into the lungs. The small scale of the particles enables them to pass through the tissue of the lung and enter in to the blood stream from where they can be spread around the body. The main health impacts associated with the exposure to air pollutants from shipping can be split into acute (short term) and chronic (long term) health impacts. The short term effects on an individual can be seen as respiratory problems that are often alleviated once exposure is reduced. Long term exposure can lead to permanent reductions in lung function, such as asthma, chronic bronchitis, heart and circulatory diseases. Further complications can occur as many of the fine particles may be carcinogenic.[4]

Within the scientific community, it is now accepted that exposure to air pollution damages human health[5]. As SO_2 is the pre-cursor to particulate pollution in the form of fine sulphate particles, separating the health effects of sulphur and particulate matter (PM) is difficult. In 1998 the Committee of the Medical Effects of Air Pollution[6] (COMEAP) estimated that during 1998, 24,000 people died prematurely as a result of exposure to air pollution, with thousands more hospitalised.[7] In 2008, the burden of particulate air pollution in the UK was estimated to be equivalent to nearly

[1] 1979 CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION (LRTAP 1979)
[2] COMEAP 2006 – Cardiovascular Disease and Air Pollution
[3] WHO, 2008, Air quality and health, Fact sheet no 313 (http://www.who.int/mediacentre/factsheets/fs313/en/).
[4] House of Commons, Environmental Audit Committee, Air Quality, Fifth Report of Session 2009-2010, Vol 1.
[5] COMEAP (2010) 'The Mortality Effects of Long Term Exposure to Particulate Air Pollution in the United Kingdom' Available from http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317137012567
[6] http://www.comeap.org.uk/
[7] http://www.publications.parliament.uk/pa/cm200910/cmselect/cmenvaud/229/22905.htm

29,000 deaths and is expected to reduce the life expectancy of everyone in the UK by 6 months on average, at a cost of around £16 billion per year.[8]

Equality impacts

Air pollution unduly impacts those already experiencing ill-health with sulphur levels strongly associated[9] with increased occurence of symptoms and premature death among those affected by lung and cardiovascular conditions. Young children, the elderly and the disabled bear a significantly greater share of the impacts of air pollution[10]. This can be exacerbated by the impact of air pollution on property prices with those on a fixed income being exposed to a higher burden of air pollution.

Impacts on the Built Environment

Building degradation often occurs as the acids formed by sulphur within the atmosphere 'attack' the fabric of buildings, often resulting in buildings that have survived for many hundreds of years undergoing a sudden deterioration in condition. The impacts of acid deposition can be seen on a variety of materials other than stone, including paint, zinc, carbon-steel, nickel and some types of plastic. Most structures undergo some level of deterioration due to acid deposition.[11]

The impact of the deterioration suffered by buildings can vary, often depending on the cultural importance of the building. A building or structure that has a particular societal importance such as Westminster Abbey or Nelson's Column not only loses the features that make it of cultural importance but may also suffer from 'knock on' impacts such as a decline in income from tourism as the visual impact of the buildings is lost. Less tangible impacts may also occur as such buildings often have emotional and spiritual value to those that visit them.[12] Economic impacts can then arise as maintenance, repair and restoration costs are incurred in order to reverse existing or prevent future damage. It should be noted that these costs can be incurred by all building owners not just to owners of buildings of historic importance.[13]

Wider Social Impacts

Increased levels of air pollution can have a negative societal impact as areas that are heavily impacted by air pollution can become less desirable as a place to live. This combined with a perceived reduction in quality of life due to poor air quality can threaten social cohesion as communities develop feelings of disadvantage and dissatisfaction due to being unable to afford to live in areas where the quality of life is perceived to be better. This effect has the potential to impact the value of properties in an area, with recent work carried out by environmental economists highlighting the relationship between air quality and housing value[14]. Research into this area by Imperial College, London, suggests that poor air quality disproportionately impacts the poorer sectors of society[15]. The reports went on to suggest that areas of poor air quality resulted in areas becoming socially deprived.[16]

Environmental Impacts

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[8] https://www.gov.uk/government/policies/protecting-and-enhancing-our-urban-and-natural-environment-to-improve-public-health-and-wellbeing

[9] COMEAP 2001, Hedley 2002

[10] COMEAP 2001, Hedley 2002

[11] Watkis, P. Holland, M. Hurley, F. Pye, S. (2006), 'Damage Costs of Air Pollution', AEA Technology Environment, March 2006

[12] Navrud, S & Ready R.C. (eds), (2002), Valuing Cultural Heritage (Applying Environmental Valuation Techniques to Historic Buildings, Monuments and Artefacts). Cheltenham. Edward Elgar

[13] Watkiss, P. et al (2000), 'Impacts of Air Pollution on Building Materials', accessed 07/0/13 from http://arirabl.org/Publications_files/Buildings-PollAtmos.pdf

[14] notably Chay and Greenstone 2005, Journal of Political Economy

[15] http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/1024.pdf

[16] http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenvaud/1024/1024.pdf

Air pollution can affect an ecosystem in a variety of ways. The deposition of sulphur into the environment results in the acidification of both aquatic and terrestrial (soil) environments. Impacts can be direct, affecting the function of vegetation and indirect by influencing the ratios of nutrients in soils and waters which in turn impact on the ecology of the area.[17]

Experiments have shown that acid rain can have a negative impact on crop yields, due to damage to the protective layer of wax on the leaves of plants which results in a disruption to the gaseous exchange in the plant, effectively resulting in the suffocation of the plant. This has been shown to result in lower crop yields and is particularly evident in crops of beets, carrots and broccoli. This is an effect that has also been seen in other vegetation, such as woodland species.[18]

Acidification of freshwater can bring about the gradual changes in the flora and fauna of the impacted area resulting in changes in the local food chain. Acidification of soil through the process of acid deposition can result in chemical changes in the composition of soil. This may result in ecosystem impacts as organisms that have developed to thrive in a particular soil may not be able to survive if the chemical composition of the soil changes. This can often lead to wide ranging environmental impacts within a community as the soil and organisms within it is often the basis on which a food chain and community is based. The result of this type of acidification is a loss of biodiversity within the area impacted.[7]

Within the UK, studies[19] have shown that a number of sensitive environments, such as bogs, heathlands, grasslands, woods and aquatic environments continue to show an increase in the levels of acid deposition exceedence. Of the 78051km^2 monitored within the UK, a study published in 2009 indicated that 45928km^2 (58.8%) suffered from excessive acidification including 73.5% of bogs (4009km^2) and 39% of freshwater sites (652 out of 1752)[20]. The recently completed pHish (Powys Habitat Improvement Scheme) Project invested over £2million to improve the fishery of the River Wye that had suffered from excessive acidification, resulting from acid rain. The work undertaken included the liming of the water system to return the pH of the water to the natural level to enable the return of native flora and fauna. The project has successfully improved the water quality of the river systems resulting in the reintroduction of salmon fisheries to significant stretches of the watercourse.[21]

Although ecosystem effects often occur, individual organisms can be exposed to air pollutants through inhalation, ingestion or absorption. Once contaminated by a pollutant an individual's response can vary greatly and be dependant on a wide variety of factors (level of tolerance, time and duration of exposure, age, sex, health factors and species) that may play an important role in an individual's reaction. These impacts can be particularly harmful to fish, aquatic invertebrates and amphibians and impact on the wider food chain.[7]

2. Policy to Reduce Sulphur Content of Marine Fuels

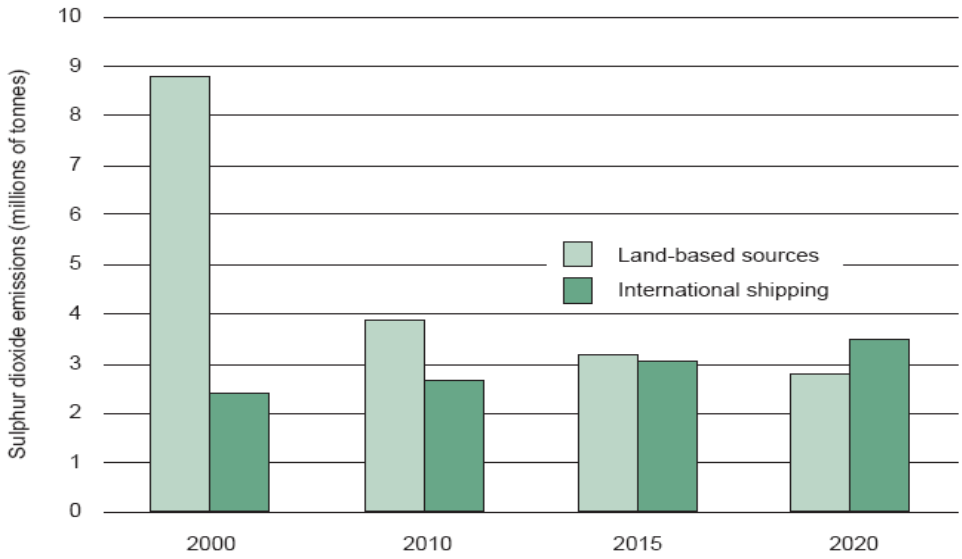
The impacts of air pollution, as outlined above, have been recognised globally and in response, steps have been taken to reduce the release of contaminants into the atmosphere.

In recent years, one of the ways in which the EU has tackled the problems of air pollution has been by limiting the sulphur content of fuels (Directive 1999/32/EC). This has resulted in a reduction of the levels of sulphur emitted by land-based sources and air transport. Further steps have included looking at other sulphur emitting industries. As the combustion characteristics of marine engines, along with the wide-spread use of unrefined fuel, results in significant amounts of SO_2, NO_X and particulate being released into the atmosphere, shipping has now become the focus of efforts to reduce air pollution.

[17] http://www.air-quality.org.uk/
[18] http://ucce.ucdavis.edu/files/repositoryfiles/ca4007p9-62962.pdf
[19] Hall, J. (2009), Updates to UIK Critical Loads and Exceedances September 2009', Centre for Ecology & Hydrology, Environment Centre Wales
[20] Hall, J. (2009), Updates to UIK Critical Loads and Exceedances September 2009', Centre for Ecology & Hydrology, Environment Centre Wales
[21] http://www.wyeuskfoundation.org/projects/phish.php

With more than 80,000 vessels estimated to call at European ports every year, shipping related to the EU is having a significant impact on the atmosphere, and, as an island nation surrounded by major shipping routes, on the air quality in the UK[22]. To date, emissions from maritime sources have not received the same level of scrutiny as land-based sources resulting in shipping continuing to emit sulphur at significantly elevated levels compared to other transport modes. In fact, the relative level of pollution associated with the shipping sector continues to increase (without further regulation, analysis published in 2005 indicated that sulphur emissions from shipping would exceed the sulphur emissions from all land-based sources at the EU level by 2020[23], as shown in Figure 1) and marine fuel remains significantly 'dirtier' on average than that used by other modes of transport.

Figure 1: Estimated EU sulphur dioxide emissions by source without further regulation



Limits on Sulphur in Transport Fuel

Sulphur emissions from the aviation and shipping sectors have historically been addressed to a more limited extent than emissions from land-based sources. The currently permissible levels of sulphur for other modes of transport are shown in Table 1 below.

Table 1: Maximum allowed sulphur content of transport fuels, parts per million

Mode of Transport	Maximum allowed sulphur content (parts per million)
Railway	10
Cars and Lorries – Petrol	10
Motor Vehicles - Diesel	10
Non-road mobile machinery (farm vehicles etc)	10
Aviation Fuel (safety limit)	3000
Inland Waterways	10

The limits for the sulphur content of fuel used by shipping are currently higher than the limits for other transport modes (see 'Background to IMO, MARPOL Annex VI and EU Directive' below). During the consultation that included consulting on the previous version of this Impact Assessment, ship owners raised concerns that the refinery sector views heavy fuel as a waste product and as a

[22] Transport Committee - Sixteenth Report, *Sulphur emissions by ships*, February 2012 http://europa.eu/rapid/press-release_MEMO-10-401_en.htm

[23] http://www.publications.parliament.uk/pa/cm201012/cmselect/cmtran/1561/156104.htm

result ships can encounter contaminants deliberately introduced into marine fuel at the refining and blending stage. Refinery industry consultees deny that this practice is widespread although there is some evidence (notably from DNV Petroleum Services) that in some cases chemical contaminants have been deliberately introduced into marine fuel.

Following work undertaken within the International Maritime Organisation (IMO) to reduce the levels of sulphur emitted through the operational practices of shipping, the EU published Directive 2012/33/EU which introduces sulphur content limits for marine fuels drawn from the agreed international standards. The limits included within the Directive have been developed in order to bring shipping further in line with other transport modes whilst still being achievable within a pre-determined timeframe.

Background to IMO, MARPOL Annex VI and EU Directive

The ownership and management chain of any ship can involve many countries, whilst the ships themselves spend their economic life moving between different jurisdictions. There is, therefore, a need for international standards to regulate shipping which can be adopted and accepted universally. The body responsible for this is the International Maritime Organisation (IMO). The IMO is a specialised agency of the United Nations with 167 Member States and three Associate Members. The work of the IMO is a comprehensive body of international conventions, supported by hundreds of recommendations governing every facet of shipping. The International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78[24], to which the United Kingdom is a signatory, provides an international regulatory regime governing the prevention of pollution from ships. It is a legal instrument composed of various documents which form a single whole. It sets out criteria which parties are required to adopt including obligations, application, violations, etc. The obligations agreed by the Parties to the Convention in the articles and regulations relate to different types of ship-generated pollution.

In response to the growing awareness of shipping's contribution to the problem of air pollution and as the IMO's senior technical body on marine pollution related matters, the Marine Environment Protection Committee (MEPC) oversaw the development of a new annex to MARPOL.

MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships was adopted in 1997 and entered into force in October 2005 to set limits on SOx and NOx emissions from ship exhausts. It included a global cap of 4.5% by mass on the sulphur content of fuel oil and also set provisions allowing for special Sulphur Emission Control Areas (SOx ECAs, 'SECAs' or 'ECAs' are abbreviations for this same area) where either the sulphur content of fuel oil used on board ships must not exceed 1.5% by mass, or ships must fit technologies to achieve equivalent SOx emissions. Limits on emissions of NOx from diesel engines were also set.

At the same time as this, the EU Sulphur Content of Marine Fuels Directive (Directive 2005/33/EC) entered in to force in July 2005. This Directive amended the Sulphur Content of Liquid Fuels Directive (Directive 1999/32/EC) to limit the sulphur content of marine fuels, linking it to MARPOL Annex VI, and to specifically limit the sulphur content of fuel burnt within the European SECAs.

The international community recognised that the requirements of MARPOL Annex VI needed to be strengthened in order to produce a meaningful reduction in air pollution. The renegotiation process lasted two years. Discussions were extensive during this period with significant support within the IMO, led by a lobbying group formed by Finland, Norway and Germany, for a 0.1% global limit on sulphur content of marine fuels. One industry representative (Intertanko) favoured a distillate-based solution with less stringent sulphur limits while the bulk of the shipping industry favoured less stringent revisions to the global and SECA limits and the permitting of alternative compliance systems. The UK supported the shipping industry in vigorously opposing a global 0.1% limit, and the distillate monofuel concept, as there was little economic or environmental evidence to support such a standard. The UK was also at the forefront of the group that championed the inclusion of an

[24] IMO (2011), International Convention for the Prevention of Pollution from Ships (MARPOL).Consolidated Edition 2011, International Maritime Organization, London, 2011

alternative technology clause, thus giving industry another option in meeting the requirements of the revised Annex VI. The major achievements for the UK and the shipping industry during these negotiations were the removal of the 0.1% global limit, the introduction of a phased introduction of the stricter sulphur limits in fuel and the availability of the option to use alternative technologies.

These negotiations resulted in a revised text for MARPOL Annex VI which, at the time, had the full support of the international shipping industry, who had worked beside the UK to achieve a proportional and meaningful outcome. Following these negotiations, the revised MARPOL Annex VI was adopted by the IMO in October 2008. The revised MARPOL Annex VI has not yet been implemented in UK law.

Following this outcome at the IMO, the European Commission, as a part of a strategy to reduce atmospheric emissions from seagoing ships, published in 2010 the proposal for a Directive that would mostly align European legislation with the MARPOL revision. In recognition of the work undertaken at the IMO, and in support of the sectors of the shipping industry that were early adopters of the requirements of the revised Annex VI, the UK lobbied hard within the EU to minimize any divergence of the proposed Directive from the revised MARPOL Annex VI and opposed those elements of the proposal that would have 'gold plated' the requirements of MARPOL. In particular, the UK lobbied extensively to ensure that the use of alternative technologies and the MARPOL fuel availability clause, which ensures that operators are protected if compliant fuel is unavailable, were included in the Directive. Both of these elements, which were developed at IMO to support the shipping industry in meeting the requirements of MARPOL Annex VI, are now, largely through the efforts of the UK negotiating strategy, included within the Directive.

However, one key difference is that the Directive requires that the sulphur content of fuel used by all ships operating outside of designated SECAs in Member States must not exceed 0.5% by mass from 1 January 2020. This differs from the revised Annex VI which will undertake a review by 2018 to assess the feasibility of the 0.5% global cap and could delay it until 2025 if there is strong evidence that 2020 cannot be achieved.

The proposed UK legislation will implement the minimum requirements of the Directive in the UK. The sulphur limits that the proposed UK legislation will enact are as follows.

- The sulphur content of fuel used by all ships operating in SECAs in the UK must not exceed 1% by mass up to 31 December 2014 and 0.1% by mass from 1 January 2015.

- Except for passenger ships operating on regular services to or from any European Union port, the sulphur content of fuel used by ships operating outside of designated SECAs in the UK must not exceed 3.5% by mass until 31 December 2019.

- The sulphur content of fuel used by all ships operating outside of designated SECAs in the UK must not exceed 0.5% by mass from 1 January 2020.

- The limit on the sulphur content of fuel used by ships at berth in UK ports will remain at 0.1% by mass; and the limit on the sulphur content of fuel used by passenger ships operating outside of designated SECAs in the UK on regular services to or from any European Union port will remain at 1.5% by mass until 31 December 2019.

- These limits can also be achieved using alternative fuels or the use of abatement systems such as exhaust gas cleaning systems (EGCS), often referred to as "scrubbers".

It should also be noted that MARPOL Annex VI includes a range of regulations aimed at reducing the NOx emissions from vessels. The European Commission is looking at how these emissions can be reduced across the Community. The Directive that is to be transposed does not contain any of the NOx requirements of MARPOL Annex VI and as such there will be no reference to the MARPOL NOx requirements within the proposed UK legislation.

3. Rationale for Government Intervention

There is evidence to show that air pollution has wide and varied negative impacts that affect the UK and its population. Scientific data and numerous studies demonstrate that shipping is now one of the major contributors of sulphur to the atmosphere. The global nature of shipping and air pollution requires a response such as MARPOL Annex VI. The EU has demonstrated, through the evidence provided by its own Impact Assessment[25], that a regional response is also appropriate to further improve air quality of its member states.

Emissions of air pollutants from the activities of the shipping industry impose impacts on the health of the population, the natural environment and the built environment, for which the shipping industry does not currently incur the costs. These negative impacts are externalities to the shipping industry. Environmental legislation widely applies the 'Polluter Pays' principle that those that cause damage should bear the responsibility for any corrective action required to offset negative impacts. This principle is also used for external costs. In the case of the emissions from shipping, which result in external costs to the wider community, there has been no attempt to strongly apply the polluter pays principle or any significant attempt by the polluting sector, in this case the shipping industry in aggregate, to minimise its impact or to compensate and offset the associated external cost. As shipping emits a significant proportion of the sulphur emissions in the EU, and self-regulation has not resulted in any aggregate reduction, it is considered that there is a need for government action to ensure that these externalities are addressed.

The UK fully supports the aims of MARPOL 73/78 to bring about a reduction in pollutants from shipping and as such is a signatory to the MARPOL Convention. As a signatory to the Convention the UK has treaty obligations to enact the appropriate Regulations. Similar treaty obligations also arise from the UK's membership of the EU. Failure to implement the requirements of the Directive would lead to infraction proceedings resulting in economic penalties for the UK. There is also a risk of reputational damage should the UK fail in international obligations.

DfT works closely with Defra and other partners to help deliver the Government's commitments on air quality. The Government is committed to creating a greener transport system by supporting the green economy and reducing the environmental impacts of travel and transport. Intervention by the Government in the regulation of air pollution from shipping will aid in the delivery of these commitments and in meeting other EU requirements.

The air quality policy adopted by the European Union has involved two complementary approaches; controlling emissions at source, and the setting of long-term ambient air quality objectives. All Member States of the European Union must comply with Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe and the 4th Air Quality Daughter Directive (2004/107/EC). The UK must also comply with the National Emissions Ceilings Directive (2001/81/EC), which sets national emission limits for four pollutants; sulphur dioxide, oxides of nitrogen, volatile organic compounds and ammonia.

This new Directive for sulphur content of marine fuels will help control emissions at source by reducing emissions from shipping. This will assist the UK with complying with the air quality Directives (2008/50/EC, 2004/107/EC, 2001/81/EC) and failure to meet these obligations may lead to infraction.

The transposition of the Directive will introduce into UK legislation a set of regulations that are, in the medium term, a very stable policy option. The phased introduction of the different fuel standards results in the final standard being implemented over five years. This represents a period of time during which the shipping industry can be assured of the regulatory framework with which it must comply. It also enables the owners and operators of vessels to plan a strategy in order to meet the requirements of the Directive, and reduces the risk that the policy may change or the goal posts may move. This offers an incentive for investment in the technologies that have been developed to meet the proposed emission standards.

[25] http://ec.europa.eu/environment/air/transport/pdf/ships/sec_2011_918_en.pdf

The shipping industry can be further assured of the consistency of the emissions standards by the presence of the SECAs that have already been established within the North and Baltic seas. As the SECAs have already been established there is no further scope for sulphur emissions to be tightened within these waters, once again enabling shipping operators and owners to be secure in the knowledge of what is required of them.

4. Policy Objectives

The objective is to reduce the emissions of sulphur and particulate matter into the atmosphere that result from the combustion of certain fuels that are used by the shipping industry. The aim is to achieve this by imposing limits on the sulphur content of such fuels or requiring the use of technology that delivers at least the same reduction in emissions.

The intended effect of this objective is to bring about an improvement in the air quality in the UK, which in turn will produce benefits for those residing in the UK, especially for those that reside near a maritime hub. An improvement in air quality is expected to lead to improvements in health, resulting in increased quality of life and reduced social costs; and benefits to the environment, including the built environment, through a reduction in deposition of air pollutants; and a range of economic benefits resulting from reduced costs to society due to the impacts of air pollution.

By implementing the proposed legislation the UK will be in full compliance with all its current international obligations with regards to MARPOL Annex VI and Directive 2012/33/EU, with the effect of the UK avoiding infraction proceedings.

5. Policy Options

Five policy options were originally considered within the implementation strategy. After consideration of the five options and their implications, two options have been brought forward to this impact assessment. Further details of the three options considered unsuitable to carry forward are included in Annex 1.

The two options that were further considered were:

1. Do nothing. Maintain the existing sulphur limits, but do not implement the new requirements.
2. Full Transposition. Transpose the Directive in full – using 'copy out' wherever possible and taking advantage of all the derogations that are available for Member States. Apply a proportionate and targeted compliance regime. Option 2 is the preferred option.

Options Identified via Consultation

Following external consultation a number of ferry operators and the UK Chamber of Shipping proposed a further option that would involve the Government issuing an exemption or waiver for a restricted period of up to five years that would allow vessels to continue to burn high sulphur fuel while operators followed a 'structured route to compliance'. As this proposal has attracted significant support from the ferry industry it is explored in more detail here.

The proposal would effectively allow up to five years of further operation on high sulphur fuel on the understanding that an operator had a robust programme in place to either upgrade a vessel with abatement systems or a plan in place to replace the vessel in question with a new ship equipped with such equipment by an agreed date. The proposal would provide a significantly extended period in which to comply with the regulations, likely reducing costs and associated disruption of upgrading or replacing vessels.

This proposal is not considered an acceptable policy outcome by Government for a number of reasons.

- The industry proposal would not achieve the full transposition of the Directive and MARPOL Annex VI leaving the UK exposed to EU infraction proceedings and in breach of its

international commitments. It is also unclear how an exemption would function legally as a vessel calling at another EU member states port would be in breach of the regime and subject to port State control.

- Secondly the proposal does not provide any technical argument for why vessels cannot operate on low sulphur fuel. It is the Government's understanding that such operation is technically possible and the issue here is economic. This could create significant problems in accepting any delay as it would require Government to disapply agreed standards to a small group of vessels in a manner that could create local and national market distortion.

- Thirdly any exemption granted by the UK would inevitably result in additional operators requesting special treatment under the regime and would likely result in significant legal difficulties. Failing to deliver the agreed reductions in air pollution would additionally create a potential for legal challenge from local authorities and port communities as well as our European neighbours who would be impacted by transboundary pollution.

- Finally the majority of EU member states have already implemented the requirements of the new directive into national law creating a situation where the UK would be asking our neighbours to reconsider their domestic legal regime as well as European negotiating positions. It is considered unlikely that such a step would succeed and reputational damage with other Member States Parliaments would likely follow.

For these reasons this option has not been considered further in this Impact Assessment.

Options Considered Further

The options that have been considered further in this Impact Assessment are the following.

Do Nothing

Although the Do Nothing option was given some consideration, this is considered to be an unrealistic option. The reasons for this are outlined below. Nevertheless, the Do Nothing scenario is examined in order to illustrate the expected impacts of the proposed regulations. The costs and benefits of the Full Transposition option have therefore been estimated against a baseline that the forthcoming international standards and EU directive do not exist.

To not implement the requirements of the Directive would undermine the Government's policy to deliver improvements to air quality. Failure to implement would also be inconsistent with the UK's international treaty obligations and the cross-government negotiating position supported by the House of Commons Environment Audit Committee to implement the revised MARPOL Annex VI. This would also put the UK at the risk of infraction and could have economic implications for the UK in the form of substantial fines. Generally the European Court of Justice consider the failure to transpose measures that protect human health to be among the more serious breaches of treaty obligations with resulting infraction fines being at the higher end of the scale. This is explored in more detail in this Impact Assessment.

Failure to implement the Directive would also put the UK's international reputation at risk. During negotiations for the Directive, the UK worked hard to ensure close alignment between the Directive and the revised MARPOL Annex VI and to ensure that the final Directive provided the shipping industry with timescales and alternative compliance opportunities to enable the aims of the Directive to be met whilst taking into consideration the concerns of the shipping industry. Failure to then 'follow through' and implement a Directive that the UK was instrumental in shaping, would harm the UK's reputation within the EU and would make it harder for the UK to find support from other Member States during any future negotiations.

Additionally the Directive implements MARPOL Annex VI, to which the UK is a party, and a failure to transpose the Directive would place the UK in breach of its wider treaty commitments. This would have wider implications for the UK's reputation at IMO and could be particularly problematic as the

IMO work to address CO_2 emissions draws heavily on the work undertaken under MARPOL Annex VI.

Under the Do Nothing scenario, the UK would not transpose the EU Directive and current limits on the sulphur content of marine fuel would remain in place in UK waters. In international waters, MARPOL Annex VI limits would apply in the territorial waters of countries that have implemented these limits, and it is considered that it is very likely that a large share of vessels operating in UK waters would comply with lower sulphur limits, either due to their flag state's regulations, due to the further declining availability of higher sulphur fuels or due to the inability to switch between fuels en route. A small share of vessels might continue to use high sulphur fuels, mostly UK flagged vessels operating exclusively in UK waters, and these vessels would not therefore incur the higher costs associated with using lower sulphur fuel or installing abatement technology. The operators of these vessels are the ones directly affected by the proposed regulations. It is also possible that some other vessels would switch to high-sulphur fuel or would switch off their scrubbers as they enter UK waters in order to reduce their operating costs. The extent to which this would take place and the impact it might have are extremely uncertain and cannot be estimated.

However, for the estimation of costs and benefits in this Impact Assessment, the baseline is that the forthcoming international standards and EU Directive do not exist. This is so that the full impact to UK businesses of the new requirements can be reported.

Option 1: Full Transposition of the Directive

Transposition of all the requirements of the Directive would avoid the negative implications of the Do Nothing option and avoid the potential for significant financial penalties due to non-compliance with European law.

The Directive establishes new lower limits for sulphur emissions, which apply differently to Sulphur Emission Control Areas (SECAs) and in other sea areas. SECAs are sea areas in which stricter controls were established to minimize airborne emissions of air pollutants from ships, as defined by Annex VI of the 1997 MARPOL Protocol which came into effect in May 2005. Annex VI contains provisions for two sets of emission and fuel quality requirements regarding SOx and PM, or NOx, a global requirement and more stringent controls in Sulphur Emission Control Areas (SECAs). In Europe, the SECAs are the North Sea and the Baltic Sea. SOx and particulate matter emission controls apply to all fuel oil used in both main and auxiliary engines together with items such as boilers and inert gas generators. The emissions controls are primarily achieved by limiting the maximum sulphur content of the fuel oils used on-board.

These fuel oil sulphur limits have been and are subject to a series of step changes over several years. The table below shows the sulphur limits that currently apply in SECAs, and the new lower limits, that will apply, following the implementation of the Directive, after 1 January 2015 in SECAs and after 1 January 2020 in other sea areas.

Table 2: Sulphur limits for fuel in SECAs and other sea areas within the UK Exclusive Economic Zone (EEZ).

Sulphur limits for fuel in SECAs	
Timescale	**Sulphur Limit**
Do Nothing	1.50%
Policy option – until 31 December 2014	1.00%
Policy option - from 1 January 2015	0.10%
General sulphur limits in other sea areas	
Timescale	**Sulphur Limit**
Do Nothing	4.50%
Policy option - until 31 December 2019	3.50%
Policy option - from 1 January 2020	0.50%

6. Overview of Approach to Estimating Costs and Benefits

Introduction

For the purposes of this Impact Assessment, the key costs and many of the benefits of the policy option have been monetised. However, given the limitations of the available evidence base, it has not been possible or proportionate to monetise some of the costs and benefits of the policy option. Costs and benefits have been identified and described qualitatively, and quantitatively where possible, and they have been monetised where robust monetary values can be estimated.

Furthermore, it should be noted that the estimates that are presented in the Impact Assessment are dependent on the data sources that have been used in this analysis and the assumptions that have been made. There are considerable uncertainties around some of these assumptions and therefore, these estimates should be interpreted as indicative estimates of the order of magnitude of these costs and benefits.

A 10 year appraisal period is used in this Impact Assessment. This is from 2015 as this is the first full year by which the regulations will be implemented in the UK.

Improvements to the Evidence Base following the consultation

Since the consultation stage impact assessment was completed, the Department for Transport and the MCA have commissioned new research from AMEC[26] to update and extend previous analysis completed by Entec in 2009[27], which provided information for estimation of costs and benefits in the consultation stage Impact Assessment.

The analysis reported in AMEC (2014) was carried out by AMEC Environment & Infrastructure UK (AMEC), Ricardo-AEA and the Centre for Ecology and Hydrology (CEH). It provides an updated assessment of the overall compliance costs associated with the implementation of the Directive, and provides updated modelling evidence and estimation of the benefits related to health impacts and environmental impacts.

In addition to updating forecasts and estimates, the AMEC (2014) analysis is based on a different study area that includes only the impacts of the changes to the sulphur limits that are in place within the UK Exclusive Economic Zone (EEZ)[28]. This is so that only costs and benefits directly generated from implementation of the regulations in the UK are estimated. This study area is smaller than the area used in the Entec (2009) study which formed the basis of the analysis for the consultation stage Impact Assessment.

For the purposes of this Impact Assessment, the assumption is made that the costs to ships operating in the UK EEZ represent costs to UK businesses. However, this may result in some overestimation of direct costs to UK ship operators, as some ships operating in the UK EEZ will not be operated by UK businesses. This approach has been taken because there is no data available that would enable this to be reliably taken into account.

The AMEC (2014) analysis considered the costs and benefits associated with three policy scenarios:

- Policy Scenario 1: In this scenario, the average sulphur content of marine fuel used in SECAs is assumed to be 1% (as per MARPOL requirements since 2010) (see below for more details). The fuel used outside SECAs is assumed to be residual oil (RO) with a

[26] AMEC. (2014), *Update to Existing Impact Assessment for the Revised Annex VI of MARPOL to Support Assessment of Impacts of Revised EU Directive on Sulphur Content of Marine Fuels*

[27] Entec (2009), *Impact Assessment for the Revised Annex VI of MARPOL*

[28] The Marine and Coastal Access Act 2009 designates an Exclusive Economic Zone in which the United Kingdom may exercise rights under the United Nations Convention on the law of the sea.

sulphur content of 2.7%, as this is understood to be the average sulphur content of this fuel internationally in practice[29]. This does not take account of the lower limit for passenger ships in the baseline on the grounds of proportionality as these ships account for a small share of total shipping activity in the EEZ. This policy scenario is the "do nothing" option which represents the baseline for the analysis of the option(s) for implementation of the Directive.

- Policy Scenario 2: this scenario estimates the impacts of the introduction of 0.1% sulphur limit in SECAs in the UK from 1 January 2015 compared to Policy Scenario 1.
- Policy Scenario 3: this scenario estimates the combined impact of the introduction of 0.1% sulphur limit in SECAs in the UK from 1 January 2015 and the 0.5% sulphur limit outside SECAs in the UK from 1 January 2020 compared to Policy Scenario 1.

It should be noted that the 1% sulphur limit in SECAs in the UK until 31 December 2014, and the 3.5% sulphur limit outside SECAs in the UK until 31 December 2019, are assumed to be met in Policy Scenario 1 which is the baseline for this analysis.

The assumptions regarding the sulphur content of fuels for each scenario are summarised in the table below.

Table 3: Sulphur content of fuels in UK EEZ in 2020 under each Policy Scenario Presented in AMEC (2014) Analysis

Policy Scenario	SECAs	Non-SECAs
Policy Scenario 1 - baseline	1%	2.7%
Policy Scenario 2 – impacts of 0.1% sulphur limit in SECAs only	0.1%	2.7%
Policy Scenario 3 – impacts of both 0.1% sulphur limit in SECAs and 0.5% sulphur limit outside SECAs	0.1%	0.5%

For SECAs this impact assessment assumesthe use of 1% sulphur fuel in the baseline against which the costs and benefits of the policy option are assessed. It should be noted that the UK has not completed implementation of the 1% limit in national law. However, consultation with the UK domestic fleet has indicated that 1% sulphur fuel in SECAs is the current norm. It is in line with MARPOL requirements since 2010 and is considered to represent the current state of the industry. The MCA considers that any internationally trading ship in UK waters will be compliant with the 1% limit due to Port State Control[30]. Ships operating exclusively inside the SECA may find it difficult to be supplied with 1.5% fuel because international legislation has affected the availability of this fuel.

In this Impact Assessment, the estimates of impacts from policy scenario 2 are applied to capture the impacts of introducing the 0.1% sulphur limit in SECAs on 1 January 2015 for the estimation of costs and benefits in the period 2015 to 2019. The estimates of impacts from policy scenario 3 are applied to capture the impacts of implementing the 0.5% limit in Non-SECAs on 1 January 2020 (and retaining the 0.1% limit in SECAs) for the estimation of the costs and benefits in the period from 2020 to 2024. This is because these respective policy scenarios represent what the sulphur content limits would be in each of these years.

Specifically, the AMEC (2014) study provided analysis as set out below for estimation of costs and benefits. The costs and benefits are estimated relative to the baseline set out above.

Costs

[29] See, for example, AEA (2009), *Cost Benefit Analysis to support the impact assessment accompanying the revision of Directive 1999/32/EC on the sulphur content of certain liquid fuels*, http://ec.europa.eu/environment/air/transport/pdf/CBA_of_S.pdf.

[30] Further information on Port State Control requirements are provided at http://www.imo.org/OurWork/Safety/Implementation/Pages/PortStateControl.aspx

- Estimation of costs to ship operators of fuel switching to lower sulphur fuels, based on fuel consumption estimates provided by Ricardo-AEA and fuel price estimates updated from the Entec (2009) study.

- Estimation of costs to ship operators of installing or retrofitting technology to reduce sulphur emissions. These costs include capital costs, non-fuel operational costs, and changes to fuel costs as a result of the additional fuel consumption of the scrubbers and the use of higher sulphur fuel than in the baseline. The estimation of these costs is based on vessel numbers updated from the Entec (2009) study, and unit cost estimates uprated to a 2013 price base year.

- Different scenarios for the costs were modelled under varying assumptions about the proportion of vessels choosing to switch from higher sulphur to lower sulphur fuels versus the proportion choosing to install scrubber technology.

Benefits

The estimation of benefits has included analysis of the wide range of effects that emissions of air pollutants from shipping can have in the environment. Poor air quality, caused by the concentration of air pollutants in the atmosphere, can affect human health, while deposition of air pollutants back to earth can, for example, affect ecosystems, biodiversity and water quality. This analysis consisted of technical modelling which involved the following.

- Estimation of emissions and fuel consumption from shipping, and how this would change compared with the baseline, has been undertaken based on the methodology used for the UK's National Atmospheric Emissions Inventory (NAEI)[31], applied to the new study area that is considered in this Impact Assessment (UK EEZ).

- Concentration and deposition of pollutants under future shipping scenarios has been simulated, and the human exposure impacts and ecosystem impacts assessed, using an atmospheric chemical transport model (the FRAME model[32]).

- Particulate and SOx concentration and changes in human exposure to these air pollutants has been assessed using another atmospheric chemical transport model (the EMEP4UK[33] model).

- Modelling of human health impacts is based on population exposure assessment produced by the Centre of Ecology and Hydrology combined with the data and the cross-government methodology for estimating health impacts of air pollution, set out in Defra guidance on valuing changes in air quality (2013)[34];

- Greenhouse gas emissions impacts have been estimated based on the fuel consumption estimates produced for this study by Ricardo-AEA;

- Ecosystem impacts have been assessed by the Centre for Ecology and Hydrology. These have been quantified in the AMEC (2014) report but not monetised. Quantification involves modelling exceedance of acidity critical loads for UK habitats sensitive to acidification under different scenarios.

The AMEC (2014) analysis included CO_2 emissions impacts in the benefits section, based on the fuel consumption estimates produced for the study by Ricardo AEA. This analysis has been updated

[31] Further information on this is provided at http://naei.defra.gov.uk/

[32] Further information on this model is provided at http://pollutantdeposition.defra.gov.uk/frame

[33] Further information on this model is provided at http://www.ceh.ac.uk/sci_programmes/emep4uk.html

[34] Defra (2013) Impact pathway guidance for valuing changes in air quality, May 2013.

for this Impact Assessment to take account of all greenhouse gas emissions associated with the modelled fuel consumption and these impacts are now included in the costs section.

The following costs and benefits sections summarise the relevant analysis from the AMEC (2014) study, and the Entec (2009) study, and summarises how the analysis provided in these studies, and the information from the public consultation, has been applied to assess the costs and benefits in this Impact Assessment.

7. Costs

The direct costs associated with the implementation of the regulations are the following.

- Costs to ship operators. Costs to ship operators of complying with the new sulphur limits have been estimated on the basis that ship operators meet the requirements of the regulations either by switching to lower sulphur fuels or by installing or retrofitting technology (exhaust gas scrubbers) which will reduce sulphur emissions. Familiarisation costs are not expected to be significant as the planned series of step changes to sulphur limits (as identified in table 2 above) has already been publicised in the shipping industry for several years. The overall costs of compliance will depend on the price differential of the lower sulphur fuels, total fuel consumption, the costs of installing scrubbers and the numbers of ship operators choosing to switch fuels and / or install scrubber technology. The key costs to ship operators have been monetised (see costs associated with fuel switching for an explanation of the costs that are not monetised).

- Administration and enforcement costs for the MCA. These costs are expected to be minimal relative to the administration and enforcement costs of the current regulations included in the baseline "do nothing " option and have not been monetised. These costs are discussed in the Administration and Enforcement section of this Impact Assessment.

- Costs from increased greenhouse gas emissions where ships use exhaust gas scrubbers or switch to lower sulphur fuels. These costs have been monetised.

Estimation of compliance costs

The approach for estimating compliance costs for the shipping industry applies analysis provided in the Entec (2009) and AMEC (2014) reports, and evidence provided through the public consultation, and is as follows.

1. Identification of the key abatement measures that could be implemented in order to comply with the emission requirements, namely fitting scrubbers or switching from high to low-sulphur fuels.
2. Estimation of the unit cost of the selected abatement measures (cost per vessel for installing or retrofitting scrubbers, or cost per tonne of fuel switched), and forecasts of fuel use and vessel numbers.
3. Development of fuel price premium scenarios to account for the cost of switching to low-sulphur fuels.
4. Estimation of the number of vessels operating in the UK EEZ in a given year.
5. Development of scenarios that reflect a different abatement measure uptake to consider different combinations of numbers of vessels switching fuels and installing scrubbers[35].

Costs associated with fuel switching

A key aspect of estimating the cost of this new regulation is the assumed price differential between high sulphur fuels and low sulphur fuels, or the 'fuel premium'. Assumptions on future fuel consumption also significantly affect the results. The fuel premium scenarios and assumptions on future fuel consumption are discussed in more detail below.

[35] See section 3.6 from Entec (2009) for further details

Although by far the biggest cost for switching to lower sulphur fuels is the fuel premium, other additional costs may be incurred if additional tanks and piping are necessary and if modifications / adjustments on fuel pumps, fuel injection systems, lubrication systems and fuel tanks are required[36]. Although these potential additional costs are acknowledged, they have not been monetised and included in the total monetised cost estimates, firstly because the percentage of the total fleet that may require such modifications is unknown as there is no data collected on this, and secondly because the cost associated with dual systems may already be incurred under the 'Do Nothing' scenario, with different sulphur content requirements for SECAs, for ships at berth in EU ports and for ships outside UK waters.

Consultation did not reveal any additional detail on the technical aspects of fuel switching with views ranging from 'no additional cost' to 'possible significant cost' with no detailed cost information provided. Input from shipping companies who have carried out design studies did not highlight significant cost issues associated with fuel switching with the expectation that the modifications would be undertaken as part of normal operational maintenance.

Fuel Premium

Forecasts of the price premium of lower sulphur fuels are extremely uncertain. The uncertainty goes beyond the difficulty inherent in price forecasting in general as it depends critically on the behaviours and investment decisions of both shipping operators and refineries[37]. There are three fuel premium scenarios presented in AMEC (2014) which have been revised and updated since Entec (2009).

The AMEC (2014) analysis produced updated forecasts of fuel price premiums (for Rotterdam rates) based on a review of recent evidence and literature. These forecasts are shown in the table below, and show the forecast price premium between fuels with different sulphur content (denoted by %S). Low, central and high forecast scenarios were produced to reflect the range of evidence identified. These fuel premium forecasts are similar to those that were presented in the consultation stage Impact Assessment, which were based on the Entec (2009) report.

Table 4: Fuel price premia forecasts by Sulphur content for 2015-2024 (£ per tonne) (2013 prices)

Fuel price scenario	**2.7%S to 0.5%S**	**1%S to 0.1%S**
low	151.3	147.7
central	200.2	199.9
high	208.8	213.0

Global fuel costs have shown significant volatility over the previous decade. Factors influencing fuel prices can include issues of supply (such as disruption caused by major refinery closures or accidents) or major geopolitical events. There is also significant uncertainly in forecasting the price premium as uptake of alternative technology, new emissions rules in non-EU states and development of new fuel sources (shale gas for example) could have an effect. However, in the absence of evidence to reasonably forecast long term changes in fuel price differentials, this impact assessment assumes that the fuel price premia shown in the table above remain the same in real terms over the appraisal period.

Public consultation did not identify any significant concerns with the fuel premium scenarios identified in the consultation stage Impact Assessment. One consultee suggested that the Rotterdam rates were inappropriate and the Singapore Bunker Market rates would be more suitable

[36] Further information on these additional costs are detailed in Appendix I to the Entec (2009) report
[37] AMEC (2013) *Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI*

particularly for long-haul voyages. While the Government acknowledges that this IA cannot fully model the international fuel market, the Rotterdam rates have been retained as they have been used in other EU studies and the values have been accepted as representative by the majority of consultees.

Fuel consumption

New estimates of fuel consumption have been produced for this impact assessment by Ricardo-AEA (as part of the AMEC (2014) study), based on the methodology used for the UK's National Atmospheric Emissions Inventory (NAEI), applied to the new study area (UK EEZ).

For the purposes of this Impact Assessment, it has been assumed that fuel consumption will increase by 1% annually up to 2020 which is consistent with NAEI analysis[38]. This assumption is made on the grounds of proportionality because there are no formal forecasts of the growth in fuel consumption within the UK EEZ. Given the limitations of the available evidence, it has then been assumed that there will be zero growth in fuel consumption within the UK EEZ between 2020 and 2024 for the purposes of this IA. This assumption is also made on the grounds of proportionality. Such a scenario would arise if the efficiency improvements, including those mandated by the IMO, exactly offset the expected growth in demand for shipping, although it is acknowledged that this exact offsetting is unlikely to arise in practice.

It should be noted that there are significant uncertainties around fuel consumption within the UK EEZ in future years. For example, it has not been possible to account for energy efficiency improvements for new vessels that are introduced over the appraisal period, and therefore the fuel consumption and the resulting cost estimates could be lower than estimated here; this is discussed in more detail below. Conversely, there could potentially be a higher increase in fuel consumption than assumed, due, for example, to increased demand for shipping associated with higher economic growth.

For illustrative purposes, the forecasts of fuel consumption for one ot the appraisal years (2020) are shown in the table below.

Table 5: Overall baseline fuel consumption in UK EEZ in 2020 (tonnes)

Fuel	SECA	Non-SECA	Total
Fuel oil (High Sulphur)[39]	2,610,582	564,663	3,175,245
Gas oil (Low Sulphur, 0.1% S)	525,436	175,749	701,185

Energy efficiency improvements for new vessels

The IMO community has agreed that international shipping will be subject to mandatory requirements to improve efficiency over the next twenty years. This measure (the Energy Efficiency Design Index - EEDI) will require existing ships to account for their energy usage and require new ships to be increasingly more efficient. These changes will occur over an extended period as the fleet is slowly replaced with more efficient ships and the measures do not apply to all vessels but it is expected that individual ships will be 20%-35% more efficient than an existing design by 2025. This may result in significant reduction in fuel consumption across the marine industry (and potentially lower the market price of fuel) but will be partly offset by the growth of the industry in absolute terms.

[38] The 1% p.a. growth rate in activities is currently used in the NAEI's emission projections for Defra's air quality assessments

[39] 'fuel oil' refers to residual oil-based fuels with the maximum sulphur content allowed/used in 2013, i.e. 2.7%S residual oil (RO) in non-SECAs and 1%S low sulphur residual oil (LSRO) in SECAs.

Industry consultees noted that the IMO energy efficiency work, and possible instruments to reduce carbon dioxide emissions being considered by the EU and UN family could result in reductions in fuel consumption across the fleet. Modelling the impact of potential measures is not possible at this time as they are still in their infancy.

Costs associated with fitting scrubbers

As identified in the evidence reviewed by AMEC[40] in a report for the UK Chamber of Shipping, installation of exhaust gas scrubbing technology on ships offers a feasible option for some operators to comply with the SO_X limit for some of their fleet. Exhaust gas scrubbers can remove 90-95% of SO_2. The report by AMEC for the UK Chamber of Shipping noted that exhaust gas scrubbers are still an emerging technology for shipping. This evidence has therefore been compared with consultation evidence from operators who have installed test bed prototype and full scale scrubber systems and those in negotiations with potential suppliers of the technology. In those instances where scrubbers have been installed, consultation evidence suggests that important design and operational lessons are still being learnt.

The method used to determine the cost of scrubbers in the previous study and consultation stage impact assessment is set out in Appendix I to the Entec (2009) report. These values have then been compared with the consultation evidence from ship operators who have fitted scrubbers. The consultation stage impact assessment presented a sensitivity where scrubber costs fell by 50% over the appraisal period. No evidence to support this assumption was presented during the consultation, and this impact assessment assumes costs remain constant in real terms over the appraisal period. This is a conservative approach which may lead to an overestimate of the costs.

The key costs associated with scrubbers are:

- Capital costs including installation costs
- Maintenance and operating costs, including the costs of additional fuel required to operate a scrubber and the costs associated with disposal of the sludge produced[41]

These costs have been monetised in this impact assessment. Fitting a scrubber would also allow lower cost higher sulphur content fuel to be used in SECAs compared to the baseline, although as noted above, fuel consumption would be higher. The estimates in this Impact Assessment include the full capital costs of fitting scrubbers to vessels that operate in the UK EEZ, but only capture the costs to these vessels of the additional fuel required to operate a scrubber within the UK EEZ and the benefits to these vessels from the use of scrubbers within the UK EEZ. It is noted that these vessels could benefit from the use of scrubbers to comply with sulphur limits outside of the UK EEZ; this is not reflected in the estimates presented in this Impact Assessment.

Entec (2009) applied capital costs per unit of an engine's installed power to the estimated engine size of each vessel type/size to obtain capital and operating costs of installing scrubbers for each vessel category and size. Auxiliary engines of bulk carriers, general cargo, tankers and "other vessels" are assumed to run marine gas oil (i.e. low sulphur fuel) in the 'Do Nothing' scenario. For these vessel categories, scrubbers would only be necessary for main engines. Running costs could be significantly lower if using a scrubber with heavy fuel oil rather than a distillate fuel. For all other vessel types, costs of scrubbers include both main and auxiliary engines.

The scrubber unit costs used in this impact assessment are expressed as capital and non-fuel operational costs on a £/kW basis for both main engines and auxiliary engines and for both new and existing vessels (i.e. for which scrubber retrofit would apply). The auxiliary engines of bulk carriers, general cargo, tankers and 'other vessels' are assumed to run on marine gas oil (MGO) in the baseline, so scrubber installation or retrofit costs do not apply to auxiliary engines in these cases.

[40] AMEC (2013) *Impact on Jobs and the Economy of Meeting the Requirements of MARPOL Annex VI*
[41] See section 5.1.3 of Entec (2009) for further details

The unit scrubber costs (on a £/kW basis) applied in this Impact Assessment are from the AMEC (2013) study and are based on data and evidence reviewed and uprated to 2013 prices. The estimates used for calculation of capital costs for new vessels and for retrofit are presented in the table below.

Table 6: Scrubber unit costs (2013 prices, £/kW)

Engine	New	Retrofit
Main engine	126.93	152.37
Main and auxiliary engine	205.11	209.37

Issues raised in the consultation

The issue of falling technology costs was explored further in the consultation process with shipping industry consultees indicating that even if production costs decreased manufacturers would seek to increase profit margins rather than pass on savings. By comparison, equipment manufacturers suggested that current price estimates were already too high and prices would fall further with time.

In general there were mixed views from consultees on the cost estimates for scrubbers in the consultation stage IA. Some ship operators felt that prices were too low and should be significantly increased while some manufacturers of scrubber systems reported significantly lower costs (CAPEX and OPEX).

There was some information from the consultation responses indicating that scrubbers pose significantly larger engineering challenges for complex, multi-engined craft such as existing ro-ro ferries with attendant increases in cost while for single engine newbuilds they are relatively straightforward.

It is noted from the consultation responses that some misgivings exist in relation to the efficacy of scrubbing systems within the shipping industry but the concept is well proven in non-marine applications (power generation) and a growing number of ship owners are announcing significant investments in the equipment. Both a major ferry operator and a cruise vessel operator announced scrubber retrofit programmes in 2013, and 2014 has seen a marked increase in system orders.

Some consultees noted that fitting scrubbers to vessels will increase the difficulty of monitoring vessels' compliance with the regulations, as vessel owners could choose to install scrubbers, but not to operate them. This would be in the operators' interest as they would be able to reduce their fuel consumption, as the scrubbers would not require any energy. The regulator would not be able to check whether the scrubbers were in operation on a voyage by comparing the fuel consumption and route data, as the uncertainty would be greater than the additional fuel required to operate the scrubbers.

One possible method for monitoring compliance would be for the regulator to require operators to record the disposal of sludge from scrubbers and compare this with the route and fuel type data. However, this is not a robust method of checking compliance and could involve additional administrative costs. It should be noted however that representatives of the scrubber industry dispute the above scenario noting that it is not as simple as 'turning off a switch' and that it should be clear if a scrubber is not being used in line with the manufacturer's type approval.

During the consultation process a number of consultees noted that the estimates in the consultation stage Impact Assessment indicated that the use of scrubbers, compared with the alternative of using lower sulphur fuel, would increase costs to industry rather than decrease them. In particular some consultees noted that the cost estimates presented in the IA suggested that there would be no 'payback' for fitting a scrubber system and this would appear to contradict the expectations and experiences of some owners who are fitting such systems. It should be highlighted that this is a different question to the one that the analysis in the IA addresses.

This Impact Assessment estimates the costs of complying with the new sulphur limits against a 'do nothing' baseline in which the regulation is not transposed. The baseline assumes that 1% sulphur content fuel is used in SECAs, while in non-SECAs the sulphur content of fuel is currently 2.7% while the analysis of the policy option considers the impacts of complying with a 0.1% sulphur content limit in SECAs and a 0.5% sulphur content limit in non-SECAs from 2020.

For the cost estimates in this Impact Assessment, when estimating the costs of fitting scrubber technology to comply with the regulations, the capital costs of the technology are annualised over the expected lifetime of the investment (25 years) and added to estimated annual operating costs. It is assumed that vessels take advantage of the opportunity provided by the scrubber technology to switch to higher sulphur content fuel i.e. from 1% to 2.7% in SECAs. The reduced cost of the higher sulphur fuel partially offsets the cost of the technology itself. However, there is still estimated to be an overall cost to ship owners and operators of installing the technology to comply with the new regulations, although as explained above. It should also be noted that the use of scrubbers to comply with sulphur limits outside of the UK EEZ are not taken into account in these estimates.

When the regulations are brought in a ship owner deciding how to comply with the regulation faces a different calculation. Specifically they may calculate the benefit of installing scrubber technology against the alternative compliance option of switching to lower (0.1%) sulphur fuel. At that point the relative costs of the options are perceived differently, with an increased fuel saving associated with switching from 0.1% sulphur fuel to 2.7% sulphur fuel. This provides a larger offset to the upfront capital cost of the scrubber unit, when calculating the total capital plus operating costs of scrubbers. Some manufacturers and users indicate payback times of between 5-10 years for a scrubber depending on the vessel operating profile and particularly the potential fuel cost savings that could be obtained from use of scrubbers.

As a newbuild ship can be expected to operate for 25 years such a system may provide significantly lower costs to an owner in the long term for some ship types. There may also be other elements of the business decision that are not fully captured in the IA uptake scenarios. For example, ship owners may prefer to install scrubber technology to reduce the uncertainty about costs that are associated with the uncertainty in forecasting future differentials in fuel prices.

Vessel Numbers

The number and type of vessels that would need to comply with the regulations were estimated in the AMEC (2014) study by starting with the vessel numbers (and types) projected for 2020 in the previous study (Entec, 2009). Since the study area differs between those two studies, and since the different regulations affect vessels in SECAs differently from those not in SECAs, some assumptions were required to estimate vessel numbers. First, the proportion of previous study area vessels operating in the UK EEZ is assumed to be equal to the proportion of fuel consumed in the UK EEZ (excluding fuel consumed while at berth), both relative to the whole of the previous study area. This means that the number of vessels operating in the UK EEZ in 2020 is estimated to be 40% of that projected for the whole area of the previous study. Second, a simplifying assumption is made that vessels are assumed to operate either in SECAs or not in SECAs. The proportion of vessels operating in SECAs is assumed to be equal to the proportion of fuel consumed in SECAs, both relative to the whole UK EEZ. This means that 81% of vessels are assumed to operate exclusively in SECAs, with the rest operating exclusively in non-SECAs. The estimated number of vessels is presented in the table below.

Table 7: Baseline vessels numbers for UK EEZ in 2020

Fuel	SECA	Non-SECA	Total
Vessel numbers	4,758	1,149	5,907

It should be noted that the vessel numbers are only relevant for cost calculations for scrubbers, since fuel switching costs are based on actual fuel consumption projections within SECAs and non-SECAs.

Compliance Scenarios

The AMEC (2014) study presents three scenarios to estimate compliance costs, varying by the approach to compliance. These scenarios are the same as those presented in the consultation stage impact assessment. Scenario B is taken as the central case in which 90% of vessels switch to lower sulphur fuels and 10% of vessels install scrubbers by 2020[42]. It has not been possible to identify precisely what percentage of vessels will comply with the regulations by either fuel switching or installing scrubbers, so this is presented as a range of possible scenarios.

- Uptake scenario A: 100% of vessels switch fuel to one meeting regulatory requirements;
- Uptake scenario B: 90% of vessels switch fuel, and 10% install scrubbers; and
- Uptake scenario C: 100% of vessels install scrubbers

The cost estimates obtained from the analysis in AMEC (2014) have been calculated for each of these three scenarios using the data discussed in the previous section. The approach taken to assess specific costs is presented in the table below.

Table 8: Approach to assessing cost elements

Cost element	Approach
Scrubber costs	
Scrubbers installation costs for newly built vessels (capex + non-fuel opex)	Uptake x number of new vessels in area x total annual cost for scrubber installation per new vessel
Scrubber installation costs costs for existing vessels (capex + non-fuel opex)	Uptake x number of existing vessels in area x total annual cost for scrubber retrofit per existing vessel
Increase in fuel consumption linked to scrubbers	Uptake x increase in fuel consumption compared to baseline x 2.7% sulphur fuel(1) cost
Decrease in fuel cost linked to switch to higher sulphur fuel 1% sulphur content fuel to 2.7% sulphur content fuel in SECAs	In SECAs only: uptake x baseline fuel oil use in area x price premium from 1% to 2.7% sulphur fuel cost
Fuel switch costs	
In SECAs: Fuel switch from 1% sulphur content fuel to 0.1% sulphur content fuel	uptake x baseline fuel oil use in area x efficiency gain x (new fuel price - old fuel price)
In non-SECAs: fuel switch from 2.7% sulphur content fuel to 0.5% sulphur content fuel	uptake x baseline fuel oil use in area x efficiency gain x (new fuel price - old fuel price)

These cost elements were then combined by AMEC to produce estimates of the overall costs of compliance for the shipping industry in 2020 for both Policy Scenario 2 and Policy Scenario 3 compared to Policy Scenario 1 as defined in Table 3 above. To produce estimates of the overall costs of compliance for the shipping industry in other years, the estimates for Policy Scenario 2 in 2020 were used as the starting point for the period 2015 to 2019, and the estimates for Policy Scenario 3 in 2020 were used as the starting point for the period 2020 to 2024. These estimates were adjusted to take account of the number of existing vessels that were assumed to be retired each year and the number of new vessels that were assumed to be introduced each year. On the grounds of proportionality, it was assumed that the number of existing vessels retired each year, the

[42] The 90:10 split assumed by Entec was based on an IMO publication: IMO (2007), *Revision of MARPOL ANNEX VI and the NOx Technical code, Input from the four subgroups and individual experts to the final report of the Informal Cross Government/Industry Scientific Group of Experts Note by the Secretariat, Sub-committee on bulk liquids and gases, 12th session, Agenda item 6, 28 December 2007* http://www.endseurope.com/docs/80213b.pdf

number of new vessels introduced each year, and the average costs per vessel for both existing and new vessels under each policy scenario would remain constant over time in real terms and would be equal the values estimated by AMEC for 2020 (see AMEC (2014) for more details).

The cost ranges estimated for the three different compliance scenarios are presented in the table below for the central fuel price scenario.

Table 9: 2015-2024 annual compliance costs (£ million, 2013 prices, undiscounted, central fuel price scenario)

Year	Uptake A	Uptake B	Uptake C*
2015	440	454	575
2016	443	456	576
2017	445	458	576
2018	448	460	577
2019	450	463	578
2020	551	571	743
2021	554	573	744
2022	557	576	745
2023	560	579	745
2024	563	582	746

The following table presents the estimated present value of the total costs over the appraisal period for each of the uptake and fuel price scenarios.

Table 10: Present Value of the total Costs (Central fuel price scenario)

Uptake Scenario	Present Value of the total Costs (£ million) by Fuel Price Scenario (2013 Price Base Year, 2014 Present Value Base Year)		
	Low Fuel Price Scenario	Central Fuel Price Scenario	High Fuel Price Scenario
Uptake A	3,062	4,127	4,319
Uptake B	3,314	4,258	4,430
Uptake C	5,583	5,433	5,423

Key assumptions and uncertainties for these cost estimates are identified in the table below.

Table 11: Summary of key assumptions and uncertainties for costs estimates

	Key assumptions and uncertainties
Costs to the shipping industry	• Average sulphur content of fuel used by ships • Future values of fuel price premium • Future costs of scrubbers • Possible technical and practical issues associated with scrubber use • Future fuel consumption • Future vessel numbers • Average engine size of vessels • Split between fuel switching and scrubber installation

Other Evidence of Overall Compliance Costs to the Shipping Industry

As previously described, the overall compliance costs will depend on how ship operators choose to meet the requirements of the legislation. By 2020 it is likely that a combination of fuel switching and installation of abatement technologies will be used to comply with the new requirements.

Some industry representatives have stated in the consultation that they expect that costs of scrubbers could decrease as the technology becomes more widespread. It has not been possible to identify appropriate forecasts of the possible decrease in costs, so this has not been applied to the

estimates of costs of scrubbers presented in this impact assessment. However, these responses suggest that the estimates that have been applied will be overestimates as they do not take account of the possible decrease over time in the costs of scrubber technology.

The AMEC (2013) report for the UK Chamber of Shipping suggested that technical and practical issues associated with scrubbing technology would mean that the only viable means of meeting the sulphur requirements will be through switching to lower sulphur fuel. However, other evidence (including recent announcements by DFDS ferries and Carnival Cruises[43]) suggests the use of scrubbers could account for greater than 10% of abatement activity to meet the requirements. It is possible that successful deployment of scrubber systems by 'blue chip' operators such as DFDS and Carnival will significantly increase interest and investment in the technology.

DNV[44] suggested in a recent report that by 2020 thousands of globally trading vessels could be carrying scrubber systems. They suggested initial uptake in the 'low hundreds' annually from 2015 along with the use of liquefied natural gas (LNG) on a wide scale. The DNV work suggests it is possible that approximately 20% to 30% of ships globally will be using scrubbers in 2020 under certain fuel price scenarios with a further 30% equipped to use LNG fuel. These rates will vary significantly depending on the behaviour of global fuel prices and the global picture for fuel supply. It should be noted however that the DNV work represents a 'snapshot' and the levels of uptake suggested have been questioned by others in the industry.

There is some evidence however that uptake is accelerating with new manufacturers entering the marketplace with type approved systems. A survey undertaken by Lloyds List suggest 5% of the operators polled are currently actively fitting scrubbers to a portion of their fleet with a further 67% exploring the use of such systems, only. 19% of those spoken to ruled out such systems at this time.

Alternative Options for Compliance

It is possible that some ship operators will opt to comply with the regulations by using alternative fuels, such as Liquefied Natural Gas (LNG) or Methanol, post-2015, that could offer cost savings and a viable alternative to heavy fuels traditionally used within shipping. These have not been considered within the monetised costs estimates in this Impact Assessment as they currently have limited use within shipping and there is limited evidence to forecast uptake in future years.

The UK currently has little infrastructure in place to fully support the use of LNG by vessels calling at its ports, and although there has been significant investment in LNG in other parts of Europe, such as in the Baltic, the UK has not seen similar levels of investment. During consultation it was highlighted that a number of UK operators are actively exploring LNG as an option with one operator investing in an LNG ferry for a UK-continental route and another in negotiations with a port to develop LNG fuel infrastructure. Both operators specifically linked their efforts to the sulphur issue. Another consultee has recently ordered an LNG fuelled new build ferry for use within the SECA as their route to compliance, they indicated that the increased CAPEX cost for such a ship would be offset by the reduced OPEX as the vessel was intended for SECA-only use. Other operators are exploring a similar approach with new build vessels.

Methanol is another alternative to traditional heavy fuels that offers significant cost savings. Consultees reported that a trial of two methanol fuelled vessels is currently taking place in the Baltic, the recent results of which have been very positive. Interest in methanol is growing as one operator has indicated the possibility of moving 24 ships over to the fuel once testing is completed. Methanol has some important drawbacks (notably in terms of energy density) but offers a potentially significant cost saving to operators of short sea services such as ferries although an increase in demand will likely reduce the cost saving somewhat. Methanol represents a very small,

[43] Carnival are understood to be investing in part as a result of a structure approach to compliance in North America which will see the company phasing in compliance systems over a period of years.
[44] Shipping 2020 - Det Norske Veritas, 2012

experimental, portion of the fuel market and has not been included in the main calculations of this Impact Assessment. However, its uptake will be revisited in the review of the policy in 2018.

The picture for alternative fuels is rapidly changing as interest in them increases. This was explored in detail in the public consultation as it was considered likely that an increased uptake of such fuels will contribute to a reduction in the overall cost of compliance. Consultees noted that there was considerable scope for new fuels to enter the marine market but that these would likely make up a very small portion of the market unless they demonstrated a strong return on investment and could be easily supplied. Consultees did not highlight any other likely technologies for use in the short to medium term but it was noted that fuel cell technology was developing and hydrogen remained an interesting long term option.

Other non-monetised costs

The new sulphur content limits could indirectly impact the UK refining industry as the balance of demand for low and high sulphur fuels shifts. Entec (2009) found that the introduction of the 0.1% sulphur limit in SECAs in 2015 will result in ship operators switching to marine gas oil (unless widespread adoption of scrubbers takes place). As a consequence, it is possible that the demand for diesel, gas and oil in North West Europe would increase and put upward pressure on prices. As the marine fuel demand in SECAs constitutes only a very small share of global fuel consumption, Entec (2009) concluded that the impact would not be enough to drive big investments and it is likely the additional low sulphur fuel will be imported into the EU. However, the expected global switch to distillates to meet the 0.5% sulphur limit in 2020 would be expected to have significant impacts for the refining industry.

Any additional costs incurred by refineries to meet sulphur limits would be expected to be passed through to end consumers in the form of higher fuel prices and are therefore captured in the fuel price premium assumptions discussed below.

Noting that there are practical limits to the level of modal shift that can occur in the UK it is also possible that a shift in transport modes and route could occur with, for example, some shorter shipping routes being preferred over longer open water routes. This could occur where the cost saving to hauliers of the shorter shipping route was greater than the additional cost of road transport. There is no suitable transport model available that would enable these impacts to be estimated.

Administrative and Enforcement Costs

As part of its commitment to Port State Control, the Maritime and Coastguard Agency (MCA) inspects a proportion of ships calling at UK ports. The MCA considers that proposed UK Regulations would not involve any additional costs for the MCA above those of the existing inspection programme since any new requirements would be incorporated into existing MCA in-house training.

There is a potential for abatement systems such as scrubbers to complicate enforcement efforts – such vessels would not be subject to the same testing for the sulphur content of their fuel with the focus of enforcement effort being directed towards confirming the abatement system has an appropriate type approval, and is being operated and maintained in line with the approval. It is unlikely this would create any significant cost burden on the regulator but could complicate training in the short term.

If the UK undertakes an enhanced monitoring and sampling programme, to ensure that vessels are in compliance with the proposed regulations, there would be an additional resource burden on the MCA. This would come in the form of additional equipment costs and the possible need for specialist training to use the equipment. Discussions in the EU have centred on mandatory fuel sampling programmes, use of remote sensing systems such as LIDAR, and the installation of Continuous Emissions Monitoring Systems (CEMS) on ships. The UK is arguing for a pragmatic, intelligence led approach to enforcement based upon the low observed level of non-compliance seen under the current sulphur regime.

These potential costs have not been monetised as it is uncertain whether the MCA will be required to complete additional monitoring and sampling activities and as such has not yet evaluated the potential costs of the equipment and training requirements. Work is ongoing through the European Maritime Safety Agency (with significant UK input) to determine the extent to which sampling activity will be needed.

Many consultees commented that the UK inspection and enforcement regime was less proactive than those being considered by some other Member States. The widespread media coverage of remote sensing systems (including aircraft and ROV sensor packages), fixed 'sniffer' installations and comprehensive fuel sampling approaches was highlighted. While the UK is active in Brussels and the IMO in the wider debate around such approaches they do not form part of the core Directive being implemented here and as a result have not been considered in the UK regulations or this impact assessment. If a major uplift of enforcement capability was required it would be assessed separately in due course.

8. Greenhouse gas emissions

The greenhouse gas (GHG) emissions impacts were assessed based on the differences in fuel consumption under the different uptake scenarios to which greenhouse gas emission factors have been applied.

Since the consultation stage IA the analysis has been updated using greenhouse gas emissions factors which take account of all greenhouse gases produced in the combustion of fuel (measured in tonnes of CO_2 equivalent) rather than using CO_2 only emissions factors. Due to its relatively high nitrous oxide (N_2O) emissions, gas oil (low sulphur fuel) has higher total greenhouse gas emissions per tonne than fuel oil (high sulphur fuel) although its CO_2 emissions per tonne of fuel combusted are lower. The impact of this change on the analysis has been that in the central scenario (90% fuel switching/10% uptake of scrubbers), there is an increase in greenhouse gas emissions.

There will be an increase in greenhouse gas emissions in all the uptake scenarios. In uptake scenarios A and B (100% fuel switching) the increase is driven by switching to fuel with higher overall greenhouse gas emissions per tonne of fuel consumed. Although there is lower fuel consumption overall in both scenarios, the additional emissions associated with the combustion of a tonne of gasoil outweigh the impact of increased fuel efficiency associated with gasoil use. In uptake scenario C, there is increased fuel consumption associated with the installation of scrubber technology (and hence increased fuel consumption overall) which has an associated rise in greenhouse gas emissions.

The analysis used the following key input data:

- CO_2e emissions factors of:
  - 3,243 kg CO_2e per tonne of fuel oil[45]
  - 3,423 kg CO_2e per tonne of gas oil[46]
  - Low/central/high non-traded carbon prices (2013 prices). Carbon prices for 2020 are £33 /tCO_2e, £66 /tCO_2e and £99 /tCO_2e respectively[47];
- Average efficiency gains switching to distillates of 4.51% (source of estimate: Entec (2009)); and

[45] Value from Defra, Greenhouse Gas Conversion Factors Repository. http://www.ukconversionfactorscarbonsmart.co.uk/ ,kgCO2e/tonne gas oil

[46] Value from Defra, Greenhouse Gas Conversion Factors Repository. http://www.ukconversionfactorscarbonsmart.co.uk/

[47] Value from DECC, Table 3 of the Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

- Average increased fuel consumption associated with scrubbers of 1.72% (source of estimate: Entec (2009)).

The non-traded carbon prices for UK policy appraisal[48] have been used to value the greenhouse gas (GHG) emissions impacts for the purposes of this impact assessment on the grounds of proportionality. However, it should be noted that only UK domestic shipping is included in the UK's carbon budgets at present, and that this does not prejudge a view on the apportioning of emissions to the UK in the event of an international agreement to reduce shipping emissions.

The changes in GHG emissions for 2020 relative to the baseline and the monetisation thereof are presented in the table below.

Table 12: Increase in GHG emissions and associated valuations for 2020

Uptake scenario	CO_2e emissions (t)	Monetisation for low/central/high carbon prices (2013 prices, £ million)		
		Central	Low	High
A - 100% fuel switch	82,396	5.4	2.7	8.1
B - 10% scrubbers + 90% fuel switch	91,825	6.0	3.0	9.1
C - 100% scrubbers	176,684	11.6	5.8	17.4

The estimated net present value over the appraisal period of the changes in GHG emissions is presented in the table below.

Table 13: Present value cost of increase in GHG emissions (2015-2024) under central carbon price assumptions

Uptake scenario	Present Value of change in GHG emissions (£ million) (2013 Price Base Year, 2014 Present Value Base Year)		
	Low Carbon Prices	Central Carbon Prices	High Carbon Prices
A - 100% fuel switch	20	40	60
B - 10% scrubbers + 90% fuel switch	22	44	67
C - 100% scrubbers	43	86	128

9. Benefits

The benefits of these regulations that can be robustly monetised have been identified to be the following.

- Benefits to health from reduced exposure to air pollutants, principally from reductions in emissions of SO_2 and Particular Matter from shipping and reduction in the Population Weighted Mean Concentrations (PWMC) of these air pollutants.
- Benefits from reduced buildings and material damage resulting from reduced SO_2 emissions.

The monetised benefits estimates do not include all the expected impacts of the regulations. Non-monetised benefits are discussed separately and include

[48] DECC, Valuation of Energy Use and Greenhouse Gas Emissions for Appraisal and Evaluation https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisa

- Benefits to the environment due to a reduction in atmospheric pollution.
- Improvement in the (non-health) quality of life of members of society that benefit from an improvement in air quality.
- Benefits to the agricultural sector as soils and water courses recover from the impact of air pollution, resulting in better crop yields and a reduction in the amount of additional nutrients that need to be added to help crop growth.

Health Impacts

The analysis produced by AMEC (2014) has provided new estimates of the health and environmental benefits of the regulations. The methodology for estimation of these benefits has followed Defra (2013) guidance[49]. In order to estimate health and environmental benefits associated with the regulations, the study involved application of the atmospheric chemical transport models FRAME[50] and EMEP4UK[51] to simulate the future deposition of sulphur and nitrogen and concentrations of PM_{10} and $PM_{2.5}$ for the UK for scenarios of emissions of SO_2 and particulate matter from shipping. The results of the models were used to assess the impacts of the emissions abatements from these regulations on population weighted mean particulate concentrations and on natural ecosystems. These were then used to estimate the health impacts and environmental impacts generated by the regulations.

Starting from the predicted reduction in population weighted mean concentration (PWMCs) for the pollutants, the main expected health benefits were assessed and monetised, based on the Defra (2013) guidance. The health effects considered were:

- Acute mortality (deaths brought forward) from SO_2;
- Respiratory hospital admissions from PM_{10} and SO_2;
- Cardiovascular hospital admissions from PM_{10}; and
- Chronic mortality (life years gained) from $PM_{2.5}$.

For each of these health effects, the AMEC (2014) study estimated the baseline number of each of these health effects by using the actual number recorded from official data for the most recent year available and by making assumptions to produce forecasts for 2020 (see AMEC (2014) for more details). The Defra (2013) guidance was followed for estimating the health effects, by modelling the effect that reduction in emissions would have on population weighted mean concentrations of air pollutants. Coefficients from the Defra (2013) guidance were applied to estimate the effect of the estimated reduction in population weighted mean concentration and the resulting impact on each of the health effects identified.

The AMEC (2014) study quantified the health impacts in 2020 for both Policy Scenario 2 and Policy Scenario 3 compared to Policy Scenario 1 as defined in Table 3. A summary of the quantified health impacts for 2020 as estimated by AMEC for Policy Scenario 3 is provided in the table below. These benefits are assumed to remain the same across all uptake scenarios as the emissions level would be the same no matter which uptake scenario was adopted.

Table 14: Summary of quantified health impacts in 2020 for UK EEZ area (Policy Scenario 3)

[49] Defra (2013) Impact pathway guidance for valuing changes in air quality, May 2013. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197900/pb13913-impact-pathway-guidance.pdf

[50] For further information on this model see http://pollutantdeposition.defra.gov.uk/frame

[51] For further information on this model see http://www.ceh.ac.uk/sci_programmes/emep4uk.html

Health impact	PM10	PM2.5	SO2	Total
Acute mortality: Reduction in deaths / year *	-	-	50	50
Acute mortality: Life year gains for UK in 2020 *	-	-	17 (8 - 25)	17 (8 - 25)
Reduction in respiratory admissions/year	108	-	76	183
Reduction in cardiovascular admissions/year	71	-	-	71
PM2.5 chronic mortality: Life year gains for UK in 2020	-	5,029	-	-

Note: (*) For acute mortality, the reduction in deaths/year and life year gains are alternative measures of the same health impact (assuming 1 death brought forward = 2-6 months loss of life expectancy, as per Defra (2013) and therefore not additional to one another

For the purposes of this Impact Assessment, it has been assumed that there would be the same health impacts (for each of the policy scenarios) in each year of the appraisal period. The estimates for Policy Scenario 2 have been applied for 2015 to 2019, and the estimates for Policy Scenario 3 have been applied for 2020 to 2024. Beyond this analysis, it would be possible to model the health benefits separately for each of the appraisal years to reflect, for example, the effect of the forecast increase in fuel consumption over the appraisal period. However, this would have required considerably greater modelling resource and the approach taken is considered to be proportionate for this Impact Assessment for estimation of the health benefits.

Monetisation of health impacts

The estimated health impacts were monetised using the values provided by Defra (2013) for 2012, uprated to 2013 prices using GDP deflators, then uplifted by 2% per year in real terms to reflect increasing willingness to pay to reduce health risks as income increases. The values thus derived for one of the appraisal years, 2020, are presented in the table below.

Table 15: Unit health values for 2020 (2013 prices, £)

Health effect	Central value	Low value	High value	Unit	Comment
Acute mortality	21,427	21,427	41,664	per year of life lost	High value only applies to 10-15% of life years
Acute mortality	7,142	3,571	20,832	per death brought forward	High value only applies to 10-15% of deaths
Chronic mortality	41,664	31,308	52,140	per year of life lost	
Respiratory hospital admissions	7,916	3,095	12,737	per admission	
Cardiovascular hospital admissions	7,678	3,571	11,785	per admission	

Central/low/high values estimates were derived based on both the range of values presented in Defra (2013) guidance, and reflecting the estimate from the guidance that one death brought forward is equivalent to 2-6 months loss of life expectancy (for acute mortality).The monetised health benefits estimated for 2020 for Policy Scenario 2 and Policy Scenario 3 are presented in the tables below.

Table 16a: Monetised health benefits for Policy Scenario 2 for 2020 (2013 prices, £ million)

Health impact			
	Central	Low	High
Acute mortality: Reduction in deaths / year	0.2	0.1	0.3
Chronic mortality: Life year gains for UK in 2020	117.6	88.4	147.1
Reduction in respiratory admissions/year	0.8	0.3	1.4
Reduction in cardiovascular admissions/year	0.3	0.1	0.5
Total	119	89	149

Table 16b: Monetised health benefits for Policy Scenario 3 for 2020 (2013 prices, £ million)

Health impact			
	Central	Low	High
Acute mortality: Reduction in deaths / year	0.4	0.2	0.5
Chronic mortality: Life year gains for UK in 2020	209.5	157.5	262.2
Reduction in respiratory admissions/year	1.5	0.6	2.3
Reduction in cardiovascular admissions/year	0.5	0.3	0.8
Total	212	158	266

Present Value of Health Benefits

The present value of health benefits over the appraisal period has been estimated using the annual values for 2020 provided in the AMEC (2014) report, which have been adjusted to account for a 2% annual increase in the real value of health benefits, consistent with the Defra (2013) guidance, and discounted to 2014 present values.

The present value of health benefits over the appraisal period is estimated as a range from £1,004 million to £1,685 million, with a central net present value of £1,343 million (2013 Price Base Year, 2014 Present Value Base Year). This range reflects the range in the unit health values from the Defra (2013) guidance.

Benefits from reduced building and material damage

The benefits from reduced material damage were estimated from the SOx emission forecasts provided by Ricardo-AEA, and reported in the AMEC (2014) analysis. The AMEC (2014) analysis took an estimated value of £189/t (2006) prices from the previous study (Entec, 2009) and uprated

this to £222/t (in 2013 prices). In line with the previous study, it was assumed that 50% of emissions from ships in port (i.e. berth and manoeuvring) and 10% of emissions from ships at sea will be deposited on UK materials. The values used for these emission were thus 111 £/t and 22 £/t respectively, thus giving the material damage reductions presented in the table below.

Table 17: Benefits from reduced material damage from SOx emissions for 2020

	SOx reduction (t)	Monetised benefit of reduced material damage (2013 prices, £ million)
Policy Scenario 2	52,995	1.3
Policy Scenario 3	81,659	2.1

For the purposes of this Impact Assessment, it has been assumed that there would be the same reductions in SOx under each of the policy scenarios in each year of the appraisal period; and the estimates for Policy Scenario 2 have been used for 2015 to 2019, and the estimates for Policy Scenario 3 have been used for 2020 to 2024. Again, this approach has been taken on the grounds of proportionality.

The net present value of benefits from reduced building and material damage over the appraisal period is therefore estimated to be £13.7 million (2013 Price Base Year, 2014 Present Value Base Year), based on the estimates provided by the AMEC (2014) report.

Summary of monetised benefits

The following table summarises the estimated monetised benefits of the regulations, based on the low, central and high estimates of the ranges reported for each of the impacts.

Table 18: Estimated Total Monetised Benefits over the appraisal period

Impact	Valuation of Benefits (Net Present Value over Appraisal Period) (£, million) (2013 Price Base Year, 2014 Present Value Base Year)		
	Low	Central	High
Health impacts	1,004	1,343	1,685
Building and material damage	13.7	13.7	13.7
Total Monetised Benefits	1,018	1,356	1,698

Summary of total monetised net present value

The total net present value of the benefits and costs are presented in the table below. These are calculated from the cost estimates and benefits estimates presented in this Impact Assessment.

- The range in the monetised benefits estimates is based on the range in the values for health impacts reported in the Defra (2013) guidance.
- The range in the monetised costs to business estimates is given by the lowest and highest cost estimates from the analysis. These are both generated in the low fuel price scenario. The lowest cost estimate is for a scenario in which 100% of vessels switch to low sulphur fuel (Uptake Scenario A) and the fuel price premium is at the low end of the range given.

The highest cost estimate is for a scenario in which 100% of vessels use scrubber technology (Uptake Scenario C) when the fuel price premium is at the low end of the range. The lower fuel price premium reduces the offsetting benefit to ships of using cheaper fuel when the scrubber technology is installed. The central estimate is based on Uptake Scenario B as explained above.

- The range in the monetised environmental costs estimates is given by the lowest and highest cost estimates from the analysis. This reflects low/central/high carbon prices for use in UK government appraisal and the differences between the uptake scenarios. The lowest estimate is based on the low carbon prices under Uptake scenario A; and the high estimate is based on the high carbon prices under Uptake scenario C. The central estimate is based on the central carbon prices under Uptake Scenario B in line with the costs to business.

Table 19: Estimated Monetised Net Present Value

	Net Present Value over Appraisal Period (£, million) (2013 Price Base Year) (2014 Present Value Base Year)		
	Low	**Central**	**High**
Total Monetised Benefits [a] (see Section 9)	1018	1356	1698
Monetised Costs to Businesses [b1] (see Section 7)	3062	4258	5583
Monetised Environmental Costs (Greenhouse Gas Emissions impact) [b2] (see Section 8)	20	44	128
Total Monetised Costs [b = b1 + b2]	3082	4302	5711
Net Benefit [b – a]	-4694[52]	-2946	-1383[53]

The table above shows the range of monetised present values of benefits and costs that have been estimated. The best estimate of net present value, based on the central present value benefits and costs estimates, is -£2,946 million (2013 Price Base Year, 2014 Present Value Base Year).

Non-Monetised Benefits

The benefits discussed in this section have not been monetised due to the limitations of the available evidence base.

Non-monetised benefits from the regulations include benefits that will occur to the environment due to a reduction in atmospheric pollution. As detailed above there are a range of environmental impacts that occur as a result of sulphur emissions. No attempt has been made as a part of this

[52] This is calculated using the high monetised costs and the low monetised benefits.

[53] This is calculated using the low monetised costs and the high monetised benefits.

impact assessment to place a value on the ecosystem services (including nutrient cycling, crop, timber and livestock production, clean water) which have been impacted by air pollution and therefore no figure is included to represent the benefits to the environment of the introduction of the proposed regulation. This is because it is not possible to robustly monetise these impacts. It is assumed that savings to the UK will be realised through a reduction in the need for remedial work to be undertaken in the future and the continued uninterrupted provision of ecosystem services within the UK. Other non-monetised benefits to the environment include the cultural appreciation of unpolluted ecosystems, for example the enjoyment of walking in a biodiverse environment which is free of pollution or the value received by enjoying an unpolluted fishery.

Other non-monetised benefits could include improvement in the (non-health) quality of life of members of society that benefit from an improvement in air quality. Wider societal benefits to areas that may have been considered undesirable due to the poor air quality might result in such areas becoming more desirable for business location and residential location.Studies within the United States have demonstrated that as air quality improves house prices increase.[54] These studies suggest that an improvement in air quality can lead to benefits reflected in an increase in property prices.

There may be benefits to the agricultural sector as soils and water courses recover from the impact of air pollution, resulting in better crop yields and a reduction in the amount of additional nutrients that need to be added to help crop growth.

A number of UK technology manufacturers have invested in developing and producing the 'scrubber' equipment that could be used to meet the requirements of the regulation. These companies are likely to benefit if demand for the technology increases.

10. EU & European Neighbours' Cost/Benefit Analysis

The European Commission's Impact Assessment concluded that the net present value of the new limits under MARPOL Annex VI would be positive with benefits exceeding costs.

There are several factors affecting the overall conclusions. An important factor is that this Impact Assessment, in contrast to the analysis by the European Commission, is limited to the UK EEZ, and therefore does not take into account the benefits that will arise from other Member States implementing the Directive. This Impact Assessment also does not take into account the benefits that would accrue to other Member States from reduction in emissions of air pollutants from ships in UK waters. There may also be benefits to the UK from actions taken by other member states to implement the directive, and these are not included in this Impact Assessment.

The prevailing westerly wind within the English Channel and North Sea make the actions taken by the UK of interest to other European countries. As a proportion of the pollution emitted from ships within the UK EEZ will reach landfall and impact upon populations within Europe, the UK has agreed to share its Impact Assessment with the French Administration responsible for implementation of the Directive in France. This sharing of information will be reciprocated by the French. It should therefore be noted that the actions of the UK will bring about benefits to other members of the EU. These benefits are not included within this Impact Assessment as they are not benefits to the UK. However this does not diminish the value of the benefit to others.

11. Implementation and Delivery Plan

The transposition of the Directive was due to be completed by 18 June 2014, so the UK is late in implementing and is now exposed to the risk of infraction. The Directive will be implemented through secondary legislation using the Merchant Shipping Prevention of Pollution Regulations.

Upon entry into force all UK vessels and vessels in UK waters will be obligated to be compliant with the requirements of the new legislation. Once the legislation enters into force the shipping industry

[54] http://web.mit.edu/ceepr/www/publications/reprints/Reprint_227_WC.pdf

would have to plan how they are going to meet the reduced sulphur limits within the Sulphur Emission Control Areas (SECA) of the North and Baltic Seas and would have until 2020 to assess how to meet the reduction in sulphur limits outside of SECA. This, along with the fact that the industry has been aware of these changes for a number of years (since late 2008) prior to the EU publishing Directive 2012/33/EU, should give ample time for ship operators and owners to source compliant fuel or implement alternative methods of compliance.

The timescales are sufficient to allow the Maritime and Coastguard Agency to adapt and develop the required survey and inspection regime that will be necessary to ensure compliance with and enforcement of the requirements of the Directive.

Supporting documentation in the form of Merchant Shipping Notices will be used to educate and inform the maritime industry and other relevant organisations about the regulatory requirements of the proposed legislation. Following consultation the MSN has been subject to some minor amendments but consultees agreed that the guidance was helpful.

12. Administration and Enforcement

The proposed legislation provides for inspections of vessels to be completed; this is in line with normal international maritime law. These inspections would be completed as a part of the MCA Port State Control Inspections. Under the existing Regulations, the MCA is able to carry out a survey and inspection regime to ensure compliance with the requirements laid down in MARPOL Annex VI. Similarly, there would no additional costs to businesses from inspections as they can already be inspected for compliance with the regulations laid down in in MARPOL Annex VI.

The proposed Regulations would also include the facility for the MCA (or appointed personnel) to survey and inspect vessels in accordance with the requirements of the Directive.

Enforcement would be carried out by the MCA as part of its existing enforcement activities, which is carried out under a regime of proportionate and targeted compliance surveys. There would therefore be no change in the work completed by the MCA to ensure compliance, As such, there would be no additional enforcement costs as a result of the proposed transposition of the Directive and no additional costs to businesses of inspections.

The proposed Regulations would provide sanctions for non-compliance. This would include provisions for a fine not exceeding the statutory maximum on summary conviction in some cases, or on conviction on indictment, a fine not exceeding the statutory maximum (£25,000) In the case of a conviction in the Crown Court, the proposed Regulations would allow for a fine established by the Court. These penalties are in line with those for other maritime pollution offences and are considered to be proportionate to the nature of the offences.

Provisions would also exist whereby a ship may be detained in UK waters should a surveyor suspect that an offence under the proposed legislation has taken place.

Collection of data and monitoring information would take place through the survey and inspection regime. When a survey or inspection takes place the details and findings of the operation is recorded as a part of the MCA's normal operational practices. This data would be available for review and monitoring purposes.

A significant number of consultees did not consider that the proposed enforcement regime was adequate and suggested that MCA should develop a significantly more stringent system for enforcement. Consultees noted that other EU member states were developing the capability to sample and inspect on a more regular basis and most had significantly more severe financial penalties in place to address non-compliance.

13. Risks and Assumptions

The methodology applied for estimation of costs and benefits in this Impact Assessment has made extensive use of data and analysis from a range of sources including new research commissioned

for this Impact Assessment. The methodology for estimation of benefits follows relevant Government guidance as identified in this Impact Assessment. However, there are a number of uncertainties that have been identified.

Cost estimates are dependent on several estimates and forecasts and are uncertain. It is possible that changes in, for example the shipping industry, supply chains, and economic conditions could lead to outcomes differing from these estimates. This applies particularly to:

- fuel price projections and differentials and resulting costs
- unit costs of scrubbers
- the number of ships operating exclusively in SECAs or non-SECAs or both, and as to how ships operating in both would meet the requirements of the Directive.

Benefits estimates are also dependent on estimation of

- the underlying emissions inventory and projections, which will depend on the growth rates in fuel consumption and expected uptake of different fuels versus technologies;
- the atmospheric modelling undertaken to estimate sulphur deposition and particulate concentrations;
- the health impacts associated with exposure to air pollution (exposure response functions);
- the valuation of health impacts and of damage to materials/buildings;

There are also uncertainties as to:

- the exact split between vessels operating exclusively in UK waters;
- how ships operating in both UK waters and other EU waters would behave when crossing from one to the other under a baseline scenario in which all other EU Member States fully implement the Directive but the UK does not;
- the number of ships operating exclusively in SECAs or non-SECAs or both, and as to how ships operating in both would meet the requirements of the Directive;

14. Infraction

Failure to complete the transposition of the Directive could result in infraction proceedings being taken against the UK by the EU, resulting in possible financial penalties, damage to the UK's reputation and negative publicity. As the UK has also previously come close to infraction proceedings on sulphur emissions it is likely that the fines imposed will be higher than the minimums indicated.

European Commission Penalty Calculations

The guidance set out by the Commission in document SEC (2005)1658 as amended by SEC (2010) 923, recommends that the European Court of Justice (ECJ) imposes penalties in the form of a lump sum payment for failing to comply with the first ECJ judgment up to the date of the second ECJ judgment with additional penalty payments in the form of a daily fine continuing from the date of the second judgment until compliance..

The formula for the lump sum penalty is:

Basic flat rate lump sum payment (€210 per day) x coefficient for seriousness (on a scale 1 to 20) x 'n' factor (17.54 for the UK, based on capacity of the Member State to pay and the number of votes it has in the Council) x number of days of infringement.

The formula for the daily fine from the date of the second ECJ judgment is the multiple of:

Basic flat rate penalty payment (€640 per day) x coefficient for seriousness (on a scale 1 to 20) x coefficient for duration (1 to 3 calculated at a rate of 0.1 per month from the date of the first judgment to the second, reaching the maximum after 2 ½ years) x 'n' factor (17.54 for the UK).

15. Assumptions

The key assumptions made in the impact assessment include:

- Once legislation enters into force compliance within the UK shipping industry will be achieved.
- The standards will be implemented globally on the dates indicated to ensure a level playing field globally and within the EU, ensuring UK shipping is not left at a competitive disadvantage. Feedback from other European member states strongly suggests the regime will be in place on time within the EU
- The price base year for costs and benefits is 2013
- Adequate fuel and suitable technologies will be available
- Alternative fuels are not (at present) viable for significant take-up as alternatives to low sulphur fuels or fitting scrubbing equipment
- Exemptions are not available and will not be issued.
- Fuel costs and fuel consumption forecasts are as detailed in this impact assessment
- Unit costs of scrubbers are as detailed in this impact assumption
- The number of ships operating in the UK Exclusive Economic Zone are as detailed in this Impact Assessment
- An increase in the use of low sulphur fuels by shipping does not result in a significant increase in the cost of fuels in other areas (road use, heating fuel etc.)

16. Wider Impacts

Competition Assessment

Provided all Member States implement the requirements of the Directive in a timely manner there will be no impact on competition within the maritime industry as a result of the proposed regulations. If Member States do not implement the requirements of the Directive and the UK does it is possible that UK organisations may be put at a competitive disadvantage. However, any Member States failing to implement the Directive will be subject to infraction proceedings by the Commission.

The Directive will not impact on competition within the equipment manufacturers market as it does not stipulate how to ensure the reduction in sulphur emitted from vessels.

Ferry operators have expressed concern that the implementation of the Directive could lead to modal shift away from sea transportation systems to land-based modes. To date there is no firm evidence to support this assertion but this possibility was highlighted as an area for further exploration in the consultation process. It should be noted that a number of the operators that have raised such concerns, operate vessels from the UK and may be responsible for employing UK citizens within the locality of port operations but are not UK owned companies.

Small Firms Impact Assessment

The MCA does not expect that many of the ships that would be affected by the proposed Regulations will be owned and operated by small firms. To flag a vessel on the UK register, the owner/company has to demonstrate a link to the UK. The company does have to be UK registered, but in practice this could be through a PO Box address registered at Companies House. The complicated nature of the maritime industry makes it hard to firmly establish the size of the company and proportion of that company that operates within the UK. However, the MCA considers that the high value of the vessels involved and the operating costs of those vessels suggest that such firms are unlikely to be classified as small. In addition, any firms that have less than 250 employees in the UK often have much larger international parent companies backing them. It is also a complicated exercise to ascertain how many people working within a UK registered company are actually employed in the UK, the large number of those employed will be on the vessels which are often crewed by different nationalities. In addition, the offices of these organisations are also not always located within the UK.

We are aware of a small number of historic vessels operated by charitable concerns who may be classed as small companies. The impact on such smaller operators will be directly proportional to the number and size of vessels operated. As smaller vessels will require smaller scrubber units or will burn less fuel, any impacts on small firms are considered to be proportionate to the contribution of their operation to the total mass of sulphur emitted.

Discussions with UK bunker supplies have not resulted in any concerns being expressed by the industry regarding specific impacts on small businesses. Industry was given a further opportunity to provide evidence of any impacts on business through the consultation process and no additional concerns were highlighted

Health Impact Assessment

A specific health impact assessment has not been undertaken. The major driver behind this policy and proposed legislation is the need to improve air quality, the consequences of which will be an improvement in health, resulting in cost saving public to the NHS and Industry. Details regarding the expected health impacts are included within the main body of this impact assessment.

Greenhouse Gas Impact Assessment

The estimated impact on greenhouse gas emissions from measures implemented by ship operators to comply with the regulations (use of lower sulphur fuels and use of exhaust gas scrubbers) are reported earlier in this Impact Assessment. The estimated impact on greenhouse gas emissions is not shown in the corresponding boxes in the 'Summary: Intervention and Options' sheet. This is because only UK domestic shipping is included in the UK's carbon budgets at present and the available evidence does not enable the proportion of the impact on greenhouse gas emissions that relates to UK domestic shipping to be estimated.

Any low sulphur fuel that is produced within EU refineries should not result in any net increase in emissions as the refineries will need to comply with the cap of the EU emissions trading scheme (ETS). This will mean that any increase in emissions will need to be offset elsewhere in the EU ETS but at a cost to the refinery industry. However, if fuel is imported from outside of the EU, there may be a net increase in CO_2 emissions in such countries. A number of stakeholders noted in the

consultation process that it is expected that the bulk of fuel will be refined outside of the EU as most petroleum investment occurs in regions with lower environmental and planning costs in order to maximise returns on investment. Due to the complexity of international fuel markets, the relative lack of information on refinery investment plans and uncertainty surrounding international marine greenhouse gas emissions, the impacts of this have not been modelled.

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17. One In Two Out

Estimated Annual Net Cost to Business

The Best estimate of the Net Benefit to business (Present Value) over the 10 year appraisal period is estimated to be -£4,258m (2013 Price Base Year, 2014 Present Value Base Year). This is calculated using the Best estimate of the Monetised Costs to Businesses as set out in Table 19 and the assumption that there would be no direct benefits to business.

On the basis of the OITO methodology, the Best estimate of the Equivalent Annual Net Cost to Business per year (EANCB) is estimated at around £407 million per year (2009 Price Base Year, 2010 Present Value Base Year).

The EANCB range, which shows the EANCB corresponding to the different fuel price scenarios and uptake scenarios discussed in this impact assessment, is shown in the table below.

Table 20: EANCB (£ million) by Fuel Price Scenario and Uptake Scenario (2009 Price Base Year, 2010 Present Value Base Year)

	Low Fuel Price Scenario	Central Fuel Price Scenario	High Fuel Price Scenario
Uptake A	292	394	413
Uptake B	317	407	423
Uptake C	533	519	518

Although the benefit of the regulations are not specifically to business, it should be noted that it is possible business will obtain some of the benefits from the impacts of the regulations including health benefits and benefits from reduced buildings and material damage. However there is no robust evidence to calculate what proportion of these benefits would be obtained by business.

Application of One In Two Out

We consider these regulations to be out of scope of OITO, since they transpose an EU Directive without any “gold plating”.

We believe that our approach to transposition is consistent with Government guidance[55]. In designing the policy instrument, the Maritime and Coastguard Agency and the Department for Transport

a. will ensure that the UK does not go beyond the minimum requirements of the measure which is being transposed;
b. have considered implementing EU policy and legal obligations through the use of alternatives to regulation but found this not to be an option for the current Directive;
c. endeavour to ensure that UK businesses are not put at a competitive disadvantage compared with their European counterparts;
d. will use copy out for transposition where it is possible;
e. ensure the necessary implementing measures do not come into force before the transposition deadline specified in the Directive;

[55] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229763/bis-13-775-transposition-guidance-how-to-implement-european-directives-effectively-revised.pdf

Post Implementation Review

The Maritime and Coastguard Agency and the Department for Transporrt will undertake a post-implementation review on the actual costs and benefits incurred by the implementation of the Regulations in the UK in order to inform a statutory review in 2018 and every five years thereafter.

Annex 1: Initial policy options considered

When considering the transposition of Directive 2012/33/EU five policy options were originally considered. The options considered were:

A. Do nothing - Maintain the existing sulphur limits under the MS Act, but do not implement the new requirements.

B. Partial transposition – Only transpose those elements which shipowners consider are 'affordable' - e.g. do not transpose the 0.1% sulphur limit for the emission control areas which some shipowners consider would be too expensive for them.

C. Partial transposition - Transpose those elements which are precisely aligned with MARPOL Annex VI, but nothing else.

D. Transpose the Directive in full – using 'copy out' where appropriate and taking advantage of all the derogations that are available for Member States. Apply a proportionate and targeted compliance regime.

E. Implement the full Directive with additional measures to enhance environmental protection and public health – e.g.: additional limits on vessels in UK waters outside the ECAs.

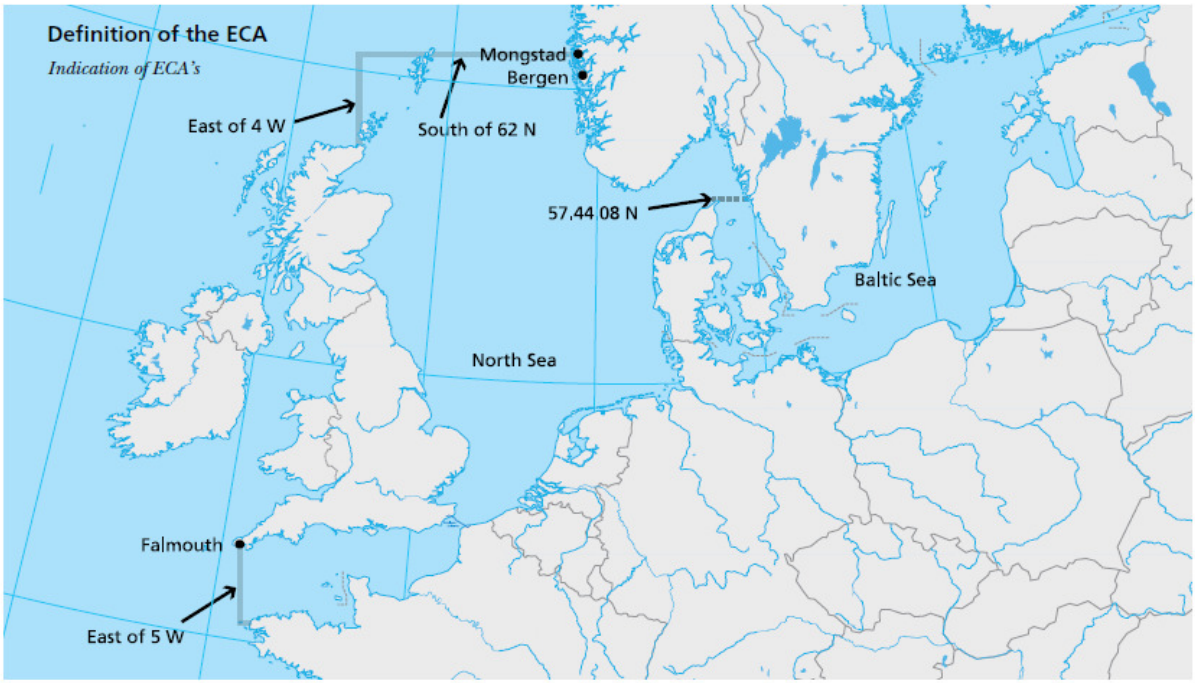
Options A and D have been considered in this impact assessment. The remaining options were previously discarded as a part of the policy decision making process.

Option B (partial transposition) was discarded as it fails to meet the Government's policy to deliver improvements to air quality and is not consistent with our international Treaty obligations or the cross-government negotiating position agreed by EAC to implement the revised Annex VI. Whilst this option would benefit ferry operators operating inside the SECAs, it would undermine equipment manufacturers who have invested heavily in developing 'scrubber' technology. There would also be a risk of infraction proceedings being launched against the UK.

During negotiations, the UK pressed for a closer alignment between the Directive and MARPOL Annex VI, without any gold-plating, similar to the option outlined in C. However, no agreement on this approach could be reached between Member States so to transpose only those elements of the Directive that align with MARPOL Annex VI would result in a partial transposition of the Directive. Like options A and B, option C puts the UK at risk of infraction. It should be noted that the Commission was disappointed by the lack of 'environmental ambition' in the Directive, we would expect it to challenge any watering down of the requirements by Member States.

One area where the Directive could be extended would be to extend the stricter 0.1% sulphur limit that applies to the North Sea and the Baltic Sea in 2015 and apply it to all UK waters. This would increase the benefits to the environment and public health, and could also minimise any distortion in competition between ports and ship operators within the SECA and those outside. This option was also opposed by the UK during negotiations when a unilateral proposal to apply stricter limits was suggested. This option is not considered viable as it gold-plates the Directive and the requirements under MARPOL Annex VI.

Annex 2: Map of the North Sea's Sulphur Emission Control Zone[56]



[56] http://www.dnv.com/binaries/marpol%20brochure_tcm4-383718.pdf