Title: Maritime Autonomy and Remote Operations **IA No: DfT00440** **RPC Reference No:** RPC-DFT-MCA-5113(2) **Lead department or agency:** Department for Transport **Other departments or agencies:** Maritime and Coastguard Agency	Impact Assessment (IA) **Date: 14/09/2023** **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Primary Legislation **Contact for enquiries:** Maritimeengagement@dft.gov.uk

Summary: Intervention and Options

RPC Opinion: Green

Cost of Preferred (or more likely) Option (in 2019 prices)			
Total Net Present Social Value	**Business Net Present Value**	**Net cost to business per year**	**Business Impact Target Status**
NQ	NQ	NQ	Qualifying Provision

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

Maritime autonomous and remote operations already exist in the UK. In the UK, these ships' operations have so far been addressed through exemptions and equivalences to the existing regulations for non-autonomous and non-remotely operated ships. A tailored approach is required to enable this rapidly growing sector to flourish safely and securely.

What are the policy objectives and the intended effects?

The purpose of this legislation is to bring the operation of remotely operated and autonomous ships in line with the regulations that apply to existing non-remotely operated and non-autonomous ships. Whilst the market is in its infancy, it is estimated that there are already over 1,000 of these ships globally with a market value of $88bn[1]. It is estimated this could rise to a market value of $150bn by 2030[2], and that the UK could take a market share of around 10%[1]. Effective regulation is considered a key requirement for that to happen, and our plans would put us ahead of any plans for international regulation and therefore place the UK at the forefront of this exciting market.

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

Option 0: Do minimum (baseline) – Maritime and Coastguard Agency (MCA) continue to use Merchant Shipping (Load Line) Regulations 1998 exemption to allow autonomous shipping and remote operations in UK. The Workboat Code is due to be updated and will include new regulatory provisions for remotely operated unmanned vessels under 24 metres in length on an exemption basis.

Option 1: Wait for International Maritime Organization (IMO) – This is the same as option 0 (do minimum) until a new regulatory instrument is agreed at the IMO, not expected to be before 2028.

Option 2: Legislate in advance of the IMO (preferred) – Amend the current primary legislation framework such as the MSA, Harbours Act 1964 and Aviation and Maritime Security Act 1990 (AMSA) to provide the powers to regulate autonomous maritime ships regardless of size, including submersible apparatus. This is preferred as it supports the objective for the UK to lead in maritime autonomy, enabling innovation, growth and jobs in the UK maritime sector whilst managing possible risks and adverse outcomes and ensuring the safe use of autonomous vessels in UK waters.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** This is a rapidly emerging market, therefore we envisage the policy to be reviewed for secondary legislation as the market develops to maturity over the coming years.

Does implementation go beyond minimum EU requirements?	N/A
Is this measure likely to impact on international trade and investment?	Yes

[1] Allied Market Research 'Autonomous Ships Market', December 2020, available at: https://www.alliedmarketresearch.com/autonomous-ships-market

[2] Department of Transport estimate based on Allied Market Research 'Autonomous Ships Market', December 2020 (https://www.alliedmarketresearch.com/autonomous-ships-market) and IFM Education and Consultany Services 'UK Marine Industries Technology Roadmap', 2015 (https://www.ifm.eng.cam.ac.uk/uploads/Resources/Reports/UK-Marine-Industries-Technology-Roadmap-2015.pdf)

Are any of these organisations in scope?	**Micro** 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, given the available evidence, it represents a reasonable view of the likely costs, benefits, and impact of the leading options.

Signed by the responsible Minister: Vere de Navbitan Date: 12/09/2023

Summary: Analysis & Evidence

Policy Option 1

Description: Wait for IMO to develop an instrument on autonomous shipping and remote operations

FULL ECONOMIC ASSESSMENT

Price Base Year 2021	PV Base Year 2022	Time Period 10 years	Net Benefit (Present Value (PV)) (£m)		
			Low: NQ	**High:** NQ	**Best Estimate:** NQ

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	NQ		NQ	**NQ**
High	NQ		NQ	**NQ**
Best Estimate	**NQ**		**NQ**	**NQ**

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

This proposal will wait for the IMO to develop autonomous shipping and remote operations legislation before aligning domestic legislation so as further to enable autonomous shipping and remote operations in the UK. Given the early stage of development of IMO recommendations and the lack of the final regulatory regime, a robust estimation of costs such as compliance, engagement and familiarisation cannot be made. That analysis will be carried out in the IAs done at consultation and final stage for the secondary legislation and certification requirements.

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

This option is not expected to deliver significantly different impacts from 2022 to 2027 compared to option 0 (do minimum), except for some transition costs of continuing to work with the IMO. From 2028 onwards, there are expected to be higher transition costs compared to option 0 (do minimum), as HMG, regulators and the UK maritime sector look to implement legislative changes. Consultation and final stage IAs for final Regulations and restrictions will fully appraise the costs. Net costs are unlikely to exceed zero as new firms will voluntarily take on the regulatory costs.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	NQ		NQ	**NQ**
High	NQ		NQ	**NQ**
Best Estimate	**NQ**		**NQ**	**NQ**

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

This is a permissive measure, as the ultimate result of an international regulatory framework will be to enable autonomous shipping and remote operations in the UK. Beyond 2028, there are expected to be some ongoing (regulatory) cost savings compared to the option 0 (do minimum), higher benefits, particularly for vessels over 24 metres in length, and improved outcomes for wider economic impacts, risks, and unintended consequences. These assumptions have been tested through consultation.

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

At this stage, none of the benefits are monetised, but they could be monetised in the future depending on which aspects of maritime autonomy and remote operations are enabled through secondary legislation, including: investment and revenue from technology sales for autonomous ship manufacturers; operational and labour cost savings for shipping companies; growth in the wider maritime sector and economy; increased/improved jobs; lower shipping costs for businesses/consumers; higher tax revenue and improved

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

The current approach (until at least 2028[1]) may present a barrier to growth, particularly as industry develops larger and more complex autonomous ships, inhibiting the development of maritime autonomy in the UK, including investment, jobs, and growth. Safety, security, health, and environmental impacts may not be properly defined, accounted for, or mitigated by government, regulators, and industry. UK domestic legislation would not be ready for future changes in international law and there is a risk that the UK will fall behind and miss out on investment and growth opportunities in this new sector.

[1] 2028 represents the earliest date we anticipate IMO reaching an agreement on regulation, ratificiation could take a further two years.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:** NQ
Costs: NQ	**Benefits:** NQ	**Net:** NQ	

Summary: Analysis & Evidence — Policy Option 2

Description: Legislate for maritime autonomous surface ships of all sizes and submersible apparatus and remote operations **in advance of the IMO** (preferred)

FULL ECONOMIC ASSESSMENT

Price Base Year 2021	**PV Base Year** 2022	**Time Period** 10 years	**Net Benefit (Present Value (PV)) (£m)**		
			Low: NQ	**High:** NQ	**Best Estimate:** NQ

COSTS (£m)	**Total Transition** (Constant Price) Years		**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	NQ		NQ	**NQ**
High	NQ		NQ	**NQ**
Best Estimate	**NQ**		**NQ**	**NQ**

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

Option 2 is an advanced version of option 1 (wait for IMO), with transition costs brought forwards as the UK develops and implements domestic legislation and regulation for maritime autonomy and remote operations earlier. Therefore the impacts in terms of magnitude, direction and affected stakeholders are as described for option 1 (wait for IMO), except the impacts (both costs and benefits) will be realised earlier under this option and are therefore subject to less discounting, because people generally prefer value now rather than later. Given that the regulation only looks at taking powers, further consultation, and final stage IAs for final Regulations and restrictions will be needed to fully appraise the costs.

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

There will likely be significantly higher up front (2022 to 2027) transition costs compared to option 0 (do minimum) associated with developing the legislation, familiarisation by industry and associated training etc., but these will likely decrease from 2028 onwards. Consultation and final stage IAs for final regulations and restrictions will fully appraise the costs. Given that the UK MASS market is currently very underdeveloped, costs are unlikely to be significant as new firms will take on the regulatory costs voluntarily as they opt to join the sector.

BENEFITS (£m)	**Total Transition** (Constant Price) Years		**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	NQ		NQ	**NQ**
High	NQ		NQ	**NQ**
Best Estimate	**NQ**		**NQ**	**NQ**

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

As with option 1 (wait for IMO), this is a permissive measure. Compared to option 0 (do minimum), legislating in advance of the IMO is expected to deliver significantly higher net benefits across the appraisal period, particularly for ships over 24 metres in length, and improved outcomes for wider economic impacts, risks and unintended consequences from 2022 to 2027 and 2028 onwards. There are also expected to be ongoing (regulatory) cost savings over the same period. These assumptions have been tested through consultation.

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

At this stage none of the benefits are monetised. Benefit categories and stakeholders are expected to be the same as in option 1 (wait for IMO). However, on balance option 2 (legislate in advance of the IMO) is expected to deliver higher net benefits than option 0 (do minimum) and option 1 (wait for IMO) given the fact that benefits (and costs) would be brought forwards to 2022 from 2028, and these would also be higher in present value terms because of discounting (3.5%). These assumptions have tested been through consultation.

Key assumptions/sensitivities/risks	**Discount rate**	3.5
The primary risk in developing the domestic legal framework in advance of the IMO is that the UK could diverge from international standards as they develop in the future, but the UK may be able to use its experience regulating autonomous and remote operations to shape and influence international discussions, reducing this risk. Additionally, where permitted, flexibility within the proposed legislative changes could also ensure that the UK is able to align with the international position as it develops. In addition, there could be a disproportionate effort compared to technology development which could also affect what is introduced in secondary legislation.		

BUSINESS ASSESSMENT (Option 2)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:** NQ
Costs: NQ	**Benefits:** NQ	**Net:** NQ	

Contents

1 Policy Rationale

1.1 Policy background

1. For the purposes of this document we refer to remotely operated and autonomous ships as 'MASS' (Maritime Autonomous Surface Ships). In this IA, MASS is defined in a broad sense, including ships, vessels, or craft with or without crew onboard, that are either remotely operated[1] or autonomous.[2] Hereafter, the term 'MASS' will be used to mean all ships, vessels and craft that are autonomous or remotely operated.

2. The UK has remotely operated MASS operating and testing in UK waters today; there are also remotely operated MASS registered to the UK Shipping Register, some of which operate in different countries' domestic waters. To operate in UK waters these ships require a seagoing certificate, and permissions from local port and/or harbour masters. They are also required to meet all relevant regulations. To operate in the UK, after the relevant survey and assessment *via* safety case, these ships may be issued with a UK Load Line Exemption. The larger the MASS, and the higher the level of autonomy proposed, the more complex this burden becomes because, the more Regulations must be accommodated through "equivalence" or "exemption".[3]

3. Many industry stakeholders are asking for interim regulation and guidance to allow the on-water testing and even commercial operation of autonomous and remotely operated ships (MASS) in UK waters, as well as access to data to support their developments. From a regulator's perspective the Government's approach to MASS shipping has been *ad-hoc*.[4]

4. We propose to regulate MASS by extending and amending the current maritime legal framework to take powers in primary legislation. The details of MASS regulation will be developed later through secondary legislation following further consultation.

5. To ensure the continued safe regulation of the maritime space and a consistent approach to the use of MASS systems above and below the surface, we propose to define autonomous submersibles and introduce powers to regulate autonomous submersibles and supporting apparatus in a manner consistent with their current regulation[5].

6. This impact assessment (IA) relates to MASS aspects of the proposed legislative changes for primary legislation only.

7. The United Nations' International Maritime Organisation (IMO) has identified four degrees of ship autonomy[6]. An individual ship might be operated under any of these degrees or autonomy at different times, even in the course of one voyage:
    a. **Degree 1** – a ship has automated processes and algorithmic decision support, but onboard crew members are still needed to operate the systems (albeit with less supervision).
    b. **Degree 2** – ships are controlled remotely, but still with onboard crew members.
    c. **Degree 3** – ships are controlled remotely with no seafarers on board.
    d. **Degree 4** – the ship is fully autonomous, but with shore-based emergency over-ride.

[1] Remotely operated ships, for the purposes of this impact assessment, refer to ships where there is a human element involved in the control or operation of the ship, but that human element is not located onboard the ship; or to a ship that carries crew but some functions of the ship are controlled from a location remote from the ship.
[2] Autonomous ships, for the purposes of this impact assessment, refers to ship that are capable of decision making and operating without human input.
[3] Evidence from interviews in smart shipping research funded by DFT, 2020 (unpublished)
[4] MARLab workshops, February 2018
[5] See paragraph 34 for further details
[6] IMO 'Autonomous shipping', accessed 21 July 2021, available at: https://www.imo.org/en/MediaCentre/HotTopics/Pages/Autonomous-shipping.aspx

8. The Government has promoted an ambitious agenda for maritime autonomy and remote operations, as set out in Maritime 2050 and the Technology and Innovation in UK Maritime (TIUK) route-map.[7] The Maritime 2050 vision is for smart shipping and autonomy to make the maritime sector a cleaner, safer and more efficient place to work, and for this to be achieved through working collaboratively with industry to encourage a culture of innovation. The Maritime TIUK route-map also sets the ambition for the UK to be at the heart of a global maritime autonomy industry and the destination of choice for industry leaders pursuing innovative maritime technologies.

9. The Maritime and Coastguard Agency's (MCA) Maritime Autonomy Regulation Lab (MARLab), funded by the Regulators' Pioneer Fund, was created to fulfil several Maritime 2050 objectives: for the Government to lead efforts to establish an active international regulatory framework for MASS and to work with industry to understand benefits, find use cases and develop proof of concepts for new technologies.

10. MARLab undertook a review of the regulatory landscape with regards to: i) enabling the safe testing of MASS technologies; and ii) promoting regulatory innovation in maritime technologies. MARLab concluded its work in September 2020, with responsibility for continuing the development of maritime autonomy passing to the Maritime Future Technologies team within MCA.[8] In addition, the Department for Transport (DfT) funded smart shipping research in partnership with Maritime Research and Innovation UK (MarRI-UK), delivered by London Economics, NLA International, Marine South East and glass.ai, that was published in November 2021. The findings of this research have been used to inform this legislative proposal and this IA.[9]

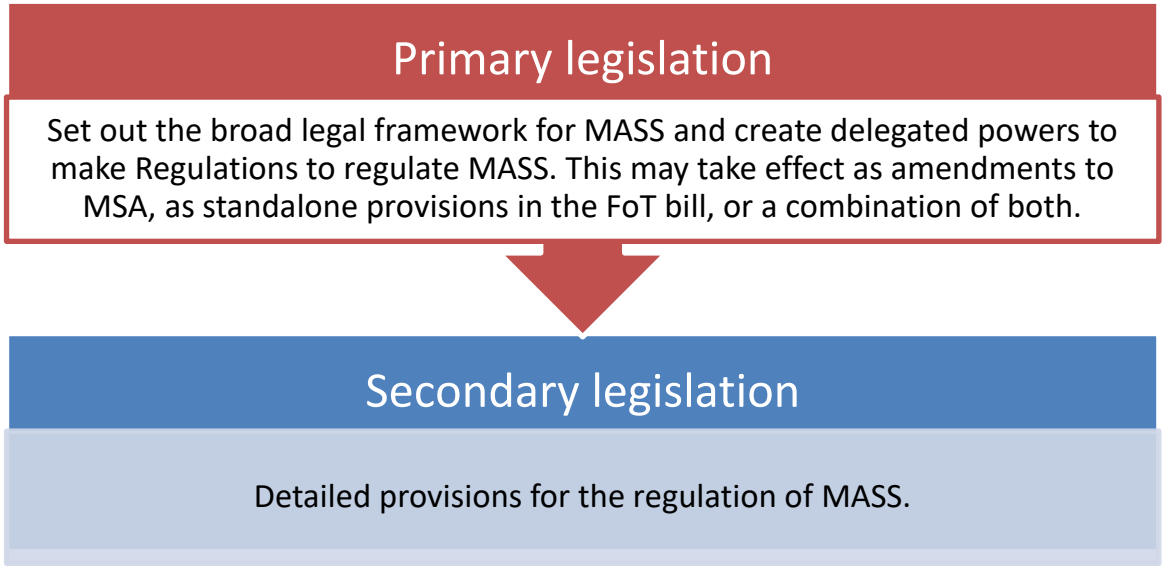
11. The MARLab review focused on smaller ships (under 24 metres) operating in the UK, because there is a regulatory cut off (the Workboat Code[10]) and all companies who had approached the MCA at that time had ships under 24m. In the last two years, the MCA and DfT have been approached by industry regarding four international trials and a number of domestic trials. Two projects include ships over 24m, and some involve new concepts such as fleet operation. As ships get larger and operate in new ways (remotely, or as a fleet) they present new policy and regulatory challenges that need to be addressed, in an expansion from MARLab's original scope.

12. MARLab identified a number of issues that would benefit from clarification in the Merchant Shipping Act 1995 (MSA) that ought to be addressed to facilitate and enable the operation of MASS (see Section 2). The recommendations from the MARLab report have formed the basis for the maritime autonomy and remote operations proposed changes to legislation.[8]

13. The scope of the legislative proposal will be wide; it would apply to all ships regardless of size, including very small craft which might not traditionally be considered as 'ships'. We will ensure that any change are aligned with other legislation, such as the Harbours Act 1964, the Aviation and Maritime Security Act 1990 (AMSA), regulations under the MSA, and international conventions (e.g. Safety of Life at Sea, International Regulations for Preventing Collisions at Sea etc.), including through the use of consequential amendments. It will apply to devolved administrations.

[7] HMG 'Maritime 2050: navigating the future', 24 January 2019, available at: https://www.gov.uk/government/publications/maritime-2050-navigating-the-future
[8] MARLab 'Maritime Autonomy Regulation Lab (MARLab) Report', 11 November 2020, available at: https://www.gov.uk/government/publications/maritime-autonomy-regulation-lab-marlab-report/maritime-autonomy-regulation-lab-marlab-report
[9] Smart Shipping Technology 25 November 2021, https://www.marri-uk.org/reports/smart-shipping-technology-report
[10] A Code of Practice for small workboats in commercial use to sea and all pilot boats, MCA, 5 February 2021, available at: https://www.gov.uk/government/publications/workboat-code

14. This proposed legislative approach sits alongside Government investment in maritime autonomy, and updates to the Workboat Code for vessels under 24 metres in length.[10] It is expected that this legislation could indirectly impact the MASS shipping industry, including shipping companies and seafarers, with more indirect impacts for the wider maritime sector and the UK and the environment. The details of secondary legislation will be determined at a later stage but are expected to cover specific segments or aspects of the MASS shipping market.



1.2 Problem under consideration

1.2.1 Opportunities

15. Before COVID-19, around 95% of goods imported and exported in the UK were moved by sea and a strong maritime industry is a strategic asset to the UK, particularly now we have left the EU, and are better placed to boost exports and influence around the world.[11] The sector employed 220,000 people in 2019 and was worth £17 billion gross value added (GVA) to the UK economy. [12] The structure of the maritime sector, with low margins and long asset life cycles, means that the sector can be slow to adopt new technologies, with potentially significant gains for countries/organisations able to identify and implement transformational technologies first. **The realisation of the majority of these impacts will not occur until secondary legislation is made to regulate MASS but they are noted to show the potential opportunities for the sector in the long term.**

16. Although, at present, the UK market for MASS is small, it is expected to grow as shipping technology develops both in the UK and abroad and have a huge impact on the shipping industry, as in many other sectors.[13] In 2018, several flagship projects were underway in Scandinavia and the Far East, and in the UK our smart shipping and MASS industries were developing at pace. For example, UK companies, such as L3 Harris, export their Maritime Autonomous Surface Ships (MASS) internationally,[14] and Essex-based Sea-Kit recently won the prestigious Shell X Prize (US$4 million global competition).[15]

[11] HMG 'Promoting the UK's world-class global maritime offer: Trade and Investment 5-year plan 2019', 2019, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/964144/maritime-5-year-plan-digital-a4-revised-feb-2021.pdf
[12] CEBR on behalf of Maritime UK 'State of the Maritime Nation 2019', 11 September 2019, available at: https://www.maritimeuk.org/media-centre/publications/state-maritime-nation-report-2019/
[13] Lloyd's Register 'Global Marine Technology Trends 2030 Autonomous Systems', August 2017, available at: https://www.lr.org/en/insights/global-marine-trends-2030/technology-trends/
[14] L3Harris, available at: https://www.l3harris.com/en-gb/united-kingdom?regional_redirect=en-gb
[15] Bloomberg 'England's Sea-Kit Leads Rivals in Race to Map Earth's Seabed', 20 October 2020, available at: https://www.bloomberg.com/news/articles/2020-10-20/england-s-sea-kit-wants-to-be-the-first-to-map-the-earth-s-entire-seabed

17. The global autonomous ships market size was estimated to be valued at US$88 billion in 2020[16], and is projected to reach US$150[17] billion by 2030. The global, wider ship technology market is estimated to grow by over 170% to US$278 billion by 2030[18] and the Government Office for Science predicts that the global 'ocean economy', as defined by the OECD including all maritime, fishing and offshore oil and gas, will double to US$3 trillion by 2030.[19]

18. The Government is encouraging the commercialisation of maritime technologies, through initiatives such as those announced in the Ten Point Plan for a Green Industrial Revolution[20], MARLab, Maritime Research UK (MarRI-UK)[21] and Innovation UK[22], with investments worth over £20 million.

19. When in operation, MASS has the potential to reduce operating costs in the shipping sector. A 2017 study estimated that the present value of the cost of owning a MASS is US$4.3 million lower than a manned ship over a 25-year period due to savings on fuel consumption, crew supplies and salaries, making it cheaper to transport people and goods.[23] Although this estimate likely varies depending on the size of the autonomous ship, the study highlights that the cost of owning an autonomous ship is less than a manned ship. This could also contribute to reducing shipping emissions such as where overall fuel consumption is reduced. The benefits have the ability to affect the supply-chain (e.g. upstream manufacturing and ancillary services), other sectors (e.g. from growth or knowledge spillovers) and end users of shipping (e.g. from higher quality services and/or lower prices).

20. Technology could reduce the need for certain jobs, replacing labour that is currently employed. For example, according to the Office for National Statistics, 27,000 jobs in the water transport sector are at risk of automation.[24] At the same time, technology also creates new types of employment, to which labour is better suited than capital i.e. more complex and less repeatable tasks.[25] Given that the running of automated ships would be shore-based, jobs created could also be safer given that on-sea work has higher than average accident and death rates[2627].The overall net impact on employment will depend on which of the two effects will dominate. Comprehensive evidence on which effect is stronger is currently limited. However, recent evidence on 28 industries from 18 Organisation for Economic Co-operation and Development countries since 1970 suggests that automation has not been employment-displacing, although it has reduced labour's share in value added to economic output.[28]

21. Indirect and induced employment is another potential benefit of investing in smart shipping technology. In 2017, 177,000 jobs were supported by the Marine Scientific and Engineering industry. Of those 177,000 jobs, 61,000 were through indirect employment (in the supply chain) and 34,000 jobs were induced employment (jobs generated in the wider economy due to growth by direct and indirect employees).[29]

[16] Allied Market Research 'Autonomous Ships Market', December 2020, available at: https://www.alliedmarketresearch.com/autonomous-ships-market
[17] DfT estimate based on Allied Market Research 'Autonomous Ships Market', December 2020 (https://www.alliedmarketresearch.com/autonomous-ships-market) and IFM Education and Consultany Services 'UK Marine Industries Technology Roadmap', 2015 (https://www.ifm.eng.cam.ac.uk/uploads/Resources/Reports/UK-Marine-Industries-Technology-Roadmap-2015.pdf)
[18] Chubb, N., Zangrando, L. on behalf of Inmarsat 'Trade 2.0: How startups are driving the next generation of maritime trade', September 2019, available at: https://www.inmarsat.com/en/insights/maritime/2019/trade-report.html
[19] HMG 'Foresight Future of the Sea', 21 March 2018, available at: https://www.gov.uk/government/publications/future-of-the-sea--2
[20] HMG 'Ten Point Plan for a Green Industrial Revolution', 18 November 2020. Available at: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution
[21] MarRI-UK 'Technology and Innovation in UK Maritime Call', 2020. Available at: https://www.marri-uk.org/funding-opportunities/technology-and-innovation-in-uk-maritime-call
[22] UK Research and Innovation 'Search results for 'maritime'', accessed 9 July 2021. Available at: https://www.ukri.org/?s=maritime
[23] Kretschmann, L., Burmeister, H. and Jahn, C. 'Analysing the economic benefit of unmanned autonomous ships: An exploratory cost-comparison between an autonomous and a conventional bulk carrier' 2017, *Research in Transportation Business & Management*, 25.10.1016/j.rtbm.2017.06.002.
[24] ONS 'Which occupations are at highest risk of being autonomated', 25 March 2019, available at: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/whichoccupationsareathighestriskofbeingautomated/2019-03-25
[25] UK Commission for Employment and Skills 'The Future of Work Jobs and Skills In 2030', 2020, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/303335/the_future_of_work_key_findings_edit.pdf.
[26] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/992017/MAIBAnnualReport2020.pdf
[27] https://www.hse.gov.uk/statistics/pdf/fatalinjuries.pdf
[28] Autor, D. and Salomons, A. 'Is Automation Labor-Displacing?', 2018, Productivity Growth, Employment, and the Labor Share. BPEA Conference Drafts
[29] CEBR 'The economic contribution of the UK Marine Engineering and Scientific industry', 2019, available at: https://www.maritimeuk.org/cebr-economic-impact-studies-2019/

22. In addition, new shipping technology could increase safety, health and security standards; the MCA (through the MAIB) has recognised that a consistently occurring factor throughout almost all accidents, incidents and errors is the human element.[30] Maritime workers face a far higher risk of fatality than the average worker.[31] Between 2011 and 2018, 65.8% of EU Member State flagged shipping accidents were attributed to human action with shipboard operation being the main contributor.[32] In 2018, 1,227 accidents involving 1,339 ships were reported to UK ships or in UK coastal waters.[33] Seafarers spend between four and six months at sea on average, leaving their family and friends onshore while they work 10 to 12-hour days.[34] MASS could reduce the need for humans to do dangerous jobs, reduce the risk of human error and the negative social impact of shipping by reducing the number of personnel at sea.[35] Again, this will be factored into the assessment of secondary legislation.

1.2.2 Uncertainty

23. However, a lack of certainty in the regulation of MASS is potentially impeding investment and innovation. In addition, changes to international law to accommodate MASS, (agreed through the IMO) are unlikely to be completed before 2028, based on IMO's Maritime Safety Committee 103rd session in May 2021.[36] Ratification would then take up to a further two years. From an industry perspective, gaps, and lack of consistency in the regulatory framework are slowing innovation. Many industry stakeholders are asking for interim regulation and guidance to allow the on-water testing and even commercial operation of MASS in UK waters, as well as access to data to support their developments. From a regulator's perspective HMG's approach to MASS has been *ad-hoc*.[37]

24. Existing UK legislation is premised on ships being manned, setting out roles and responsibilities for the people and organisations involved in shipping operations. Commercial ships are regulated through the MSA, and regulations explicitly or implicitly assume that a ship has crew onboard to operate it (and that a pilot, where used, will also always be on board). MASS challenges many of these assumptions, meaning that MASS might not in all respects be able to comply with the required legislation.

25. As mentioned before, to date, autonomous shipping in the UK has been addressed through exemptions, exceptions, and equivalences to the existing regulations. This is only UK exemptions and therefore may not be accepted internationally which limits the scope of a ship. Every time a trial of MASS is organised, the operator must prove the safety case and obtain exemptions from national and international maritime safety requirements for each voyage (e.g. Load Line, Safety of Life at Sea, Convention on the International Regulations for Preventing Collisions at Sea and Safe Manning). In addition, trials are normally conducted using a manned escort ship, or a Notice to Mariners which warns sea users of live MASS trials. Classification Societies and Insurers also need to make special arrangements to assure themselves that the relevant risks are covered. The larger the MASS, and the higher the level of autonomy proposed, the more complex this burden becomes because, the more Regulations must be accommodated through "equivalence" or "exemption".[38] Where exemptions are used by default, this infers that a tailored approach is required.

[30] MCA 'Human Element Guidance – Part 2 The Deadly Dozen – 12 Significant People Factors in Maritime Safety', 2016, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/837844/MGN_520_Final.pdf
[31] Roberts, S., Nielsen, D., Kotowski, A. and Jaremin, B., 2014. Fatal accidents and injuries among merchant seafarers worldwide. Occupational Medicine, 64(4), pp.259-266.
[32] The data includes ships flying a flag of an EU Member State, accidents in territorial sea and internal waters of Member States or wherever there are interests of Member States involved, as reported in EMCIP. [EMSA (2020). Annual Overview Of Marine Casualties And Incidents 2019. Available at: http://www.emsa.europa.eu/accident-investigation-publications/annual-overview.html
[33] Marine Accident Investigation Branch 'Annual Report 2018', 2019, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/817106/2019-AnnualReport2018.pdf.
[34] IMO 'FAQ On Crew Changes And Repatriation Of Seafarers', 2020, available at: http://www.imo.org/en/MediaCentre/HotTopics/Pages/FAQ-on-crew-changes-and-repatriation-of-seafarers.aspx
[35] de Vos et al. 'The Impact of Autonomous Ships on Safety at Sea – A Statistical Analysis', Reliability Engineering & System Safety, Volume 210, 2021, 107558, ISSN 0951-8320, https://doi.org/10.1016/j.ress.2021.107558.
[36] IMO MSC 'Autonomous ships: regulatory scoping exercise completed', May 2021, available at: https://www.imo.org/en/MediaCentre/PressBriefings/pages/MASSRSE2021.aspx
[37] MARLab workshops, February 2018
[38] Evidence from interviews in smart shipping research funded by DFT, 2020 (unpublished)

26. While this approach has enabled MASS trials on a limited scale, it is expected to become increasingly unsustainable as the market grows, as levels of autonomy increase, and more complex regulatory issues need to be addressed. This could represent a potential barrier to growth and discourage industry from testing MASS in UK waters. Specific areas for consideration include the regulation of the autonomous ships' control location, known as the Remote Operation Centre (ROC). The ROC is also where the personnel employed to operate autonomous ships operate and where Port, Flag and Coastal state obligations, safety, security and environmental considerations, and liabilities and insurance will likely reside.

1.2.3 Risks

27. Without establishing UK legislation for autonomous shipping and remote operations, there is a potential missed opportunity to use our knowledge and experience to shape and influence standards across the globe as other countries and multilateral organisations, such as the IMO, set their own standards. There is a risk the UK falls behind global market leaders such as Norway, Denmark, Singapore, and France, and is unable to capture some or all of the benefits as MASS companies may choose to domicile outside the UK. Belgium, Russia, and Finland are also leading the development of their own MASS legislation.[8]

28. In addition, existing international conventions were created under the assumption that a crew would be onboard, so conventions may need to be updated to reflect the presence of autonomous ships. Without clearly defined roles and responsibilities, there is an increasing risk of accidents as we transition to a world in which more autonomous and/or unmanned ships operate alongside each other, manned ships, and other hazards. From 2012 to 2014, 31% of marine accidents were associated with technology in the UK.[39] In the aviation sector, small unmanned aircraft (drones) were involved in around 125 'Airprox' incidents in 2019 (there was a dip in 2020 and 2021 due to reduced flight traffic).[40] For example, Gatwick Airport had to be closed for 3 days which affected over 1000 flights and 150,000 passengers[41], and there has been a number of police reports about drone incursions at prisons and critical national infrastructure.[42]

29. Ethical considerations will also need to be addressed in the development of autonomous ships. When autonomous ships have to decide and all options have a bad outcome, it is important to understand how the systems decide on which option to choose. Government, industry, and the wider public should be involved in agreeing how autonomous ships are programmed to make decisions, to minimise risk to uninvolved third parties and ensure liabilities are appropriately distributed between stakeholders.

30. Underwater vehicles have been operating by autonomous means for decades, but these operations have been focused primarily on defence and marine research and there has been limited impact by these vehicles on wider maritime users. Powers are needed as autonomous submersible apparatus, which do not carry people so do not support human life, are already being developed in the UK. They will eventually enter port areas and operate in more highly populated areas, so there is a need to close this gap.

[39] Bielic, T. et al. 'Preventing marine accidents caused by technology-induced human error', 2017, Pomorstvo. 31. 33-37
[40] An Airprox is a situation in which, in the opinion of a pilot or air traffic services personnel, the distance between aircraft as well as their relative positions and speed have been such that the safety of the aircraft involved may have been compromised. UK Airprox Board 'Monthly Airprox Reviews', 2019, available at: https://www.airproxboard.org.uk/Reports-and-analysis/Monthly-summaries/Monthly-Airprox-reviews/
[41] The Telegraph (2018) https://www.telegraph.co.uk/news/2018/12/22/gatwick-airport-drone-chaos-man-woman-arrested-passengers-brace/
[42] BBC News 'Gatwick drone policing costs 'shocking'', 25 March 2019, available at: https://www.bbc.co.uk/news/uk-england-47696499

1.2.4 Conclusions

31. The aim of this proposal is to lead the way internationally by introducing domestic legislation that will allow the safe operation of MASS and encourage the growth of autonomy as an innovative step in our maritime technology industry.

32. Amendments are needed to enable MASS to operate on the UK Flag and within UK waters, and to ensure an equivalent level of oversight is given to MASS and non-MASS. It is proposed to achieve this by extending and amending the current maritime legal framework to take powers in primary legislation to regulate MASS i.e. by bringing the operation of MASS ships in line with the regulations that apply to existing non-MASS ships. The details of MASS regulation will be developed later through secondary legislation following further consultation.

33. The broad definition of maritime autonomy coupled with the fast pace of technology development will require sufficiently flexible powers to allow the regulation of all degrees and levels of maritime autonomy, for both iterative and step-changes in technological developments. These developments must be compatible with the framework of international conventions and provisions which govern non-MASS and must not derive in unintended consequences e.g. the master of a MASS must not be considered a seafarer.

34. To ensure the continued safe regulation of the maritime space and a consistent approach to the use of autonomous and remotely operated systems above and below the surface, we propose to define autonomous submersibles and introduce powers to regulate autonomous submersibles and supporting apparatus in a manner consistent with their current regulation.

1.3 Rationale for intervention

35. Regulation can both be a driver of, and a barrier to, adoption. Government and regulators should therefore seek to create regulatory certainty while ensuring that they develop regulation that is conducive to innovation without creating additional barriers. At present, MASS is a relatively small market in the UK, with a handful of companies in R&D phases. These are able to operate legally by relying on exemptions and equivalences to the existing legislation. Without which, MASS are unable to operate within UK waters.

36. The lack of regulation reflects the current situation internationally. The IMO currently has no regulatory measures for autonomous vessels and is unlikely to develop regulation before 2028. Some states do not allow the operation of MASS in their waters. Consequently, if someone wished to operate a MASS to travel from one country to another, this would require national and international maritime safety requirements for each country (e.g. Load Line, Safety of Life at Sea, Convention on the International Regulations for Preventing Collisions at Sea and Safe Manning), which is extremely time consuming and may be distorting the market.

37. Currently, the operator of a MASS must prove the safety case and obtain exemptions from maritime safety requirements to operate. The larger the MASS, and the higher the level of autonomy proposed, the more complex this burden becomes because, the more Regulations must be accommodated through “equivalence” or “exemption".[43] Where exemptions are used by default, this infers that a tailored approach is required.

[43] Evidence from interviews in smart shipping research funded by DFT, 2020 (unpublished)

38. This approach is expected to increasingly represent a barrier to innovation and growth as the market develops, and therefore a potential government failure. These can be considered as follows:

39. **Uncertainty** – The long lead time and uncertainty around success of technology development can dampen the incentives to invest in new technology.[44] In addition, recent interviews found a lack of joined-up thinking and working to encourage the development and adoption of smart shipping technologies in the UK.[9] These upfront development costs and uncertainty can lead market players to delay investment or under-invest, potentially hoping to benefit from the others' investment. The UK has typically seen lower levels of industry investment in R&D compared to other developed economies, something that the Government's announcement to increase R&D spending to £22 billion each year attempts to address.[45] The proposed powers to regulate MASS, along with government investment, could signal to the industry that the Government is willing to bridge the gap between action today and positive outcomes in the future. It also provides certainty to industry that MASS will be able to operate in the UK legally and safely.

40. By reducing uncertainty, industry are more likely to invest in the sector. The increase in certainty means investors face less risk when investing in the future of MASS and are more likely to recover any sunk costs associated with initial investment. In turn, investors will be more likely to invest in the market and encouraged to innovate if the Government provides certainty.

41. This has the potential to result in further positive spillover benefits or unexpected outcomes that are not captured by the initial developers and/or investors.[46] Industry investment may result in knowledge being transmitted by the movement of labour between sectors; knowledge exchange between workers via conferences, publications and informal exchanges at meetings or networking events;[47] cross-sector collaborations and diversification strategies for suppliers of technology.[48] In the space sector, research by London Economics (for the UK Space Agency) found that private benefits of R&D to innovators (i.e. ripple effects) appear to be approximately £3-4 in impact for each £1 of public expenditure, with the spillover impacts to the broader public being significantly larger.[49] This can mean that developers and/or investors underinvest in R&D projects.[50] This problem applies to maritime autonomy given the emerging nature of these technologies. However, ensuring there are powers to regulate and enable the sector are needed to initiate these benefits, as the proposed powers to regulate MASS, could signal to the industry that the Government recognises the positive spillovers that these new technologies will bring to the UK.

42. **Externalities** – Private sector investment in and operation of MASS technology may fail fully to take account of the impact on third parties, i.e. may cause positive or negative externalities. Government legislation can better account for these externalities and spillover benefits, unlocking (or dissuading) investment and activities which the private sector may not support (or may support excessively) without corrective incentives. Clear legislation that enables secondary legislation and guidance could ensure opportunities and risks are properly managed and mitigated. For example, accidents between autonomous ships and other vessels, people or objects could be reduced.

[44] House of Commons 'Bridging the valley of death: improving the commercialisation of research', 13 March 2013, available at: https://publications.parliament.uk/pa/cm201213/cmselect/cmsctech/348/348.pdf
[45] HMG 'New plans to put uk a front of global innovation race', 22 July 2021, available at: https://www.gov.uk/government/news/new-plans-to-put-uk-at-front-of-global-innovation-race
[46] It should be noted that the level of transmission depends on the transmission mechanism. For example, investment in proprietary R&D that is kept secret will yield lower spillover impacts than R&D that is subsequently shared with others, e.g. via publication.
[47] UK Space 'Spillovers In the Space Sector', 2019, available at: https://www.ukspace.org/wp-content/uploads/2019/04/Spillovers-in-the-space-sector_March2019.pdf
[48] Nessie project 'Cross-Sector Knowledge Transfer: North Sea Solutions For Innovation In Corrosion For Energy', 2018, available at: http://www.nessieproject.com/library/reports-and-researches/nessie-report-cross-sector-knowledge-transfer
[49] London Economics 'Spillovers in the space sector', 2018, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/788725/LE-UKSA-Spillovers_in_the_space_sector-FINAL_FOR_PUBLICATION_050319.pdf
[50] Aghion, P. and Jaravel, X. 'Knowledge Spillovers, Innovation and Growth', 2015, The Economic Journal, 125(583), pp.533–573.

43. **Moral hazard** – Creating legislation without clear roles and responsibilities, a robust monitoring and enforcement regime, and adequate penalties, runs the risk that the regulatory regime would be, or would be perceived to be, impotent. In addition, licence-holders may take unnecessary risks if they believe Government will cover the costs of accidents. This is a situation known as "moral hazard": because there is low or no risk of their being held responsible, and because they will not bear all the costs of non-compliance or offences, licence-holders might not take (costly) action to reduce risks. A monitoring regime and appropriate enforcement, liability and insurance measures will require organisations to comply with regulations and reduce risks to socially acceptable levels.

44. Thus, government intervention is needed to establish high level powers to develop a comprehensive regulatory framework and guidance to further enable a broad range of potential MASS from and into the UK. Industry welcomes this move; it will give existing and potential MASS manufacturers and operators the legal certainty they need to enter the UK market. Only government, through Parliament, can create the powers and subsequent detailed regulations and guidance.

1.4 Policy objectives

45. Maritime 2050 and the Technology and the Innovation in UK Maritime (TIUK) Route Map set out HMG's ambition for the future of shipping:[7]

> "*The UK is determined to be world-leading in the design, manufacture, uptake, and use of smart shipping technologies. To achieve this, we will develop a UK legislative framework for autonomous vessels and lead efforts to establish an international regulatory framework. We will support industry in developing and testing new technologies by funding flagship projects and learning from other sectors like the automotive industry. The UK will be a vibrant hub of research and development. Shipping companies will benefit from a highly competitive register for technologically advanced and autonomous vessels."*

46. In addition, proposals by the Taskforce for Innovation, Growth and Regulatory Reform included one on maritime:[51]

> *"Proposal 10.1 Create a world-leading regulatory framework for autonomous vehicle and other disruptive mobility solutions: Modernise maritime law to support safe testing and deployment for Marine Autonomous Surface Ships"*

47. Changes to legislation to enable MASS supports the delivery of Government and Departmental priorities, including the development of new transport technologies that benefit transport users, growing and levelling up coastal communities, reducing environmental impacts and increasing the UK's global impacts. The primary objective of this policy is to lead the development of legislation to support and enable the introduction of MASS technologies, whilst maintaining health, safety, security, and environmental standards and fairly distributing liabilities (legal responsibilities) between stakeholders. From the problem under consideration, these objectives can be summarised as follows:

    a. Give the UK the powers to ensure the new and growing MASS sector is appropriately regulated and supported

    b. Ensure there is a cohesive and consistent approach between MASS and non-MASS regulation.

[51] HMG 'Taskforce on Innovation, Growth and Regulatory Reform independent report', 16 June 2021, available at: https://www.gov.uk/government/publications/taskforce-on-innovation-growth-and-regulatory-reform-independent-report

c. Ensure that all ships in the UK fleet and operating in UK waters are built, surveyed, operated, and inspected to ensure they do not cause harm to other maritime users, the environment, human health, property, or resources

d. Allow the UK to provide an active and informed position in international discussions that will shape the regulation of MASS internationally and the development of an IMO instrument

e. Prepare the UK domestic law framework for future changes in international law

48. The specific outcomes that are intended to flow from these objectives are shown in Figure 1 below:

Figure 1 Intended outcomes for policy objectives

Outcome
Maintain/improve regulatory standards, including safety, security, and environment
Reduce regulatory uncertainty for MASS industry
Develop efficient MASS regulation
Encourage investment in MASS
Facilitate innovation in the maritime sector and associated knowledge spill overs
Encourage growth in the maritime sector and wider economy
Enable creation and diversification of jobs in the maritime sector
Facilitate improved welfare and safety for the maritime sector
Lead the development of MASS internationally
Enable the UK to meet future autonomy related IMO obligations
Facilitate the fair and equitable distribution of benefits, costs, and risks among stakeholders

1.5 Options considered

49. The options outlined here cover the legislative options only (highlighted green, Figure 2). There are other interventions that are happening in parallel, including government investment and R&D, to meet the policy objectives set out in Maritime 2050 and TIUK. These other options are not explicitly appraised in this IA but should be considered as part of the wider maritime autonomy context.

Figure 2 Intervention options for smart shipping

Intervention options	
Funding	Providing R&D funding and de-risking innovation investments
Collaboration	Facilitating collaborations and partnerships
Skills development	Supporting education and skills development
Policy & regulation	Policy and regulatory frameworks that foster innovation

50. The purpose of the maritime autonomy aspects of the proposed legislative changes (taking powers) is providing certainty and increasing support for MASS technologies as the market develops. Therefore, banning MASS was not considered as an option since it does not meet the policy objectives.

51. Through the MARLab and MCA Maritime Future Technologies team review, Government and industry have discussed the implications of regulating different types of operations (e.g. pleasure vs. commercial) and levels of autonomy (e.g. remotely navigated vs fully autonomous). The MCA is already updating *The Workboat Code* to include provision for the safe operation of remotely operated unmanned surface vessels under 24 metres, but this excludes fully autonomous vessels, vessels above 24 metres in length and underwater apparatus.[52]

52. The proposed legislation would apply to all ships and craft regardless of size, including very small craft which might not traditionally be considered as 'ships'. We will be ensuring that any changes are aligned with other relevant maritime legislation (which may mean consequential amendments are made to other legislation), such as the Harbours Act 1964, the Pilotage Act 1987, the Aviation and Maritime Security Act 1990 (AMSA), regulations under the MSA, and international conventions (*e.g.* Safety of Life at Sea, International Regulations for Preventing Collisions at Sea etc.). It will apply to devolved administrations.

53. This proposed legislative approach sits alongside Government investment in maritime autonomy, and updates to the Workboat Code for vessels under 24 metres in length.[10] It is expected directly to affect the MASS industry, including shipping companies and seafarers, with more indirect impacts for wider maritime sector and the UK. The details of any secondary legislation will be determined at a later stage but are expected to cover specific segments or aspects of the MASS market.

54. We are not proposing to designate test areas for maritime autonomy trials. As long as appropriate certification through the current exemption processes can be obtained there are methods by which MASS can be trialled in all UK waters. Allowing the trialling of MASS across the UK provides a wide variety of environments for them to be tested, including in real-life scenarios. We consider that the powers proposed in the preferred option for legislative change would render designated test areas unnecessary because the powers would create a safe, secure and environmentally-sound regulatory framework for the development of these ships.

55. In addition, we consider that primary legislation in the following areas will not require amendment to allow the operation of autonomous ships in UK waters:

    a. Search and Rescue (SAR) obligations on ships – covered by the IMO's International Convention for the Safety of Life at Sea (SOLAS) and SAR Convention.

    b. Wreck and salvage requirements – wreck includes jetsam, flotsam, lagan, and derelict found in or on the shores of the sea or any tidal water, and salvage includes all expenses, properly incurred by the salvor in the performance of the salvage services.

    c. Port State Control within domestic legislation - the MCA is responsible for checking that ships visiting UK ports and anchorages meet UK and international safety rules.

    d. The options below reflect the current structure of UK and international shipping legislation and are not intended to provide granular, prescriptive regulations at this stage given the emerging nature of maritime autonomy in the UK and abroad. The preferred option is designed to provide the UK with powers to regulate MASS as

[52] HMG 'Workboat Code', 5 February 2021, available at: https://www.gov.uk/government/publications/workboat-code

the market develops *via* secondary legislation under the proposed changes to primary legislation. The proposed legislation would apply to all ships and craft regardless of size, including very small craft which might not traditionally be considered as 'ships. The details of any secondary legislation will be determined at a later stage but are expected to cover specific segments or aspects of the MASS market.

1.5.1 Option 0 – Do minimum (baseline)

56. The MCA would continue to use the exemption that is available through the Merchant Shipping (Load Line) Regulations 1998, to allow autonomous shipping to continue to operate within UK waters and under the UK Flag. MASS would continue to be obliged to comply with all other regulations. The Workboat Code would be updated for remotely operated unmanned vessels under 24 metres in length, but their regulation would be limited to the current powers of the MSA and related primary legislation.

57. The practical benefits of retaining the existing process are that: (i) industry are aware of the requirements; (ii) the MCA can continue to use a safety-case approach to ensure these ships are thoroughly assessed to support their safe operation within UK waters; and, (iii) this approach can be taken without amending primary legislation.

58. There are a number of risks involved in continuing with the current approach: (i) reputationally, there is a perception that the industry is being held back by existing legislation and Government is not doing enough to support emerging technologies; (ii) the Load Line Exemption Certificate was not originally designed for the regulation of MASS and it would be preferable to have a bespoke regime for this; (iii) gaps in powers (for example around training and Remote Operation Centres) would remain, which could limit the safe operation of these ships; (iv) exemptions and equivalences may not be available or suitable as industry develops larger and more complex MASS which could limit operations in UK waters; and, (v) the UK domestic legal framework would not be ready for future international discussions and changes in international law.

59. In addition, there is a reputational risk, where in the absence of UK legislation on MASS, the UK may lose its reputation as a leader in MASS. This could also potentially reduce the UK's effectiveness to direct the development of new instruments and the practical implementation of the safety requirements of MASS as part of discussions at the IMO.

60. This option does not support the Ministerial priorities and Government position to be a leader in maritime autonomy and in supporting HMG's levelling up agenda, as it does not consider the full range of MASS or build on existing legislation to improve the regulatory process for MASS, which may limit the benefits and increase the risks associated with the MASS in the UK.

1.5.2 Option 1 – Wait for IMO to develop an instrument on autonomous shipping and remote operations

61. This option is the same as option 0 (do minimum) until a new regulatory instrument is agreed at the IMO. The most recent discussion at IMO indicated that following a Regulatory Scoping Exercise further work is needed to identify how to regulate in order to allow the safe operation of MASS internationally.[53] Based on current workloads, IMO has signalled that a new instrument could be developed but not before 2028, which would need a further two years to be ratified into UK law.

[53] IMO Maritime Safety Committee 'Outcome of the regulatory scoping exercise for the use of maritime autonomous surface ships (MASS)', 3 June 2021, available at: https://wwwcdn.imo.org/localresources/en/MediaCentre/HotTopics/Documents/MSC.1-Circ.1638%20-%20Outcome%20Of%20The%20Regulatory%20Scoping%20ExerciseFor%20The%20Use%20Of%20Maritime%20Autonomous%20Surface%20Ships...%20(Secretariat).pdf

62. The practical benefits of this option are that: (i) it would guarantee consistency between the domestic and international regulatory framework for the safe operation of autonomous ships; (ii) industry are aware of the current process to get a MASS on the water in the UK; and, (iii) the MCA can continue to use a safety-case approach to ensure these ships are thoroughly assessed to support their safe operation within UK waters. The risks with this approach are the same as for the baseline option above.

63. This option does not support the Ministerial priorities and Government position to be a leader in maritime autonomy given the likely timeframes for a new IMO regulatory instrument, which may mean higher costs and risks and lower benefits in the interim period, and delayed future benefits associated with MASS in the UK.

1.5.3 *Option 2 – Legislate for maritime autonomous surface ships of all sizes, autonomous/unmanned submersible apparatus and remote operations* in advance of the IMO *(preferred)*

64. This is the preferred option. The UK would make new primary legislation to provide for the regulation of all MASS regardless of size or degree of autonomous operation. These provisions would also cover submersible apparatus, to ensure there is a consistent application of autonomy within the maritime domain in the future. This approach meets the policy objectives sets out above.

65. Our aim is to allow flexibility to develop appropriate definitions, or allow for the amendment of existing definitions, in secondary legislation as the MASS industry and international law evolve. Further details of such requirements would be developed in consultation with industry and operators.

66. Our proposal includes four key elements:

    a. To identify and determine key definitions and roles for the operation of remotely operated and autonomous ships.

    b. Ensuring that the MCA can regulate autonomous ships of any size, including craft that might not traditionally be considered as ‘ships’.

    c. To grant the MCA new powers to develop Regulations for Remote Operation Centres (ROCs) to ensure the safe operation and management of remotely operated or autonomous ships.

    d. Ensuring that the MCA and DfT and ports and harbours have sufficient powers to regulate health and safety, security, and the environmental aspects of autonomous ships and ROCs.

67. We may need to enable the Secretary of State to give the MCA powers to define and clarify terms and roles for the operation of autonomous ships, in addition to those defined in the primary legislation, as set out below. This would allow flexibility to develop appropriate definitions in secondary legislation as the maritime autonomy industry evolves. There is no current consensus on what these terms and roles should be, but these powers should provide the flexibility to change the definitions as experience of maritime autonomy develops and the international legal framework evolves.

68. To ensure parity across the industry and ensure safety, security and the protection of the marine environment we are seeking to ensure that the MCA has the powers to apply and perform its current statutory responsibilities (survey, inspection, certification, and enforcement) on UK-flagged autonomous ships, their operations in UK waters, and their associated ROCs.

69. The primary risk in developing the domestic legal framework now is that the UK could diverge from international standards as they develop in the future, for example when defining terms and definitions of autonomous ships. However, the UK should be able to take its experience on the regulation of autonomous ships to the international discussions to shape that discussion to reduce this risk.

70. This option is the preferred choice. It supports the Ministerial priorities and Government position to be a leader in maritime autonomy, by enabling HMG to support innovation, growth and jobs in the UK maritime sector whilst managing the possible risks and adverse or unequitable outcomes.

Definitions and responsibilities

71. We propose the following key terms be contained in primary legislation (except note that term (v) is for the purpose of this document[54] and could potentially be defined in secondary legislation)[55]:

    a. ***"Maritime Autonomous Surface Ships" or "MASS****" includes every description of vessel or craft used in navigation that can for any part of its voyage, fully or in part navigate or operate autonomously or through remote operations.* We propose that this definition of MASS would apply to all ships and craft regardless of size including very small craft which might not be considered to be 'ships'.

    b. *"**Remote operations**" means controlling the functioning of an operation on a MASS from a different location from that MASS.*

    c. *"**MASS master**" includes a person (except a pilot) having command or charge of a MASS".*

    *d. "**Remote Operator**" includes every person, including a MASS master, who is employed or engaged in any capacity to undertake remote operations of a MASS.*

    *e. "**Remote Operations Centre" or "ROC"** – is a location from which a MASS may be operated, which is not situated on board the vessel.*

72. A variety of terms is used across industry to describe MASS. Having considered terms used by industry, other countries, and developments at the International Maritime Organisation (IMO), we propose that this definition of MASS would apply to all ships and craft regardless of size including very small craft which might not be considered to be 'ships' under current legislation. The proposed changes to legislation will not provide definitions for degrees or types of autonomy, but for clarity, the following are included within the scope of the legislation:

    a. Remotely operated ships that have no persons on board;

[54] These definitions reflect the latest information but are subject to change following further legal review and work with the Office of Parliamentary Counsel

b. Remotely operated ships that may have persons onboard (e.g. crew, personnel and/or passengers); and

c. Ships operating fully autonomously (currently no distinction as to whether persons are on board or not).

73. To ensure the continued safe regulation of the maritime space and a consistent approach to the use of autonomous and remotely operated systems we propose to introduce powers to regulate autonomous/unmanned submersible apparatus in a manner consistent with manned submersible apparatus to be exercised at a future date through secondary legislation when these concepts mature. In current legislation the Master performs a key role and holds significant responsibilities in regard to the vessel they are onboard, having overall responsibility for the vessel, crew, cargo, passengers, and regulatory compliance. With the growth and adoption of MASS we propose that a similar arrangement is mirrored in the new legislation for the person having command of a MASS (a MASS Master). The proposed definition is based on the following principles:

    a. A Master does not need to be onboard a MASS;

    b. the definition of Masters should focus on their roles and responsibilities, removing any reference to their physical location in relation to a vessel, or the characteristics of the vessel (e.g. manned or unmanned). The legislation would need to ensure, subject to extraterritoriality limitations, that all responsibilities are enforceable against a Master not on board a vessel;

    c. The definition must not change the responsibilities the Master has in respect of conventional ships.

74. We also propose that there should be an entity or person, that is based or registered in the UK, who is accountable and responsible for designated aspects of a MASS at all times, including in the event of an emergency or accident, should enforcement action not be able to be taken against a MASS Master or if there is found to be corporate negligence.

75. We also propose that Remote Operator be defined in primary legislation, but the principles and details of certification and training requirements for a Remote Operator including hours of rest for watchkeeping, will be developed in secondary legislation. Current powers allow the MCA to ensure ships are safely manned and we need to ensure this is applicable to MASS as well. MASS may be manned remotely with ships being operated by a person called a Remote Operator.

76. We also propose that additional powers are needed to ensure that safe manning considerations can be applied to MASS, including from the ROCs from which these ships are remotely operated. The regulation of ROCs is not straightforward under the MSA. The proposed changes to legislation would provide the MCA with these powers, including powers to ensure that safe manning principles can be applied to ships, which are operated remotely, or autonomous. The ROC is a location from which a MASS may be operated, which is not on board the vessel. The details of the requirements for ROCs will be developed in secondary legislation.

Ports and Harbours

77. As with other legislation, including the MSA, we would use any changes to legislation to ensure that definitions in harbours legislation (both general and local Acts) are broad enough to cover MASS, for example the definitions of 'ship' and 'master'. The term "MASS Master" may also need to be defined in harbours legislation. However, offences enforceable against a Master as currently defined will in principle be enforceable against a MASS Master not on board a vessel, subject to the extraterritorial efficacy of sanctions.

78. Although existing pilotage provisions can largely be retained, definitions and measures may need to be widened to ensure for the possibility of remote pilotage or pilotage undertaken by software potentially without direct human supervision. This may affect human pilot employment in the future, but that may be offset by opportunities in ROCs.

79. Otherwise, we do not consider that new powers in harbours legislation are required to enable harbours to regulate MASS operations within their jurisdictions.

Marine equipment

80. The overall system for type approval of marine equipment is believed to be appropriate for MASS and ROCs and we propose to apply it to them. We will ensure that the MCA has the necessary powers to regulate equipment fitted to MASS and ROCs relevant to safety, security and pollution prevention. It is acknowledged that the equipment that is currently covered by the 2016 Regulations under the MSA and the standards which are applied may need to be amended to include new types of equipment. In particular, the regulation and type approval of software systems/algorithms may need to be considered independently of the (variety of) hardware they may ultimately be used with.

Security

81. Maritime security is currently governed by a range of different legislative instruments including international conventions such as SOLAS and the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation (SUA), primary legislation such as the Aviation and Maritime Security Act 1990 (AMSA 1990) and secondary legislation, including the Port Security Regulations 2009. We propose that certain changes may be necessary to the legislative framework governing maritime security:

    a. To fix any 'inoperabilities' in the International Ship and Port Facility Code and associated regulations when applied to MASS/ROC;
    b. To make extra security regulations for MASS/ROC where there are new security vulnerabilities they present (including cyber);
    c. To ensure existing UK legislation is amended to cover MASS/ROCs (including powers, offences and definitions); and
    d. To implement new international law requirements on MASS/ROC and to amend existing UK regulations in line with these.

Liabilities and insurance

82. Existing international conventions developed under the auspices of the IMO govern liability, compensation, and compulsory insurance requirements for most shipowners. These conventions cover such things as oil pollution damage caused by ships; damage suffered by passengers on seagoing ships (including death and personal injury claims); and wreck removal. Specific provision is also made to uphold a shipowner's right to limit its liability. At present, for insurance purposes, the thirteen Protection & Indemnity (P&I) Clubs which comprise the International Group (IGP&I) between them provide marine liability cover for approximately 90% of the world's ocean-going tonnage.

83. The IMO Legal Committee, which primarily deals with liability and compensation issues related to the operation of ships, including damage, pollution, passenger claims and wreck removal, met in July 2021 and concluded that, in general, MASS can be accommodated within the existing regulatory framework of the international conventions under the purview of the Legal Committee.

1.5.4 Alternative Options

84. This regulation is being undertaken alongside other inventions (that are not assessed in this Impact Assessment), which are set out in the table below. These wider interventions represent alternative options of supporting the sector without utilising primary powers.

Figure 2 Intervention options for smart shipping

Intervention options	
Funding	Providing R&D funding and de-risking innovation investments
Collaboration	Facilitating collaborations and partnerships
Skills development	Supporting education and skills development
Policy & regulation	Policy and regulatory frameworks that foster innovation

85. The non-regulatory interventions partially meet intended policy outcomes, as set out in the table below.

Figure 3 Intended policy outcomes by non-regulatory intervention options (crosses mark where the outcome is met/partially met by intervention)

Outcome	Funding	Collaboration & Partnerships	Skills Development
Maintain/improve regulatory standards, including safety, security and environment			
Reduce regulatory uncertainty for MASS industry			
Develop efficient MASS regulation			
Encourage investment in MASS	X	X	
Facilitate innovation in the maritime sector and associated knowledge spill overs	X	X	X
Encourage growth in the maritime sector and wider economy	X		X
Enable creation and diversification of jobs in the maritime sector			X
Facilitate improved welfare and safety for the maritime sector			X
Lead the development of MASS internationally		X	
Enable the UK to meet future autonomy related IMO obligations			
Facilitate the fair and equitable distribution of benefits, costs, and risks among stakeholders		X	X

86. However, these non-regulatory interventions alone are not enough to achieve *all* the intended policy outcomes. Notably, they do not achieve the outcomes required around enabling regulations, reducing uncertainty and enabling the UK to lead and influence future IMO obligations. The three key reasons for this are set out below.

87. Firstly, non-regulatory options will only be a stop-gap as regulation will be required once the IMO completes its work. The IMO is expected to develop an international regulatory regime for MASS by 2028 at the earliest. At this point, it is not an option for the UK to ignore the international regulatory regime and continue with a non-regulatory regime.

88. Secondary, one of the main drivers of the proposed primary legislation, is to provide a wide scope to capture all types of MASS and make legislation for operating them clear and easy to understand. Given that an international regulatory regime is coming, only regulatory options can provide greater certainty to a new market and confidence that UK regulation will be aligned to future international regulations. Non-regulatory approaches would likely result in negative outcomes such as uncertainty. This will stifle innovation and investment, as described in Section 1.2, Problem under consideration.

89. Finally, a regulatory regime for the maritime sector already exists. The current regulatory regime does not envisage the use of non-manned ships and so is not best suited to ensure that they do not cause harm to other maritime users, the environment, human health, property or resources. There is no reason that MASS needs less regulation than non-MASS. For MASS to be regulated in the same, safe way as non-MASS, a regulatory approach must be used. Any true alternatives to regulation, would also require revoking the regulatory system we already have.

2 Costs and Benefits

2.1 Methodology

90. This impact assessment covers the primary legislation to take powers to regulate MASS in the UK. The powers to regulate by themselves are not expected to impose direct costs to business or society, nor directly lead to benefits. The secondary legislation and accompanying guidance that is expected to create those impacts is not yet determined.

91. Whilst the proposed legislation is aimed at liberalising and increasing business activity in the UK maritime autonomy sector, these effects are not expected to be immediate as the legislation is a first step in enabling this activity.[56] Given that this regulation focuses on giving powers to regulate MASS, it is not currently possible or proportionate to monetise impacts.

92. However, consultation and impact assessments will be completed for subsequent secondary legislation for which this primary legislation sets the groundwork. Please see the Monitoring and Evaluation section for details on the ongoing assessment of the sector, the outcome of which will enable further assessments for subsequent regulation.

93. This impact assessment qualitatively describes the indirect impacts of primary legislation, without making speculative forecasts about the total impacts of both the primary legislation and future secondary legislation that is yet to be determined. Impacts will be quantified when secondary legislation is proposed using the powers set out in the recommended primary legislative changes. This is in line with the Regulatory Policy Committee's guidance[57]:

"…*where uncertainty over the contents of the secondary legislation means that departments need to submit a further IA at the secondary legislation stage for EANDCB validation. In this scenario, the primary legislation stage IA must still indicate the potential scale or nature of impacts of the whole policy, for example if the enabling powers are used, and an explanation for why a more robust assessment is not possible at this stage."*

94. The best available evidence for informing both current and future legislative policies for maritime autonomy in the UK is set out below. Consultation was used to test and gather available evidence about businesses that may be directly or indirectly impacted and associated impacts for stakeholders. Although consultation showed that stakeholders generally agree with the impacts set out below, there were no data provided to support these assumptions. This being so, they will be further tested alongside secondary legislation which is expected to cover specific segments or aspects of the MASS market.

95. Finally, the appraisal follows the standard 10-year appraisal period (from 2022 to 2031 inclusive). It should be noted that, as maritime autonomy technology is still in early stages of development, there are expected to be high upfront investment and R&D costs relative to long-lived benefits. This could justify a longer appraisal period. However, there is significant uncertainty in how the market for MASS will develop, even within a 10-year appraisal period, so it is not proportionate to consider a longer appraisal period.

[56] Regulatory Policy Committee 'Business Impact Target specific issues: direct versus indirect impacts', March 2019, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/790016/RPC_case_histories_-_direct_and_indirect_impacts__March_2019__1_.pdf

[57] Regulatory Policy Committee 'RPC case histories: assessment and scoring of primary legislation measures', August 2019, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827907/RPC_case_histories_-_Primary_legislation__August_2019.pdf

2.2 Evidence from Maritime Autonomy Regulation Lab (MARLab) Report [8]

The MARLab report of the MSA concluded that no provisions in the legislation expressly prohibit MASS operations. However, several provisions in the MSA are ambiguous and therefore unclear as to whether they raise compliance issues for MASS.

96. The review confirmed that gaps in the regulatory framework exist as it was written with no foresight of MASS. These issues, although not absolutely impeding MASS, do provide practical difficulties for the UK's enforcement of its applicable Coastal State law when MASS are operated in the UK's maritime zones. However, there are potential barriers to MASS trials in UK waters. This is because of the lack of clarity for both MASS operators and State regulators since it makes any authorisation process and the policing of compliance more arduous and *ad hoc*. The aspects of the MSA that would benefit from clarification fit broadly in the following areas:

    a. Roles and Responsibilities,
    b. Safety (and, in particular, Manning Levels)
    c. Training, and
    d. Remote Operations.

97. As part of the MARLab work, the Cabinet Office's Policy Lab conducted stakeholder analysis of the UK MASS industry. Policy Lab conducted over 40 interviews with MASS related individuals from industry, ports, academia, UK Government bodies, and international Government organisations. Interviews focused on current experiences of MASS regulations, the MCA, and broader trends within MASS research and testing. A snapshot of these interviews is presented anonymously here (Figure 4), as well as a Stakeholder Network Map (Figure 5).

98. The initial realisation was how complex and large the MASS industry already was in the UK, and that there were areas we were not aware of or in regular contact with, such as University of Strathclyde or smaller sensor developers (out of 210 links made, 78 were new to the MCA). This was a useful exercise that identified the broad range of stakeholders we needed to access, alongside the ship developers and users of MASS.

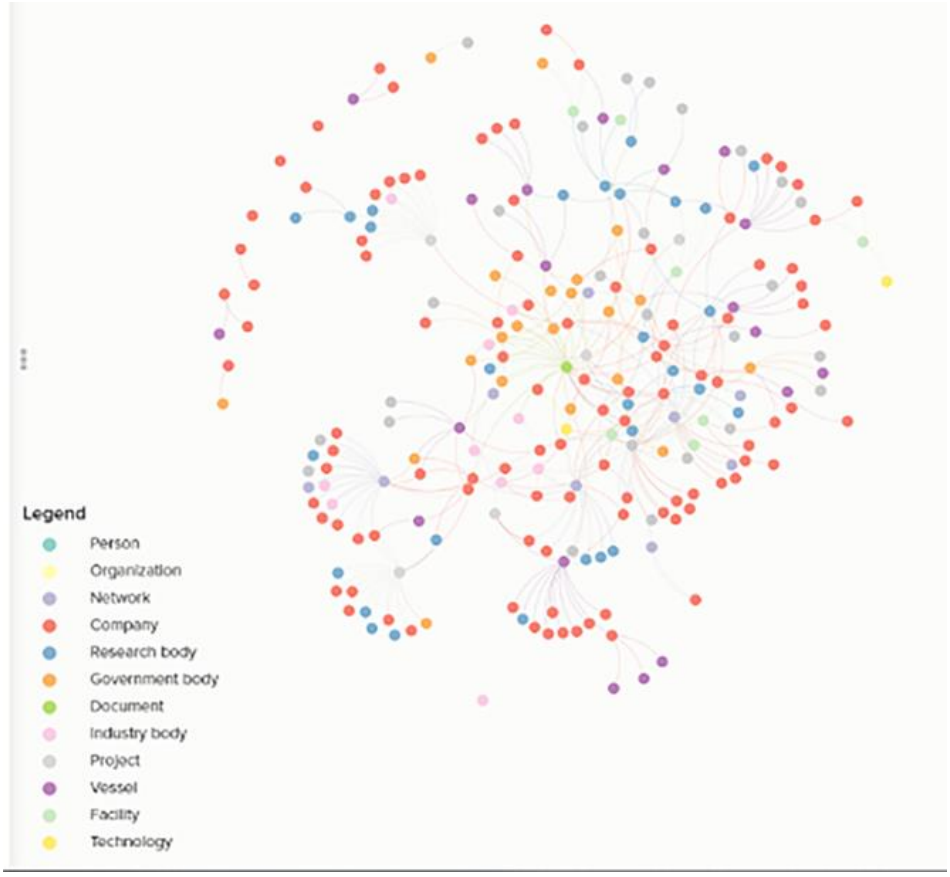
Figure 4 Anonymised MASS interview extracts, Policy Lab [8]

"if the MCA was to put a flag in the ground and declare its position, I think you would see business flock to this country because [they] would know where they stand."

"To actually get them to find a way of giving thumbs up, was by giving the vessel effectively a Loadline Exemption Certificate. Which is not ideal at all … it a very expensive and painful method"

"Goal-focused regulation, something that's flexible which allows industry to interpret the way in which its going to meet a safety goal other than being very prescribed in the regulations about specifically how everything's got to be done. The challenge for industry and the MCA then is to create the evidence base which allows those flexible solutions to be brought forward and approved as being likely to achieve those safety goals."

Figure 5 Stakeholder network map for MASS (using Kumu) [8]



MARLab recommendations

99. From the MARLab review of the MSA, the following recommendations were made:

a. To remove any doubt that the "Master" of a MASS does not need to be on board it, clarification would be beneficial that an individual who is the equivalent of the master will (probably) not be on board a MASS. Clarification needs to ensure that there is a nominated individual who has the equivalent responsibilities.

b. Terms such as "crew", and "seaman", which appear in the Act imply that these individuals are on board their ship. Clarification and alternative terminology for onshore personnel would be beneficial.

c. The Act stipulates that a vessel shall have a minimum manning level. Although there is no express requirement for a minimum number of attending personnel, there is a risk that it is not legitimate to interpret this as zero. In such a case, Section 49 could be an impediment to MASS trials. Clarity on this point is therefore a necessity.

d. The clarification of Health and Safety laws – what apply on board, what on shore, and do on-board laws apply to personnel with on-shore duties? Is the onshore safety legislation sufficient to address all the relevant requirements that are applicable to personnel on a ship?

e. The training of the MASS equivalent of a “Master” should include both the minimum standards of training as for the Master of a conventional vessel, and specific, recognised training on the MASS platform and the statutory basis to prescribe such standards should be clarified.

f. The MSA requires that certain documentation is displayed or carried on the vessel, or that documents can be served to that vessel. Clarification is necessary to the effect that the documentation may be elsewhere provided it is easy to locate and that there is a clear and obvious location where documents can be served.

g. To geographic boundaries for the operation of MASS require defining (is it permissible for a MASS to be operated from outside the UK and if so what contractual or other constraints should be applied).

h. To the extent the traditional means of law enforcement such as boarding and inspection of ships may not be viable in the MASS context, consideration should be given as to viable alternatives.

2.3 Summary of stakeholders and impacts

100. This section sets out the stakeholders expected to be impacted by the final regime proposed. This includes those impacted by the setting out of key definitions and introduction of powers in primary legislation and stakeholders which may also be impacted by the secondary legislation which is expected to include more detail around the regulatory framework.

101. As outlined in Section 2.1, there is a large degree of uncertainty that may impact how the overall regime performs – including growth of the emerging maritime autonomy sector and details of the final regime which will be established later through secondary legislation. Due to this uncertainty, it has not been possible to separate out and quantify the impact of this primary legislation. Overall impacts will be further tested in consultation and final stage impact assessments for secondary legislation.

2.3.1 Stakeholders

102. All the options considered will impact on the same group of stakeholders but to differing degrees and with differing outcomes. The stakeholders include:

MASS manufacturers – Companies in the upstream R&D and manufacturing part of the supply-chain that provide shipping companies with MASS. At the moment MASS manufacturers are the same as operators. Increased developmental opportunities are facilitated through the new regulations, increased market activity as the uptake of MASS increases.

MASS companies – Companies providing MASS operations are the most directly affected by regulations, in terms of familiarisation, training, engagement with the MCA, Certifying Authorities (CA) and Responsible Organisations (RO) and other compliance requirements. However, these companies are expected to have the most to gain from regulation too, in terms of the opportunity to enter the market and associated investment, operational efficiencies, reduced labour costs etc.

Seafarers – Mixed impact on seafarers, with some expected short-term displacement of current sea-based roles (with potential for long-term structural unemployment), but potential augmentation of roles and increased land-based opportunities with higher wages. May be impacted by increased training needs as new technology makes it way onboard. May also improve working conditions by increasing safety onboard and a reduction in the need for crew to undertake dangerous tasks.

Ports and Harbour Authorities – Impacted by MASS operations within their jurisdiction and potential needs for understanding the legislation, train, and make operational and capital changes to comply, but could also benefit from efficiencies, market growth and knowledge spillovers.

Wider maritime sector – This includes non-MASS shipping companies, pleasure craft and other users of waters, and maritime professional business services. These companies and individuals may want to understand the legislation and develop training. In addition, existing non-MASS shipping companies may be affected by increased competition from MASS companies. However, the wider maritime sector may also benefit from efficiencies, market growth, knowledge spillovers and a reduction in externalities and adverse outcomes.

HMG and regulators – This include central government, devolved administrations, and regulators, such as the MCA, CAs, ROs and Maritime Accident Investigation Branch (MAIB). Costs may include the implementation of the legislation i.e. actually regulating

the MASS industry, engaging with industry, other countries and the IMO, and any potential liabilities in the event of accidents/claims. However, HMG and regulators could benefit from MASS itself (*e.g*. public services such as Search and Rescue), increased tax revenue from market growth and a reputation as a market leader.

Businesses and consumers – These include companies and individuals in the downstream part of the MASS supply-chain as well as companies in parallel and unrelated sectors of the UK economy. These stakeholders could benefit from increased efficiencies, market growth and knowledge spill overs.

Non-seafarers – MASS may impact the wider, land-based jobs market in the UK, opening up new opportunities in MASS R&D and manufacturing, as well as remote operations. It may also open up 'seafaring' careers to those that had not previously considered a career in maritime.

2.3.2 Costs

103. The following costs have been identified for all the options, but these will impact stakeholders differently and vary across options too:

a. **Familiarisation** costs/time for industry

b. **Training** costs/time for HMG, regulators, and industry

c. **Capital** expenditure for compliance by industry, including mitigation of impacts, and development of regulator

d. **Operational** expenditure for compliance by industry, including mitigation of impacts

e. **Engagement** between HMG, regulators, industry, other countries, and IMO

f. **Time** spent surveying and certifying ships for registration

g. **Time** spent monitoring & enforcing e.g. inspections

h. **Certification** costs

i. **Safety, security, health, and environmental** impacts, which may be negative if not regulated effectively

j. **Accidents investigation** costs for industry and the accident investigator, including wreckage and salvage costs

k. **Insurance** for industry and associated claims outcomes depending on liabilities

l. **Unemployment** in short-term from displacement and long-term structural changes. This is due to labour market frictions stemming from UK maritime operations being geographically concentrated and requiring highly specialised skills that are difficult to apply to other sectors. These frictions would be lower the longer a time horizon we consider as the labour market adjusts.

2.3.3 Benefits

104. The following benefits have been identified for all the options, but these will impact stakeholders differently and vary across options too:

a. **Investment** and activity in MASS and shipping sectors following regulatory certainty and associated **knowledge spill overs** from R&D to the scientific community and academia, as well as other sectors.

b. **Economic growth** from MASS technology development, adoption and sales by shipping companies and associated **operational efficiencies**, driven both by the MASS technology itself and competition between autonomous and incumbent shipping companies. These may be passed through to businesses and consumers through **lower shipping costs/prices** too.

c. **Growth effects** for the maritime supply-chain (indirect, Type I multiplier) and wider economy (induced, Type II multiplier) related to new market opportunities.

d. **Labour** requirements and costs lower from adopting MASS technologies (positive productivity shock), but there may also be new **job opportunities** in MASS labour market, including augmented and new roles e.g. engineering, data processing, coding, remote operations etc.

e. **Safety, security, health, and environmental** impacts, which may be positive if regulated effectively.

f. **Public services** improvement from MASS e.g. Search and Rescue.

g. **Tax revenue** from market growth.

h. **Reputational** *i.e*. leadership in regulation at IMO.

Figure 6 Summary of stakeholders and impacts

Stakeholders	Illustrative costs	Illustrative benefits
MASS shipping manufacturers	Familiarisation costs/time Training costs/time Capital expenditure for compliance	Investment and activity in the MASS sector Revenue from technology sales to MASS companies
MASS companies	Familiarisation costs/time Training costs/time Pre-engagement with regulator Capital expenditure for compliance, including mitigation of potential impacts Operational expenditure for compliance, including mitigation of impacts Certification costs Insurance & claims Monitoring & enforcement e.g. inspections	Increased investment and activity following regulatory certainty Operational efficiencies from adopting MASS technologies Lower labour requirements and costs from adopting MASS technologies
Seafarers	Short-term displacement of jobs Training costs/time Short-term adverse safety impacts Long-term structural unemployment	New/augmented roles e.g. engineering, data processing, coding, remote operations etc. Long-term safety and welfare improvements
Ports and Harbour Authorities	Familiarisation costs/time Training costs/time if and when MASS use ports Capital expenditure for compliance Operation expenditure for compliance Insurance	Growth by maritime autonomy market (indirect, Type I multiplier) Efficiencies and pass through of lower shipping costs New market opportunities (growth effects)
Wider maritime sector e.g. non-MASS shipping companies pleasure craft, users of waterways, insurance	Familiarisation costs/time Training costs/time e.g. training colleges Increased competition from MASS companies	Growth by maritime autonomy market benefits supply-chain e.g. professional services (indirect, Type I multiplier) New market opportunities (growth effects) Knowledge spill overs Improved safety, security, health, and environment
HMG and regulators	Increased regulatory activity for MCA (including Certifying Authorities and Responsible Organisations), MAIB and other regulators Training costs/time Capital expenditure for compliance Certification Monitoring & enforcement e.g. inspections Accidents investigation Co-operation within HMG and with industry, other countries, and the IMO Potential liabilities in the event of accidents/claims	Public services improvement from MASS e.g. Search and Rescue Increased tax revenue from market growth Reputational i.e. leadership in regulation at IMO
Businesses and consumers		Growth by maritime autonomy benefits other sectors e.g. wages on retail (induced, Type II multiplier) Efficiencies and pass through of lower shipping costs (catalytic multiplier) Knowledge spill overs to the scientific community and academia, as well as other sectors
Non-seafarers		Increase in opportunities in MASS labour market

2.4 Option 0 – Do minimum (baseline)

106. This section sets out the baseline (or counterfactual) for maritime autonomy in the UK, including the current and expected future state of the UK shipping and labour markets, which the MASS sector will either be a subset of or additional to.

107. To facilitate comparisons with the other options, Figure 7 groups these more detailed costs, benefits, wider impacts, risks and unintended consequences into broad categories. Based on the expected timings of option 1 (wait for IMO) these are split across the time periods 2022 to 2027 and 2028. Figure 7 shows our assumptions about the direction and absolute size of these impacts for the do minimum option. These were widely agreed with at consultation:

108. **Benefits** are separated out for ships above and below 24 metres in length based on the current differential treatment of ships above and below 24 metres in option 0 (do minimum) compared to the alternative options, and include economic growth (direct, indirect and induced), investment tax revenue, public service improvements, knowledge spillovers and positive labour markets impacts.

109. Costs are split into –
   a. **Transition costs**, including development, investment, capital expenditure, training, time spent surveying ships for registration and associated certification costs/fees, and
   b. **Ongoing costs**, including operational expenditure, time spent monitoring and enforcing *e.g.* inspections, accident investigation and insurance.

110. **Risks and wider impacts** include safety, security, health, environmental, labour market, competition, and reputational impacts.

Figure 7 Aggregated impact assumptions for option 0 (do minimum), in absolute terms

Impact over time	2022 to 2027	2028 to 2031	2032+
Benefits <24 metres	Positive, medium	Positive, medium	
Benefits >= 24 metres	Positive, low	Positive, low	
Transition costs	Negative, low	Negative, low	
Ongoing costs	Negative, medium	Negative, medium	
Wider impacts (WEI)	Negative, medium	Negative, medium	

111. The following sections describe the expected (illustrative) costs and benefits, wider economic impacts (WEI), risks and unintended consequences for the current approach to regulating MASS, building on the stakeholders, costs and benefits identified in the previous section. These are used to inform the assessment above (Figure 7).

Current and expected future number of UK shipping companies

112. Every merchant ship must be registered in a country (the 'flag state') and ship registration can, in part, be considered an indicator of the overall health of a country's maritime sector.[58] In HMG published maritime and shipping statistics, the following, overlapping definitions of the UK fleet are used:

   a. **UK registered:** the ship is UK registered

[58] HMG 'Shipping Fleet Statistics: 2020', 11 March 2021, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/967763/shipping-fleet-statistics-2020.pdf

b. **UK direct owned:** the registered owner of the ship is a company registered in the UK
c. **UK parent owned:** the company having the controlling interest in the direct owner is a UK company
d. **UK managed:** the company managing the ship is a UK company

113. This IA only focuses on the UK stakeholders and impacts, as per HMT Green Book guidance. Therefore, stakeholders based in the UK such as ports and harbours are included in the analysis. However, to estimate the potential impact of these legislative changes, registered ships and companies need to be segmented to identify UK shipping companies. Whilst the flag of ships is important for determining the number of UK registered ships, UK shipping companies operating UK flagged ships will help us determine the impact on UK companies as a result of the proposed legislative changes. Ships registered under other flags are excluded from this analysis.

114. In addition, the UK Ship Register (part of the MCA) and IHS Markit Ship and Port Data contains useful information for segmenting the UK shipping market, including ship length. To reflect the difference between option 0 (do minimum) and the alternative options, this IA has segmented registered ships into shorter and longer than 24 metres in length. At the end of Q1 2021, there were over 100,000 ships in the global fleet, with over 50,000 shipowner companies and over 30,000 ship manager companies. These were heavily skewed towards ships over 24 metres (Figure 8 and Figure 9). [59]

115. As of Q1 2021 there were 32 shipowner and 28 ship manager companies for the UK flagged ships under 24 metres where the UK was the country of economic benefit for the shipping activities (Figure 8). For UK flagged ships over 24 metres, there were 359 shipowner and 267 ship manager companies where the UK was the country of economic benefit for the shipping activities (Figure 9).

Figure 8 UK and non-UK ships under 24 metres and associated companies [55]

Registered flag	Country of economic benefit	Number of ships	Shipowner companies	Ship manager companies
UK	UK	52	32	28
UK	Other	9	7	9
Other	UK	12	10	10
Other	Other	4,292	2,292	2,249
Sub-total		**4,365**	**2,341**	**2,296**

Figure 9 UK and non-UK ships over 24 metres and associated companies [55]

Registered flag	Country of economic benefit	Number of ships	Shipowner companies	Ship manager companies
UK	UK	787	359	267
UK	Other	362	249	195
Other	UK	1,080	928	419
Other	Other	97,924	51,166	29,275
Sub-total		**100,153**	**52,702**	**30,156**

116. When looking at the number of active enterprises by ONS Standard Industrial Classifications (SIC2007) for water transport and ship and boat manufacturing sectors, the number of enterprises remained roughly the same from 2014 to 2019 (Figure 10). For sea and coastal passenger and freight water transport companies, the number of enterprises is also higher than the number of shipowner and manager companies for UK flagged ships (regardless of country of economic benefit), suggesting that the number of UK shipping companies could be almost c.1,500 in 2019.

[59] DfT analysis of UK Ship Register and IHS data, July 2021 (unpublished)

Figure 10 Business demography, UK, Table 3.2 – Count of active enterprises by SIC2007, 2014 to 2019 [60]

Standard Industrial Classification (SIC2007)	2014	2015	2016	2017	2018	2019
301: Building of ships and boats	1,080	1,095	1,140	1,110	1,080	1,055
30: Manufacture of other transport equipment	**2,405**	**2,520**	**2,700**	**2,840**	**2,825**	**2,695**
501: Sea and coastal passenger water transport	605	620	630	625	635	650
502: Sea and coastal freight water transport	820	830	800	795	790	825
503: Inland passenger water transport	230	235	225	230	225	215
504: Inland freight water transport	80	85	75	75	70	65
50: Water transport	**1,735**	**1,770**	**1,730**	**1,725**	**1,720**	**1,755**

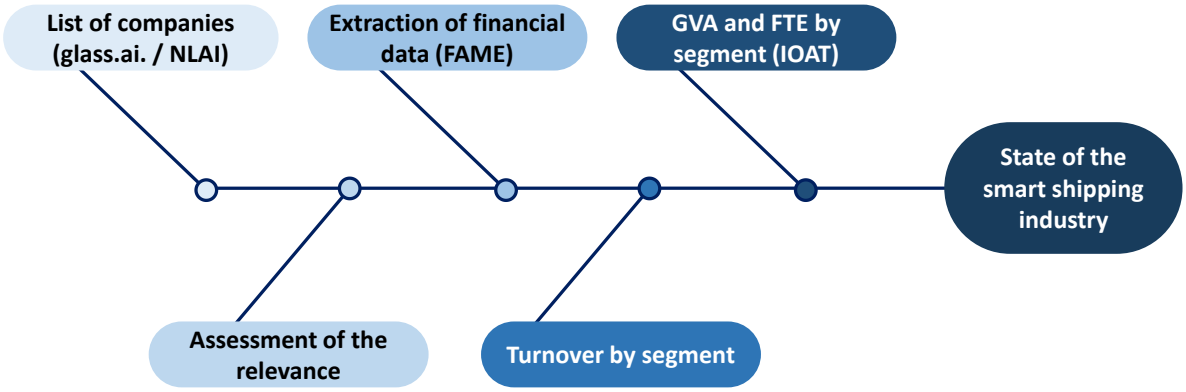
117. Assuming the rate of change similar over the next 10 years, the number of UK shipping companies is expected to broadly stay the same or increase slightly. This IA therefore assumes the latest available data from the UK Ship Register, IHS Global (Q1 2020) and ONS (2019) is a suitable proxy to estimate the number of UK shipping companies over the 10-year appraisal period i.e. the number of UK shipping companies stays constant over time 10-year appraisal period.

Current and expected future number of UK MASS companies [9]

118. UK MASS companies are either a subset of or additional to the current and expected future number of UK shipping and ship manufacturing companies. Based on smart shipping research funded by DfT in partnership with MarRI-UK, NLA International (NLAI) provided an initial list of smart shipping companies. These were then consolidated by London Economics using *glass.ai*, an ongoing artificial intelligence (AI) discovery process or "web crawler" that reads websites and classifies websites as a company website if it detects certain criteria around content. As a result, more than 450 companies were analysed in this research. For each company, London Economics manually investigated publicly available information (website, companies house, LinkedIn) to determine the relevance of the company, using FAME data. (Figure 11)

119. This research identified 215 relevant smart shipping companies that split between four market segments. **38 companies were identified as active in the autonomous vessel segment**, with others in the smart ports, on-board technologies, and professional and business services segments. Note that companies can be active in multiple segments, and that autonomous ship manufacturers and operators currently overlap as the ships are trialled by the developers and manufacturers.

Figure 11 Method for identifying UK smart shipping companies, including MASS [9]



n.b. GVA = Gross Value Added; FTE = Full-Time Equivalent; IOAT = Input-Output Analytical Tables

[60] ONS 'Business demography, UK', 17 November 2020, available at: https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/datasets/businessdemographyreferencetable

120. There is uncertainty in the expected future number of MASS companies, and this IA does not attempt to forecast them. However, the smart shipping research outlined an approach using a "Bass Diffusion Model"[61] to estimate the adoption and benefits of MASS. For any given time in this model, there are levels of innovators who are the first to seek out and adopt the technology, levels of imitators who wait to see the experiences of others until choosing whether to adopt the technology or not, and the ultimate market potential.

121. As more and more organisations adopt the new technology, more and more organisations are tempted to adopt, and more of those tempted do actually adopt. Therefore, the number of imitators increases over time while the number of innovators decreases. The ultimate market potential imposes an upper limit on the potential number of adopters (adoption rate).

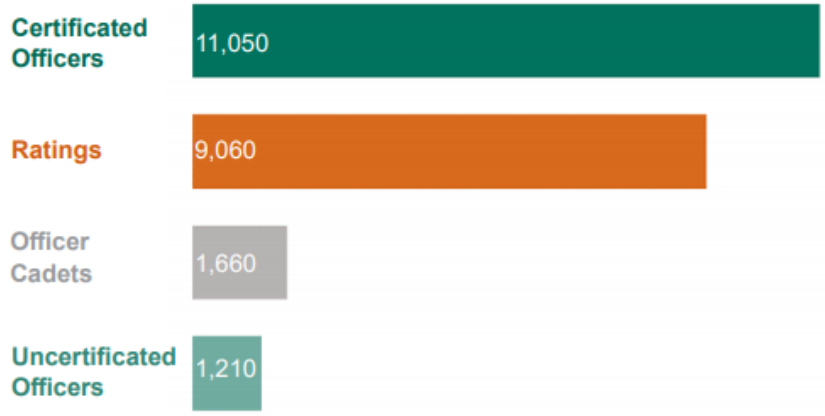
122. Based on the current number of UK autonomous ship companies (38) and current number of UK shipping companies (up to c.1,500 if using ONS data, Figure 10), the expected number of UK autonomous ship companies is anywhere between 40 and 800 by the end of the 10-year appraisal period, assuming the market structure does not fundamentally change (i.e. up to c.1,500 UK companies). By way of comparison to another technology change in shipping over the past few decades, the global Liquefied Natural Gas (LNG) shipping fleet is expected to grow from 138 ships in operation in 2021 to 174 ships in operation by 2028 (after reaching its market saturation point in 2024), according to a research report by DNV, and we would expect there to be fewer owner and manager companies than ships.[62]

Current and expected future number of UK seafarers [63]

123. Based on the MCA Seafarer Documentation System and Chamber of Shipping Seafarer Employment Survey, an estimated 22,970 UK seafarers were active at sea in 2020, with overall numbers being broadly stable in recent years (Figure). There has been an overall downward trend in the number of UK seafarers over the past 15 years. However, between 2012 and 2020 numbers have been broadly stable with the exception of 2018, due to a large increase in Ratings explained by changes in the data coverage of the Chamber of Shipping data.

124. There were 42,920 certificates to work on UK ships issued by the Maritime and Coastguard Agency in 2020, 15,370 of these were UK nationals. These figures have been broadly stable since 2010. The majority of UK seafarers active at sea were male (83%), with larger female representation in Uncertificated Officers and Ratings.

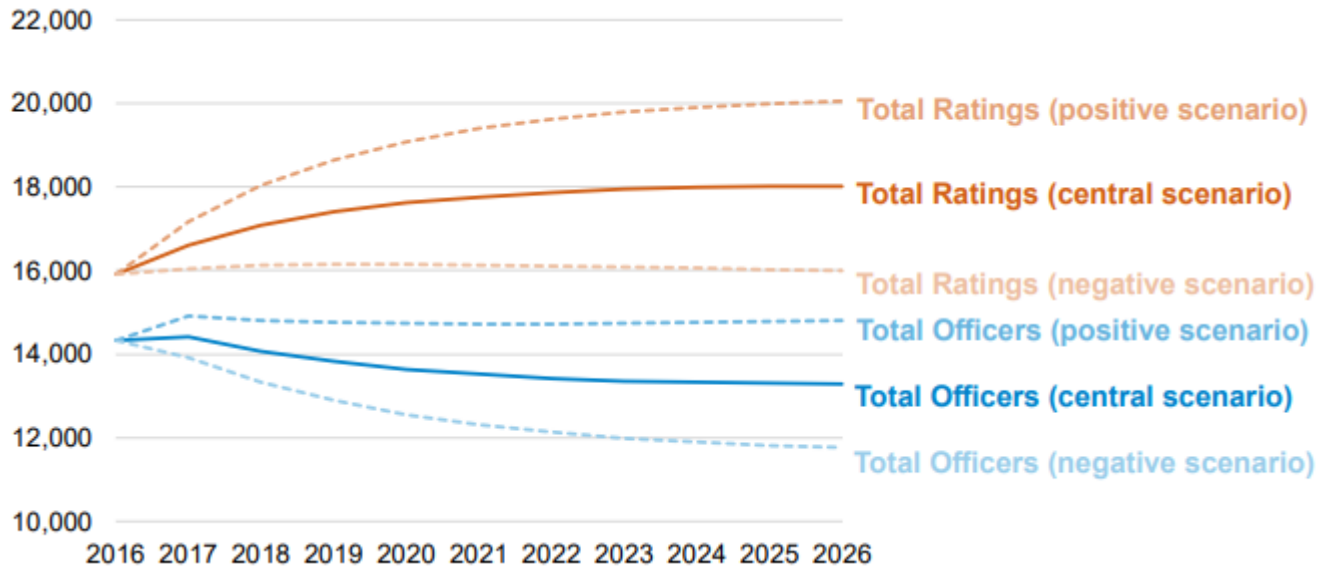
Figure 12 UK seafarers active at sea by type 2020 [59]



[61] L Qian and D Soopramanien, Using diffusion models to forecast market size in emerging markets with applications to the Chinese car market, Journal of Business Research,Volume 67, Issue 6, 2014
[62] DNV 'Alternative fuel technologies', accessed 22 July 2021, available at: https://www.dnv.com/maritime/alternative-fuels-and-technologies-in-shipping/index.html
[63] HMG 'Seafarers in the UK shipping industry: 2020', 24 February 2021, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/964225/seafarers-in-the-uk-shipping-industry-2020.pdf

125. The latest Department of Transport seafarer projections were delivered by Oxford Economics and published in 2016. Although based on the same underlying data as presented in these statistics, numbers were the results of a modelling approach which made several adjustments and assumptions, and so are not directly comparable. The figures projected an increase in the supply of UK Ratings, and a decrease in the supply of total UK Officers - though sensitivity scenarios were also produced (Figure 13). These projections were published before the coronavirus pandemic and so do not reflect any impact of the pandemic.

Figure 13 Sensitivity scenarios for the supply of UK seafarers, 2016 to 2026 [59]



126. Based on the above evidence, the number of UK seafarers may slightly increase (+15%) or decrease (-10%) by the end of the 10-year appraisal period. This IA therefore assumes a range of possible outcomes and impacts for UK seafarers by the end of appraisal period.

2.4.1 Illustrative benefits

127. The practical benefits of retaining option 0 (do minimum) are that: (i) industry are aware of the requirements; (ii) the MCA can continue to use a safety-case approach to ensure these ships are thoroughly assessed to support their safe operation within UK waters; and, (iii) there is no need to amend legislation.

128. However, the economic benefits of option 0 (do minimum) are likely to be weighted towards shipping operations ships under 24 metres categories, given the current differential treatment of ships above and below 24 metres in option 0 (do minimum) compared to the alternative options. The benefits are also expected to be either lower or delayed compared to additional Government legislative intervention (Figure 7). That said, maintaining the current approach will allow the MASS industry to mature and stabilise, with learning being gathered from the projects currently allowed under the exemption process. Growth of maritime autonomy may also occur, allowing for data and evidence to be gathered to inform the development of future legislation if required.

2.4.2 Illustrative costs

129. Any ship, whether new-build or transferring from another flag, must be surveyed before it can be registered on the UK Ship Register. Retaining the current approach will ensure that no additional costs are imposed on the maritime autonomous industry in ensuring compliance. However, these costs are expected to be higher per ship given the current, ad-

hoc nature of ensuring compliance, which may cause delays in waiting to gain exemptions for MASS, and current powers do not enable the authorities to survey or inspect all of the operations involved in MASS. The current approach can be resource intensive for the MCA, and exemptions and equivalences may not be available or suitable as industry develops larger and more complex MASS. This may present a barrier to growth as the market develops.

Surveys and inspections

130. Surveys can be carried out by MCA surveyors or, in certain cases, by MCA-approved Class surveyors through the Alternative Compliance Scheme (ACS) or Enhanced Authorisation Scheme (EAS).[64] MCA authorise six Recognised Organisations (ROs), which are members of the International Association of Classification Societies (IACS), to carry out a proportion of their statutory survey work. For smaller ships that operate under the UK Codes of Practice, MCA have authorised 10 Certifying Authorities (CAs) to survey and issue certificates on their behalf.[65]

131. MCA's standard hourly survey rate are £147 per hour Monday to Friday between 8am and 6pm, £221 per hour Monday to Friday between 6pm and 8am and all day Saturday, and £294 per hour all day Sunday,[66] but actual times taken to survey and therefore total costs per ship may vary e.g. bigger ships with more complex designs may take longer, and different ROs and CAs may be quicker or slower.

132. MCA undertook 2,895 surveys and 2,472 inspections of UK ships during the 2019-20 Financial Year. In the same period, MCA also carried out 1,387 Port State Control inspections on 1,318 individual ships to ensure they were meeting the required standards during which they identified 3,446 deficiencies with 33 ships being detained in the period. In 2019-20, MCA investigated 171 new cases and conducted 10 prosecutions.[65]

Registration

133. In addition, the registration of a ship (excluding fishing vessels), including registration of a ship whose registration has expired, is £153 or £333 for the Premium Service. The renewal of a registration under regulation 42 of the Merchant Shipping (Registration of Ships) Regulations 1993(a) is £72 or £172 for the Premium Service. The registration of fishing vessels, including registration of a vessel whose registration has expired, is £159 for a simple registration, £196 for a full registration or £376 for a full registration with the Premium Service. The renewal of a registration under regulation 42 of the Merchant Shipping (Registration of Ships) Regulations 1993 is £70 or £170 for the Premium Service.[67]

[64] UK Ship Register 'Survey', accessed 22 July 2021, available at: https://www.ukshipregister.co.uk/other-services/survey/

[65] MCA ' Annual Report and Accounts 2019-2020', 2020, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/928608/MCA_Annual_report_and_accounts_2019_-_2020.pdf

[66] MCA 'Application for Survey or Inspection Marine Offices South', accessed 22 July 2021, available at: https://products.payments.service.gov.uk/pay/reference/5e8ddca91b3c42699c1aa3c33643a6bd

[67] MCA 'Maritime & Coastguard Agency quick guide to fees – November 2018', 12 December 2018, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/749572/Maritime___Coastguard_Agency_fees_2018.pdf

MCA expenditure and income

134. MCA's total expenditure has risen by £14.4 million to £371.8 million in FY 2019-20. The main elements of the increase were staff costs £3.5 million, Search and Rescue Helicopters (SAR-H) £3.6 million, pollution response £4.4 million and Telecommunications and IT £4.4 million (Figure 14). Total MCA income increased by £0.5 million to £15.4 million in FY 2019-20, reflecting higher revenue from contracts with customers mainly due to a rise in marine surveys income (£5.9 million). Registration of ships generated £1.1 million in income in FY 2019-29 (Figure 15, excludes commercial and other income).[61]

135. Therefore, it is likely that this policy would generate costs to MCA in relation to MASS, passed through to companies through fees and charges, well below the +/-£5 million expected annual net direct cost to business (EANDCB) threshold for impact assessments,[68] given the total surveys and registrations income and expenses were around £6-7 million each year in the past 2 financial years. In addition, it may well save costs associated with examining and certifying seafarers if the number of seafarers is reduced by MASS. To provide another sense of scale to help justify this, the MARLab team was set up with £1 million funding from the UK Government's Department for Business, Energy, and Industrial Strategy's (BEIS) Regulators' Pioneer Fund.

136. The regulatory cost to business was tested through consultation. Although stakeholders did not disagree, there was uncertainty around what the cost would be. This will be tested again at consultations associated with the secondary legislation.

Figure 14 MCA Statement of Comprehensive Net Expenditure, for the year ended 31 March 2020 [61]

	2019-20			2018-19		
	Income	**Expense**	**Net**	**Income**	**Expense**	**Net**
	£000	**£000**	**£000**	**£000**	**£000**	**£000**
Statutory services						
Marine surveys	5,866	5,902	(36)	5,106	5,150	(44)
Registration of ships	1,084	1,162	(78)	1,068	824	244
Seafarers' examinations and certification	2,152	2,446	(294)	2,447	2,257	190
Other statutory services	202	286	(84)	450	361	89
Total	**9,304**	**9,796**	**(492)**	**9,071**	**8,592**	**479**

[68] HMG 'Better Regulation Framework', March 2020, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/916918/better-regulation-guidance.pdf

Figure 15 MCA Fees and Charges, direct income and expenditure (excluding overheads) [61]

	Note	2019-20 £000	2018-19 £000
Revenue from contracts with customers	[3]	(13,601)	(13,076)
Other income	[3]	(1,843)	(1,793)
Total income		**(15,444)**	**(14,869)**
Staff costs	[2]	56,279	52,773
Purchase of goods and services	[2]	253,308	289,326
Depreciation and impairment charges	[2]	60,432	15,618
Other operating expenditure	[2]	(4,592)	(60)
Net provision (release)/expense	[2]	464	(249)
Total operating expenditure		**365,891**	**357,408**
Net operating expenditure for the year		**350,447**	**342,539**
Finance expense	[13]	5,913	-
Net expenditure for the year		**356,360**	**342,539**
Other comprehensive net expenditure			
Items which will not be reclassified to net operating expenditure:			
Net (gain)/loss on:			
Revaluation of property, plant and equipment		(109)	(902)
Revaluation of intangible assets		(130)	(22)
Revaluation of inventories		(420)	62
Total net revaluation (gains) and losses		**(659)**	**(862)**
Comprehensive net expenditure for the year		**355,701**	**341,677**

2.4.3 Illustrative risks, and unintended consequences

137. There are several potential wider economic impacts and unintended consequences involved in continuing with the current approach:

a. The costs associated with *ad-hoc* exemptions and the focus of the Workboat Code updates on vessels under 24 metres in length may present a barrier to growth, inhibiting the development of maritime autonomy in the UK, including investment, jobs, and growth.

b. Safety, security, health, and environmental impacts may not be properly defined, accounted for and mitigated by HMG, regulators, and industry. For example, the distinction between ships under and over 24 metres in length may present a barrier to integrated MASS with existing non-MASS operations.

138. There are a number of risks involved in continuing with the current approach:

a. Reputationally, there is a perception that the industry is being held back by existing legislation and Government are not doing enough to support emerging technologies;

b. the Load Line Exemption Certificate was not originally designed for the regulation of MASS and it would be preferable to have a bespoke regime for this;

c. gaps in powers (for example around training and ROCs) would remain, which could limit the safe operation of these ships;

d. exemptions and equivalences may not be available or suitable as industry develops larger and more complex autonomous shipping which could limit MASS operations and financial successes in UK waters; and

e. the UK domestic legal framework would not be ready for future international discussions and changes in international law.

139. In addition, there is a reputational risk, where in the absence of UK legislation on MASS, the UK may lose its reputation as a leader in maritime autonomy. This could also potentially reduce the UK's effectiveness to direct the development of new instruments and the practical implementation of the safety requirements of MASS as part of discussions at the IMO.

2.5 Option 1 – Wait for IMO to develop an instrument on autonomous shipping and remote operations

140. This section sets out the expected impacts of waiting for the IMO to develop an instrument on MASS, compared to option 0 (do minimum) using the same grouped categories of impacts split across the time periods 2022 to 2027 and 2028 onwards.

141. Figure 16 illustrates that, compared to option 0 (do minimum), waiting for the IMO is not expected to deliver significantly different impacts from 2022 to 2027, except for some transition costs of continuing to work with the IMO. From 2028 onwards, there are expected to be higher transition costs compared to option 0 (do minimum), as HMG, regulators and the UK maritime sector look to implement legislative changes. As a result, there are expected to be some ongoing (regulatory) cost savings compared to the option 0 (do minimum), higher benefits, particularly for ships over 24 metres in length, and improved outcomes for wider economic impacts, risks and unintended consequences beyond 2028.

142. On balance, option 1 (wait for IMO) is expected to deliver higher net benefits than option 0 (do minimum), but lower net benefits that option 2 (legislate in advance of the IMO) given the delayed benefits (and costs), which would be significant reduced in present value terms because of discounting (3.5%) and would likely be limited by the cut off of the 10-year appraisal period.

Figure 16 Aggregated impact assumptions for option 1 (wait for IMO), relative to option 0 (do minimum)

Impact over time	2022 to 2027	2028 to 2031	2032+
Benefits <24 metres	Zero	Positive, low	
Benefits >= 24 metres	Zero	Positive, high	
Transition costs	Negative, low	Negative, medium	
Ongoing costs	Zero	Positive, medium	
Wider impacts (WEI)	Zero	Positive, medium	

n.b "positive" for "ongoing costs" means cost savings

2.5.1 Illustrative benefits

143. The practical benefits of option 1 (wait for IMO) are that: (i) it would guarantee consistency between the domestic and international regulatory framework for the safe operation of autonomous ships (reflected by expected positive WEI of this option compared to option 0); (ii) industry are aware of the current process to get an autonomous ship on the water in the UK; and, (iii) the MCA can continue to use a safety-case approach to ensure these ships are thoroughly assessed to support their safe operation within UK waters. The risks with this approach are the same as for the baseline option above.

144. From 2022 to 2027, the economic benefits of option 1 (wait for IMO) are likely to be the same as option 0 (do minimum). Beyond 2028, the benefits are expected to be higher than option 0 (do minimum), particularly for autonomous ships over 24 metres in length. This is the main additional benefit of option, but given it does not occur until at least 2028, it will likely be limited compared to option 2 (legislate in advance of the IMO).

2.5.2 Illustrative costs

145. In waiting for the developments to mature in the IMO, the UK could benefit from a wider spectrum of experience achieved in other nations, which might not be available to the UK e.g. certain environments or types of ship, reflected by negative but low transition costs from 2022 to 2027. This may help to ensure a more complete introduction of legislation at the point of defining it, reflected by negative, transition costs beyond 2028 compared to option 0 (do minimum). These are expected to be lower, in absolute terms, than option 2 (legislate now).

146. As a result, compared to option 0 (do minimum), option 1 (wait for IMO) is expected to have ongoing (regulatory) cost savings, given the ad-hoc nature of the current exemption process. These savings are not expected to be realised until at least 2028.

2.5.3 Risks and unintended consequences

147. The risks and unintended consequences with this approach are the same as for the option 0 (do minimum) until 2028, and thereafter are expected to be reduced.

2.6 Option 2 – Legislate in advance of the IMO (preferred)

148. This section sets out the expected impacts of legislating in advance of the IMO for maritime autonomous and remotely operated surface ships of all sizes and autonomous submersible apparatus (option 2, preferred) compared to option 0 (do minimum), using the same grouped categories of impacts split across the time periods 2022 to 2027 and 2028 onwards.

149. Figure 17 illustrates that, compared to option 0 (do minimum), legislating in advance of the IMO is expected to deliver significantly higher net benefits across the appraisal period, from 2022 to 2027 and 2028 onwards. However, there will likely be significantly higher up front (2022 to 2027) transition costs compared to option 0 (do minimum) associated with developing the legislation, familiarisation by industry and associated training etc., but these will likely decrease from 2028 onwards. As a result, there are expected to be some ongoing (regulatory) cost savings compared to the option 0 (do minimum), higher benefits, particularly for ships over 24 metres in length, and improved outcomes for wider economic impacts, risks and unintended consequences across both 2022 to 2027 and 2028 onwards.

150. On balance, option 2 (legislate in advance of the IMO) is expected to deliver higher net benefits than option 0 (do minimum) and option 1 (wait for IMO) given the fact that benefits (and costs) would be brought forwards to 2022 to 2028, and these would also be higher in present value terms because of discounting (3.5%).

Figure 17 Aggregated impact assumptions for option 2 (legislate now), relative to option 0 (do minimum)

Impact over time	2022 to 2027	2028 to 2031	2032+
Benefits <24 metres	Positive, low	Positive, low	
Benefits >= 24 metres	Positive, high	Positive, high	
Transition costs	Negative, high	Negative, low	
Ongoing costs	Positive, medium	Positive, medium	
Wider impacts (WEI)	Positive, medium	Positive, medium	

n.b "positive" for "ongoing costs" means cost savings

2.6.1 Illustrative benefits

151. The practical benefits of option 2 (legislate in advance of the IMO) are to: i) give the UK the powers to ensure the new and growing sector of MASS is appropriately regulated and supported; ii) ensure there is a cohesive approach to maritime operations and regulatory oversight as between MASS and non-MASS shipping (reflected by expected positive WEI of this option compared to option 0); iii) ensure that all ships in the UK fleet and operating in UK waters are built, surveyed, operated and inspected to ensure they do not cause harm to other maritime users, the environment, human health, property or resources; iv) allow the UK to provide an active and informed position in international discussions that will shape the regulation of MASS internationally and the development of an IMO instrument; and, v) prepare the UK domestic law framework for future changes in international law.

152. The economic benefits of option 2 (legislate in advance of the IMO) are likely to be higher than option 0 (do minimum). Option 2 will enable MASS shipping of all ship lengths across the time period from 2022 to 2027 and 2028 onwards. This will have a beneficial impact in terms of business opportunity and certainty of operations. The impact will be particularly large for MASS over 24 metres in length, as regulatory exemptions for remotely operated unmanned ships are due to apply only to vessels under 24 metres in length[69]. This is the main additional benefit of this option, and it is expected to be higher than option 1 (wait for IMO) as the benefits are brought forwards to 2022 from 2028.

2.6.2 Illustrative costs

153. There are expected to be higher up front (2022 to 2027) transition costs compared to option 0 (do minimum) associated with developing the legislation, familiarisation by industry and associated training etc., but these will likely decrease from 2028 onwards. This is the opposite to option 1 (wait for IMO), where the bulk transition costs are expected from 2028 onwards, and they are also expected to be slightly lower for option 1 compared to option 2 given the work by other Member States, which HMG, regulators and UK maritime sector could lean on.

154. The regulatory framework is likely to be complex, so stakeholders of potential and existing firms will need to spend time familiarising themselves with the requirements. These costs are driven by the number of people that need to familiarise themselves with the regulations, their wage rates and the complexity of the regulations. These factors will be considered for each individual regulation and requirement generated using the powers taken in these primary regulations.

[69] Maritime and Coastguard Agency continue to utilise Merchant Shipping (Load Line) Regulations 1998 exemption to allow autonomous shipping in UK. The Workboat Code is due to be updated and will include new regulatory provisions for remotely operated unmanned vessels under 24 metres in length on an exemption basis.

155. As a result, compared to option 0 (do minimum), option 2 (legislate in advance of the IMO) is expected to have ongoing (regulatory) cost savings, given the ad-hoc nature of the current exemption process. These savings are expected to be realised across both 2022 to 2027 and 2028 onwards, which represents greater savings than option 1 (wait for IMO).

2.6.3 Risks and unintended consequences

156. The primary risk in developing the domestic legal framework now is that the UK could diverge from international standards as they develop in the future, for example when defining terms and definitions of MASS. However, the UK will be able to take its experience on the regulation of MASS to the international discussions to shape that discussion to reduce this risk. Flexibility within the proposed changes to legislation will also ensure the domestic regulations can be amended to ensure they are in line with international instruments and guidance as they are developed. There are also the following risks and unintended consequences:

157. By not waiting for international discussions and regulation to be finalised there is a danger that the UK may implement much more rigorous requirements than the IMO later introduce. This may put the UK MASS industry and UK shipping at a competitive disadvantage with its international competitors. This may also impact on the ability of foreign flagged autonomous ships being able to operate in UK waters, as it may be designed and operated to a lower standard than would be accepted in UK waters. Similarly, there is also a risk that the UK regulation would have to change again to make it align with the IMO regulation.

158. There is a risk relating to the public/industry perception of the level of detail and regulation the proposed changes to legislation would deliver. There will still need to be the development of secondary legislation and consultation on its contents which may disappoint or frustrate some within industry. This will need to be managed through careful communication with key stakeholders.

159. An unintended consequence of removing the uncertainty around the use and development of autonomy is that the adoption of the technology might be greater than expected. This could potentially outstrip the supply of suitably qualified personnel or education of those operating in the maritime space. Either stifling the growth of maritime autonomy or leading to operators, masters and regulators not being able to react with full understanding of the situation.

160. There is an uncertainty in how widely and to what extent maritime autonomy will be adopted in relation to surface ships or how the growth of subsurface might change. This could result in a disproportionate effort to regulate a section of the maritime industry that could fail to deliver the expected returns to the UK economy.

161. Without careful review and consideration of the amendments that are expected to be made to secondary legislation there is the danger of unintended consequences on the regulation of non-MASS ships. Although all care will be taken and due diligence will be demonstrated, this risk should be acknowledged.

2.7 Summary of impacts

162. Option 2 (legislate ahead of the IMO) is an advanced version of option 1 (wait for IMO), with impacts brought forwards as the UK develops and implements domestic legislation and regulation for maritime autonomy and remote operations earlier. Therefore the impacts, as summarised in Figure 7, in terms of magnitude, direction and affected stakeholders are similar for both options, except the impacts (both costs and benefits) will be realised earlier under option 2 and are therefore subject to less discounting, because people generally prefer value now rather than later.

163. Given that the proposed regulation only looks at taking powers and, by nature of being a new and emerging market, a clear final regulatory regime is still under development, a full monestised assessment of impacts has not been possible at this stage. Impacts will be fully assessed in consultation and final stage IAs at secondary legislation. As mentioned in the methodology section, this is in line with the Regulatory Policy Committee guidance[70].

[70] Regulatory Policy Committee 'RPC case histories: assessment and scoring of primary legislation measures', August 2019, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827907/RPC_case_histories_-_Primary_legislation__August_2019.pdf

3 Wider impacts

3.1 Innovation Test

164. The emerging nature of MASS means that it is inherently innovative, and the proposed primary legislation is designed to enable HMG to better regulate the market and reduce barriers to entry. Without the legislation, there is a risk that other countries will benefit from this innovation to the detriment of the UK and therefore that we will not achieve the policy objectives.

165. At present, MASS is a relatively small market in the UK, with a handful of companies in R&D phases. These are legally permitted to operate on an exemption basis. This approach is expected to represent a barrier to innovation and growth as the market develops, and therefore a potential Government failure. Therefore, Government intervention is needed to put in place high level powers to develop a comprehensive regulatory framework and guidance to further enable a broad range of potential MASS operations from and into the UK.

166. The options in this IA reflect the current structure of UK and international shipping legislation and are not intended to provide granular, prescriptive regulations at this stage given the emerging nature of maritime autonomy in the UK and abroad. The preferred option is designed to provide the UK with powers to regulate maritime autonomy as the market develops via secondary legislation under the proposed changes to primary legislation. The proposed legislation would apply to all ships and craft regardless of size, including very small craft which might not traditionally be considered as 'ships'. The details of any secondary legislation will be determined at a later stage but are expected to cover specific segments or aspects of the MASS market.

167. Whilst the expected costs to business of subsequent secondary legislation, guidance and regulation may have adverse impacts on innovation, by virtue of it being more specific, the primary legislation as a whole is designed to enable innovation in the UK maritime sector by reducing barriers to entry for MASS. The approach considers a wide possible definition of maritime autonomy and therefore should not preclude any possible future types of autonomous shipping and remote operations and as a result permit a wide range of innovation. It also mitigates the risk of designing a narrow legislative and regulatory framework that could become outdated quickly if the market moves at a different speed or direction than set out in legislation.

3.2 Small and Micro Business Assessment and Competition Assessment (SaMBA)

168. Small and Micro Businesses are classified as companies with 49 or fewer employees. This proposed legislation will apply to all businesses, regardless of size. However, it is not expected to adversely impact competition. It is enabling legislation to cater for the emerging MASS market, and any business will be able to enter the market, provided they meet the conditions for ship certification and registry.

169. It would not be appropriate to exclude small and micro businesses from this legislation because this would also exclude small and micro businesses from the benefits associated with the enabling legislation and guidance. Nor would it be appropriate to provide exemptions from licensing and regulation requirements due to the need to maintain safety.

170. The proposed legislation is expected to increase competition in the UK ship manufacturing, operation, and labour markets, and improve the UK's global competitiveness in these markets. Existing (incumbent) non-MASS ship manufacturers, operators, and labours (Figure 8, Figure 9 and Figure 10) may be subject increased competition from autonomous ship manufacturers, operators, and the technology itself. For example, lower labour and operational costs for autonomous ships may allow autonomous shipping companies to offer lower prices than non-MASS shipping companies, incentivising these companies to cut costs, potentially through adoption of autonomous shipping technology, and lower prices to compete.

171. Recently, there has been a growth in vertical and horizontal market integration in the global maritime transport sector, indicating a potential trend towards market shares being concentrated to a few businesses.[71] The minimum efficient scale for providing shipping services is large, which presents a natural barrier to smaller firms entering the market.[72] For example, there has been a trend towards larger container ships in recent decades, with Ultra Large Container Vessels (ULCVs) able to carry over 10,000 Twenty-foot Equivalent Unit (TEU) containers and the largest ship, HMM Algeciras (Panama), able to carry 24,000 TEU.[73]

172. In addition, large capital requirements may act as a barrier to entry in the marine technology sector. To compete in the market entrants are required to invest a large amount of capital in both research and development as well as product development,[74] with increasing development costs the closer to market technologies get.[75]

173. In the UK water transport sector, the vast majority of businesses are Small and Micro-sized e.g. 94.7% of sea and coastal freight water transport companies have 49 or fewer employees. The same is true for the building of ships and boats sector, where 94.3% of companies have 49 or fewer employees (*Figure 18*). Whilst the companies may be impacted by the proposed legislation, in terms of familiarising themselves with the legislation and experiencing increased competition from autonomous ship manufacturers and operators, they could also gain from manufacturing and adopting MASS technology.

Figure 18 Business Population Estimates for the UK and regions 2020, Table 7 [76]

	Micro (1-9)	Small (10-49)	Medium (50-249)	Large (250+)
301 Building of ships and boats	80.0%	14.3%	3.8%	1.9%
501 Sea and coastal passenger water transport	78.7%	14.9%	4.3%	2.1%
502 Sea and coastal freight water transport	76.3%	18.4%	5.3%	0.0%
503 Inland passenger water transport	69.6%	26.1%	4.3%	0.0%
504 Inland freight water transport	85.7%	14.3%	0.0%	0.0%

[71] UNCTAD (2019b). Review of maritime transport 2019. Available at: https://unctad.org/en/PublicationsLibrary/rmt2019_en.pdf [Accessed 15/09/2020].
[72] The minimum efficient scale is the minimum level of output a firm needs to produce so that the cost per unit of output Is decreasing with increasing scale. If the minimum efficient scale is large, firms must produce a high level of output relative to the total industry output to operate efficiently and competitively in the market.
[73] Marine Insight 'Top 10 World's Largest Container Ships In 2021', 5 March 2021, available at: https://www.marineinsight.com/know-more/top-10-worlds-largest-container-ships-in-2019/
[74] Port Technology International 'Successful Delivery Of Terminal Infrastructure', 2017, available at: https://www.porttechnology.org/technical-papers/successful_delivery/
[75] John Hopkins Applied Physics Laboratory 'Parametric Cost and Schedule Modeling for Early Technology Development', 2018, available at: https://www.jhuapl.edu/Content/documents/ParametricCostScheduleModeling.pdf
[76] HMG 'Business population estimates', 8 October 2020, available at: https://www.gov.uk/government/collections/business-population-estimates

174. For companies currently involved in autonomous ship development in the UK (38) based on the smart shipping research, almost all that are solely focused on developing autonomous ships (11) are classified as SMEs. The remaining companies that are involved in both developing autonomous ships and other activities are skewed towards larger numbers of employees, with the largest of these, IBM, classified as a large enterprise (250+ employees).

175. The proposed legislation provides broad powers to permit increased business activity, which will provide new potential benefits to all businesses, regardless of size, as it is designed to improve access to the UK MASS market. The specifics of how this are implemented, which will determine any disproportionate impacts or barriers felt by SMBs, will be defined through secondary legislation. Any future SaMBA assessments will focus on the fixed costs and barriers to entry for SMBs e.g. standard rates for certification or legal fees.

176. Several consultation responses were concerned with high compliance, and consequently enforcement costs, as a proportion of turnover. These costs will occur after secondary legislation and hence have not been fully appraised in this impact assessment. Following secondary legislation, small and micro businesses are expected to face regulatory and compliance costs similar to the non-MASS industry. This will be tested through consultation and the SaMBA and Competition Assessment alongside further secondary legislation under the proposed changes to legislation.

177. Therefore, whilst the proposed primary legislation is not expected to disproportionately and adversely impact small companies, it has been designed to be flexible in order to both provide HMG with powers to regulate a range of maritime autonomy activities in the UK, but also reduce barriers to entry for SMEs and increase competition.

3.3 *Equalities Impact Assessment, Health Impact Assessment and Human Rights*

178. There is a statutory duty to consider the effects of policies on those with protected characteristics under the Public Sector Equality Duty (PSED) set out in the Equality Act 2010.

179. As set out in our evidence-based Equality Impact Assessment (unpublished), we consider that the approach to the safe operation, certification and inspection of MASS will not have a clear adverse or disproportionately negative impact on people who share a protected characteristic.

180. Analysed within the Equalities Impact Assessment are industry, public and other Government departmental views collected during the FoT Regulatory Review consultation which concluded in November 2021. We received 55 responses from a wide range of maritime stakeholders. Overall, respondents to the consultation were in favour of our proposed policies. The feedback was used to inform policy decisions, including measuring the impacts on groups of people with protected characteristics. All of the stakeholders who responded to the question regarding PSED said there would either be a neutral impact or benefits. However, we did not receive any data or evidence to support these assumptions.

181. Developing autonomous technology may offer people with protected characteristics more opportunity to enter the maritime industry as some traditional maritime roles transition to more office-based environments, such as Remote Operating roles. The Foresight Future of

the Sea report supports this theory, stating that autonomous ships could put the UK at the forefront of growing opportunities in specialist ship building, legal and regulatory innovation.[77]

182. Updating primary legislation to enable the operation of autonomous ships should offer opportunities to all groups considered within the (PSED). Further Equality Impact Assessments may be completed during the remaining decision-making process, and/or when secondary legislation is considered. The Department will monitor how the policy is effecting people who share protected characteristics once implemented.

183. We do expect the proposal to affect or impact upon existing health inequalities, particularly through secondary legislation. Updating primary legislation to enable to operation of remotely operated and autonomous ships is expected to impact employment levels and skills within maritime. Evidence suggests there could be job losses, however, the development of automation could also create new types of employment within the sector.[9] The Department will monitor how the policy effects health inequalities once implemented. When secondary legislation is introduced proposed legislative changes will be analysed accordingly.

184. The policy does not affect or contravene any measures contained in the Human Rights Act 1998.

3.3 Justice Impact Test

185. Offences arising from this primarily legislation have not yet been outlined in the policy detail. Once outlined, they are expected to extend some existing offences to cover remotely operated ships, remote operation centres and those responsible for them. The overall impact on the criminal justice system is likely to be negligible. It is possible more prosecutions may be pursued as a result of extending the offences, particularly if the regulation change resulted in the growth of the shipping industry. However, this would only have a slight increase in workload for magistrates' courts and is a very small proportion of total cases which the criminal justice system deals with. As result, no impacts have been quantified at this stage, as they are likely to be marginal.

186. A full and proportionate approach to the justice impact test will be developed once the remaining policy decisions for the regime have been made and will be published alongside the updated analysis. The impact test will be reviewed and updated accordingly.

187. This will remain under review for secondary legislation affecting MASS policies.

[77] The Future of the Sea Report, available at: assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/706956/foresight-future-of-the-sea-report.pdf

4 Monitoring and Evaluation

188. The Department for Transport is committed to the monitoring and evaluation of major policy and legislative changes, in accordance with the Magenta Book[78].

189. As discussed in section 2.1 Methodology, there is a large degree of uncertainty that may impact how the overall regime performs including growth of the emerging maritime autonomy sector and details of the final regime, which will be established later through secondary legislation. This uncertainty may be partially mitigated by regular reporting and a focus on process evaluation as detailed in the following paragraphs.

190. As this primary legislation only sets out key definitions and introduces the powers necessary to put in place a regulatory framework, it is not expected to enact or enable change directly. As a result, it is not possible or appropriate to provide specific details on the plan for monitoring and evaluation at this stage. The detail and regulatory framework of the final regime will be established through secondary legislation and guidance. A full and proportionate approach to the monitoring and evaluation will be developed once the remaining policy decisions for the regime have been made and will be published alongside the updated analysis. The plan will be reviewed and updated accordingly.

191. This interim monitoring and evaluation plan is designed to provide as much detail as is appropriate and relevant at this stage of introducing new powers. As the regime develops further via guidance and secondary legislation, the monitoring and evaluation plan will continue to be developed. This plan covers the objectives of the regime as a whole, including SMART objectives.

4.1 Objectives of the regime

192. As set out in section 1.4 Policy objectives, the objectives of this policy are to:

a. Give the UK the powers to ensure the new and growing MASS sector is appropriately regulated and supported.
b. Ensure there is a cohesive and consistent approach between MASS and non-MASS regulation.
c. Ensure that all ships in the UK fleet and operating in UK waters are built, surveyed, operated and inspected to ensure they do not cause harm to other maritime users, the environment, human health, property or resources.
d. Allow the UK to provide an active and informed position in international discussions that will shape the regulation of MASS internationally and the development of an IMO instrument.
e. Prepare the UK domestic law framework for future changes in international law.

193. Section 2.4 (baseline) set out the high uncertainties associated with future trends of the emerging maritime autonomy sector. This uncertainty around the baseline presents challenges when drawing a causal link between policy objectives and the proposed regulatory framework. However, within this constraint, the Government has identified the Specific, Measurable, Achievable, Realistic and Time-limited (SMART) objectives that sit underneath the five strategic objectives of the policy.

194. Due to the uncertainty around future IMO legislation and how relevant participants and new entrants to the market may interact with the proposed legislation, it has been deemed

[78] https://www.gov.uk/government/publications/the-magenta-book

that five-year intervals are appropriate to evaluate the effectiveness of the regime against these objectives. This period was chosen to balance the time needed to observe how the regime operates in practice, the benefit of timely information and the opportunity to influence IMO discussions expected to start around 2028. Flexibility has been built into the monitoring and evaluation plan to allow for regular monitoring and the ability to report early so that the monitoring and evaluation can be delivered when appropriate within this five-year period. However, the objectives are formally defined over each five-year period in order for these to be full time-limited, SMART objectives.

195. **Ensure the MASS sector is appropriately regulated and supported** – there are several key outcomes to this objective. Firstly, that efficient regulation of MASS is developed, reducing regulatory uncertainty in the sector and encouraging growth, innovation and investment. Secondly, that the regulation aligns with the Department of Transport's strategic priority to grow and level up the economy. This leads to two separate SMART objectives interventions:

    a. That the regulation is efficient and reduces regulatory uncertainty for public authorities and industry. This is difficult to measure quantitatively or causally, however, qualitive measures may be used. By comparing the proposed regime as a whole against the current exemption approach, evaluation should focus on comparable aspects. One such feature might be on the usefulness of guidance and whether public authorities and businesses actively engage with it and find it accessible. This may be measured by considering total proffesionals' time spent reading the guidance. The focus on specific aspects means this objective will be specific and measurable. As the regime aims to comply with future changes in international law, it would not be realistic to have an objective to minimise all administrative burdens. Moreover, it would not be optimal to minimise burdens where there may be a net benefit. Therefore, for this objective to be reasonable and realistic, it should be targeted at excess time burdens for industry and regulators, where there is no clear benefit as discussed throughout the rest of this Impact Assessment.

    b. That the regulation encourages growth, investment and innovation in the MASS sector should be monitored quantitively. Consultancy research into the UK maritime technology sector[79] provides a reasonable baseline to the market size in 2021; 215 relevant companies to the smart shipping industry, of which 38 are in the autonomous ship segment. However, as this is an emerging sector, there is currently no regular data collection associated with MASS specifically. MASS statistics are currently captured in wider maritime statistics such as the Department of Transport's annual seafarer statistics. As the maritime market evolves, new fields could be added into these statistics such as the number of electro-technical officers added in 2020[80]. Alongside a more detailed monitoring and evaluation plan with the secondary legislation, consideration will be given to adding a new 'autonomy' field to the annual seafarer statistics and engaging with the MCA to monitor businesses engaging with the regulations.

196. **Ensure a cohesive approach to maritime operations and regulations between MASS and non-MASS shipping.** It is a reasonable assumption that a cohesive approach would lead to no excess burdens between the MASS and non-MASS industry and their respective regulators. Therefore, the SMART objective can be seen as the same as those that relate to efficient regulation.

[79] Smart Shipping Technology 25 November 2021, https://www.marri-uk.org/reports/smart-shipping-technology-report
[80] Seafarers in the UK Shipping Industry:2020, pg 6 Seafarers in the UK Shipping Industry 2020 (publishing.service.gov.uk)

197. **Ensure UK ships and ships in UK waters do not cause harm to maritime users, the environment, human health, property or resources** – whilst it is not currently possible to draw a strong causal conclusion between maritime autonomy regulations and marine casualties and incidents, it is possible to monitor the number of marine casualties and incidents reported to the Marine Accident Investigation Branch and published annually[81]. These report on *"an event or sequence of events…which has occurred directly in connection with the operation of a ship that endangered, or if not corrected would endanger the safety of a ship, its occupants or any other person or the environment (e.g. close quarters situations are Marine Incidents)[82]"* and associated to ships with a UK flag or in UK waters. Ideally, the proposed maritime autonomy and remote operations regime would maintain/decrease the number of marine casualties and incidents so a realistic target would be for these reported marine casualties and incidents to be similar to or below historical levels.

198. **Allow the UK to provide an active and informed position in international discussions** – this will also help to meet the Department of Transport's strategic priority to increase our global impact. This objective would be met if part of the UK's legislation or practical experience in the MASS sector is reflected in the IMO legislation, expected around 2028. Similarities and differences between the UK proposed legislation and IMO proposed legislation could be used as a measure of how successful the UK was in informing international discussions and consequently acting as a global leader in maritime autonomy.

199. **Prepare UK domestic law framework for future changes in international law** – the intended outcome here is to enable the UK to meet future autonomy IMO obligations efficiently. Therefore, the SMART objective can be seen as the same as those that relate to efficient regulation. This may be achieved up until the IMO's future legislation is ratified, expected around 2029.

[81] MAIB annual report - GOV.UK (www.gov.uk)
[82] Annex B, MAIB Annual Report 2020