



Department  
for Transport

# **Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018**

Given by the Secretary of State under section  
2(2)(e) of the Space Industry Act 2018

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# 1. Introduction

## The regulator's functions under the Space Industry Act 2018

In accordance with [section 2\(1\) of the Space Industry Act 2018](#), the regulator must exercise its functions with a view to securing public safety.

In exercising its functions under the Act, the regulator is also required by section 2(2) to take account of:

- a. the interests of persons carried by spacecraft or carrier aircraft
- b. the requirements of persons carrying out spaceflight activities
- c. the interests of any other persons in relation to the use of land, sea and airspace
- d. the requirements of persons with interests in property carried by spacecraft
- e. any environmental objectives set by the Secretary of State
- f. the interests of national security
- g. any international obligations of the United Kingdom
- h. any space debris mitigation guidelines issued by an international organisation in which the government of the United Kingdom is represented

If there is a conflict in the application of the above provisions, the regulator must apply them in the manner it thinks is reasonable having regard to the provisions as a whole.

These are separate from the Civil Aviation Authority's (CAA) functions with regards to air navigation and any aviation specific environmental objectives or guidance issued to the CAA under the Transport Act 2000.

This guidance sets out the environmental objectives set by the Secretary of State under section 2(2)(e) of the Space Industry Act 2018 and provides specific guidance from the Secretary of State to the regulator on how to interpret its environmental duties with respect to these objectives.

The UK is a contributor, member, or signatory to the following international guidelines that address space debris mitigation and end of life disposal plans for satellites and launch vehicles (accurate as of 2020):

- Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space
- Guidelines for the Long-term Sustainability of Outer Space Activities
- European Code of Conduct for Space Debris Mitigation
- Inter-Agency Debris Coordination Committee Space Debris Mitigation Guidelines
- Space Debris Mitigation Requirements BS ISO 24113-2019
- Disposal of orbital launch stages BS ISO 16699:2015
- Requirements on Space Debris Mitigation for European Space Agency Projects

None of these guidelines are legally binding on the UK or any other signatory. However, all signatories commit, as a condition of their ongoing participation in the relevant forums, to make best efforts to implement the principles in any missions licensed by the signatory. The Space Industry Act 2018 places a duty on the regulator to take account of international space mitigation debris guidelines when carrying out its functions under section 2(2)(h), and within the draft<sup>1</sup> [Space Industry Regulations 2021](#), give the regulator the power to place conditions on any licence to address debris mitigation (Schedule 1, paragraph 1(g)). These provisions have been included to ensure the safety, security and sustainability of the orbital environment. The regulator's duties with regard to debris mitigation sit alongside its duty to take account of the environmental objectives set by the Secretary of State.

## Devolved administrations

Devolution has brought changes to the role of government in the United Kingdom. Regulation of space is a 'reserved' matter for the UK parliament and government.<sup>2</sup> However, ground-based facilities, for example supporting infrastructure at spaceports, will include matters that are within devolved competence and will be subject to applicable devolved regulation or policy requirements.

## Purpose of this guidance

The purpose of this guidance is to provide the regulator and the public with clarity on the government's environmental objectives relating to spaceflight and associated activities in the UK.

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<sup>1</sup> At the time of publication, the Space Industry Regulations 2021 have not concluded the Parliamentary process nor come into force.

<sup>2</sup> Scotland Act 1998. The Scotland Act 1998 (Transfer of Functions to the Scottish Ministers etc.) Order 1999, No. 1750. Government of Wales Act 1998. Northern Ireland Act 1998.

Under [section 11 of the Space Industry Act 2018](#), the regulator has a duty to take account of an assessment of environmental effects (AEE), submitted as part of an application for a spaceport or launch operator licence, when deciding to grant the licence or impose any conditions on the licence. The objectives presented in this guidance are consistent with the environmental topics which must be addressed in an AEE.

This guidance does not seek to replace the comprehensive [airspace change guidance](#) already issued to the CAA with regards to the airspace change process or [its air navigation guidance](#). Instead, this guidance should be considered complementary to the approach already taken by the CAA when exercising its air navigation functions, to ensure that:

- the space sector can make an important contribution to the UK economy in a sustainable way
- the environmental impact of spaceflight activities is minimised and mitigated as much as it is practicable and realistic to do so

This guidance has taken into account the government's broader approach to the environment, and in particular it draws on the UK government's [25 Year Environment Plan](#) which sits alongside the government's [Plan for Growth](#) and [Clean Growth Strategy](#).

The guidance is divided into the following sections:

- the government's environmental and sustainability policies
- specific spaceflight environmental objectives
- factors relevant to spaceport operations
- factors relevant to launch operations

## 2. Government environmental and sustainable development policies

In 2005, the UK government reviewed and developed its 1999 strategy around sustainable development, to take account of new policies and the international ambition for sustainability to form the cornerstone for global development approaches.

The updated strategy, '[Securing the future – delivering UK sustainable development strategy](#)', aims to ensure that globally people have the right to their basic needs and enjoy a better quality of life without compromising that of the future generations. To do this, the strategy set out four agreed priorities:

- sustainable consumption and production
- climate change and energy
- natural resource protection and environmental enhancement
- sustainable communities

The United Nations Sustainable Development Goals (SDGs) are a global call to action to achieve a better and more sustainable future for all. The 17 SDGs were adopted by all UN Member States in 2015 and address the challenges being faced globally on poverty, inequality, climate change, environmental degradation, peace and justice.

The UK set out its commitment and approach to achieving the UN goals through the '[Agenda 2030: Delivering the Global Goals](#)'. A cross-Whitehall sustainable development forum has also been set up to co-ordinate and facilitate the implementation of these goals in the UK.

The [National Planning Policy Framework](#) (NPPF) states that the purpose of planning is to help contribute to the achievement of sustainable development. It sets out the government's economic, environmental and social planning policies for England. Planning is a devolved matter and planning policy in respect of Scotland, Wales and Northern

Ireland is currently set out in the [Scottish Planning Policy](#), [Planning Policy Wales](#) and in Northern Ireland by the [Strategic Planning Policy Statement](#). These national planning policies outline approaches to the preparation of local and neighbourhood plans and for making decisions on planning applications.

To achieve sustainable development, the [planning system](#) applies three broad objectives to be delivered through planning proposals and the decisions made on those proposals. These objectives are:

- **an economic objective** to aid in building a strong and reliant economy
- **a social objective** to support strong and healthy communities
- **an environmental objective** to contribute to protecting and enhancing the natural, built and historic environment

## Applying the policy framework to commercial spaceflight

Commercial spaceflight in the UK will have implications at the global, national, regional and local level for the successful delivery of the SDGs. Spaceflight has the potential to affect climate change, local air quality and noise<sup>3</sup> levels which can impact human health, ecological receptors and the marine environment.<sup>4</sup> To deliver the economic, social and environmental objectives, a balance will need to be struck between avoiding or minimising negative environmental impacts and maximising the contribution of spaceflight activities to the economy and the environment.

The government's 25 Year Environment Plan, sets out a new and ambitious framework for environmental governance to help England<sup>5</sup> deliver its environmental objectives and meet its commitments under the SDGs. This plan represents a step-change in environmental protection and recovery for the UK.

The [UK Marine Policy Statement](#) provides a framework for taking decisions affecting the marine environment to ensure achievement of sustainable development in the UK marine area.

The regulator can contribute towards delivering the government's sustainable development and environmental aims and objectives by complementing and reinforcing the balance between sustainable development whilst minimising environmental harm and promoting environmental enhancement (environmental net gain).

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<sup>3</sup> The effects of vibration, from proposed spaceflight activities, is required to be addressed as part of the assessment of environmental effects submitted with the launch operator or spaceport licence application.

<sup>4</sup> In this document the 'marine environment' includes marine activities and users such as ports, shipping, safety and freedom of navigation, offshore infrastructure, fisheries, aquaculture, tourism and recreation.

<sup>5</sup> As environmental policy is devolved, responsibility rests with the Scottish Government, Welsh Government and Northern Ireland Executive, the proposals in the 25 Year Environment Plan apply to England only. However, the UK Government is responsible for a number of policies and programmes which affect sectors across the UK and internationally, therefore some aspects of the Plan will apply to the UK as a whole.



There are other government policies which have not been mentioned here. More detail will be provided on specific policies and how they relate to the environmental objectives in the subsequent sections.

Following the UK's departure from the European Union (EU), the regulator and industry should have due regard to any new environmental legislation, policies and guidance. The government will also periodically amend this guidance to reflect changes to the regulatory landscape.

### 3. Environmental objectives for spaceflight activities

The main environmental effects of UK spaceflight activities are likely to be:

- the effects of spaceflight emissions on climate change and on levels of ozone in the upper troposphere and stratosphere
- the effects on local air quality around the spaceport
- the effects of spaceflight noise on people and wildlife at the spaceports and under flightpaths
- the effects on the marine environment from jettisoned objects, as well as coastal spaceports and launch activities

The environmental objectives for spaceflight are therefore to:

- minimise emissions contributing to climate change resulting from spaceflight activities<sup>6</sup>
- protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities
- protect people and wildlife<sup>7</sup> from the impacts of noise from spaceflight activities
- protect the marine environment from the impacts of spaceflight activities

These environmental objectives facilitate the government's overall environmental policies and address both the local and global impacts of spaceflight activities. The overarching

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<sup>6</sup> The UK's contribution to global emissions through spaceflight activities and considering emissions from the full journey (even once it has left UK airspace/boundaries).

<sup>7</sup> The impacts on domesticated animals and livestock should be considered alongside wildlife.

objective is to avoid or minimise the environmental effects of spaceflight activities within the context of supporting a strong and sustainable UK space sector.

## 4. Guidance to the regulator on the interpretation of the environmental objectives

### Emissions contributing to climate change

The Secretary of State has set an environmental objective for the regulator to ‘minimise emissions contributing to climate change resulting from spaceflight activities’.

The majority of spaceflight activities, for both vertical and horizontal launch, will emit carbon dioxide (CO<sub>2</sub>), other greenhouse gas emissions and particulates (soot) as exhaust products. These combustion emissions from launch vehicles can contribute to climate change and lead to impacts on the global ozone layer.

The UK government has made clear commitments to reduce greenhouse gas emissions and adapt to climate change,<sup>8</sup> while maximising the economic opportunities of clean growth. This is reflected in its international obligations the UK is signed up to, such as the [Paris Agreement](#); and legislation, such as the [Climate Change Act 2008](#); and strategies such as the Clean Air Strategy 2019, Plan for Growth, the Clean Growth Strategy and the 25 Year Environment Plan.

Under the Climate Change Act, the government and the devolved administrations set legally binding targets to reduce greenhouse gas emissions from 1990 levels. To achieve this, they set carbon budgets which provide a five-year statutory cap on total greenhouse gas emissions emitted in the UK. In April 2021, the government announced it will set the world’s most ambitious climate change target in the Sixth Carbon Budget, to reduce carbon emissions by 78% compared to 1990 levels, in line with the recommendation from the independent Climate Change Committee.

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<sup>8</sup> Resilience and adaptation to changing climate is required to be addressed as part of the assessment of environmental effects submitted with the launch operator or spaceport licence application. The regulator should refer to the following guidance [Green Book supplementary guidance on accounting for the effects of climate change](#).

The [Clean Growth Strategy](#), published in October 2017, sets out the UK's plans to grow the national income while cutting emissions contributing to climate change. The strategy sets out a comprehensive set of policies and proposals to deliver increased economic growth and decreased emissions.<sup>9</sup> It provides two guiding objectives to reducing emissions:

- to meet the UK's domestic commitments at the lowest possible net cost to UK taxpayers, consumers and businesses
- to maximise the social and economic benefits for the UK from this transition

To achieve these objectives, it identifies the need to nurture low carbon technologies. Furthermore, it recognises the importance of enhancing the benefits and value of natural resources which account for 15% of the UK emissions (for example, supporting peatlands).

**The regulator will be in a position to contribute to the government achieving its climate change goals to ensure that emissions contributing to climate change from spaceflight activities do not undermine the legally binding [carbon budgets](#) set for the UK.<sup>10</sup>**

It should be ensured that emissions contributing to climate change from spaceflight activities do not hamper the UK's ability to meet its domestic and international obligations with regards to climate change and greenhouse gas emissions.

Present day global ozone loss as a result of spaceflight activities amounts to less than 0.1% of the ozone layer.<sup>11</sup> However, ozone depletion from spaceflight activities could become significant as the global space industry, including the UK spaceflight industry, increases. It is anticipated that this contribution will likely remain trivial when compared to other sources. **Nonetheless, where possible, the regulator should encourage the UK spaceflight sector to adopt cleaner fuels and technologies which minimise the contribution of this sector to climate change and ozone depletion. Care should be taken to ensure that where cleaner fuels or technologies are adopted, that they do not introduce their own significant environmental effects. Comparison of effects might need to be considered to establish which are the most appropriate fuels and technologies to introduce.**

When considering the contributions of spaceflight activities to emissions contributing to climate change, ancillary services at a spaceport prior to launch operations should also be taken into account. This could include carrier aircraft, transit, or on-site energy sources (for example, standby generators) and vehicle movement. **The regulator should ensure that**

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<sup>9</sup> This is in line with the Paris Agreement which follows on from the Kyoto Protocol and sets out a global framework to avoid dangerous climate change by limiting global warming to below 2°C and pursuing efforts to limit it to 1.5°C.

<sup>10</sup> The UK and Wales targets will require bringing all greenhouse gas emissions to net zero by 2050. Scotland's target is to reduce greenhouse gas emissions to net zero by 2045. Northern Ireland sets the target of reduction to 35% of 1990 levels by 2030.

<sup>11</sup> Martin Ross, Darin Toohey, Manfred Peinemann and Patrick Ross. '[Limits on the Space Launch Market Related to Stratospheric Ozone Depletion](#)' *Astropolitics* 2009, 7:1, pages 50-82

**applicants for a spaceport or launch operator licence consider the contributions of ancillary services to emissions contributing to climate change within their AEEs.**

When considering an AEE submitted with an application for a spaceport or launch operator licence, **the regulator is expected to take into account the mitigations proposed by the applicant to limit any significant effects associated with emissions contributing to climate change from spaceflight activities.** For a launch operator this could include:

- consideration of energy efficiency measures and propellant, for example, switching to cleaner fuels
- launch vehicle design, for example, launch vehicle size, sustainable materials used and engine design
- consideration of meteorological conditions, for example, wind direction so that any emissions could disperse away from sensitive receptors
- carbon offsetting<sup>12</sup>

It is likely that aviation will be impacted when launch activities are taking place, for example, due to re-routing of air traffic. **The regulator will therefore need to ensure that spaceflight activities do not unduly impact on the efficient use of airspace which could result in an increase in the emissions contributing to climate change produced by air traffic. All reasonable steps should be taken to ensure that these impacts are minimised.**

## **Air quality**

The Secretary of State has set an environmental objective for the regulator to ‘protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities’.

At the local level, spaceflight activities have the potential to impact air quality through the contribution of pollutant emissions, either directly or as secondary pollutants formed through atmospheric chemical reactions. The [Air Quality Strategy for England, Scotland, Wales and Northern Ireland](#) provides a framework for UK air quality improvements and sets out UK air quality standards and objectives to measure the progress of improvements. The regulator will also need to consider air quality standards set in future environmental legislation, policies and guidance, following the UK’s departure from the EU,

The 25 Year Environment Plan, for England, sets the goal to achieve clean air by ‘meeting legally binding targets to reduce emissions of five damaging air pollutants; this should halve the effects of air pollution on health by 2030’. The five damaging pollutants identified are:

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<sup>12</sup> Prospective applicants must follow established best practice when considering these mitigation measures. The sequential process, referred to as the ‘mitigation hierarchy’, must be adopted to avoid, mitigate and reduce any negative environmental effects before considering compensation and offsetting measures.

- fine particulate matter
- ammonia
- nitrogen oxides
- sulphur dioxide
- non-methane volatile organic compounds

National strategies have also been set across the UK to tackle all sources of air pollution, including the [Clean Air Strategy](#), the [Clean Air Plan for Wales](#) and [Cleaner air for Scotland](#). These strategies recognise the importance of improved air quality which is fundamental to human health and the quality of the environment. The strategies set out comprehensive actions for tackling air pollution and delivering air quality improvements

The types of pollutants that will be produced from spaceflight activities will largely depend on the type of propellant used. Likely pollutant emissions that could arise and directly affect local air quality include: carbon monoxide (CO), oxides of nitrogen (NO<sub>x</sub>) including nitrogen dioxide (NO<sub>2</sub>), volatile organic compounds (VOCs), sulphates (SO) and particulate matters (PM<sub>2.5</sub> and PM<sub>10</sub>). Secondary pollutants, such as ozone (O<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>) and some particulates may also form through atmospheric chemical reactions.

As the improvement of air quality is a high priority for the UK, it is essential that emissions associated with spaceflight activities, and their contributions to local air quality, do not result in statutory air quality standards set both nationally and locally, being exceeded. **Therefore, when assessing an AEE submitted in support of a spaceport or launch operator licence application, the regulator should consider whether the proposed activities are within the relevant statutory air quality limits and national objectives for pollutants.**<sup>13</sup>

The adverse impacts of poor local air quality on ecological receptors due to emissions from spaceflight activities should be identified and conservation objectives taken into account within the AEE. Ecological receptors will include:

- internationally designated sites – special protection areas (SPAs), special areas of conservation (SACs) and Ramsar sites
- nationally designated sites – sites of special scientific interest (SSSIs), areas of special scientific interest (ASSIs), marine conservation zones (MCZs), marine protected areas (MPAs), national nature reserves, local nature sites such as local wildlife sites, ancient woodlands and national and local nature reserves
- protected or priority habitats and species

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<sup>13</sup> Consideration should be made to the standards and limits set for the nation in which the activities take place.

**The regulator should ensure that air quality assessments provided as part of a spaceport or launch operator licence applicant's AEE take into account the UK's obligations relating to the conservation of nationally and internationally important habitats and species where relevant.**

**The regulator should consider whether the pollutant emissions from the proposed activities are compliant with the relevant environmental standards for habitats in [England](#), [Wales](#), [Scotland](#) and [Northern Ireland](#) as appropriate.**

To assess the significance of the emissions that could affect human health and ecological receptors, these emissions should be compared to the relevant statutory air quality standards and environmental standards (for protected conservation areas) for all substances emitted.

**The regulator should ensure that any air quality assessment provided, in a spaceport or launch operator licence applicant's AEE, also considers emissions from ground operations and ancillary services.** For example, ahead of a launch it is likely that there will be an increase in traffic movements in the vicinity of the spaceport, which could impact local air quality. Static testing of the launch vehicle is also likely to result in longer term localised emissions, as well as more frequent short-term peaks compared with the launch itself. Such activities should also be considered when assessing the impacts on air quality from spaceflight activities.

Opportunities to improve air quality and mitigate any significant effects should be identified. Mitigation measures to reduce the impacts of spaceflight activities on local air quality could include:

- review of ground operations and ancillary services, for example, on-site energy sources, vehicle movement
- spaceport location, for example, positioned away from sensitive receptors
- opportunities to incorporate biodiversity improvements and environmental enhancement (environmental net gain)

## Noise

Noise from spaceflight activities is anticipated to be one of the biggest environmental concerns for both the impacts on human and wildlife receptors. Spaceflight activities, for both vertical and horizontal launch, have the potential to create significant noise events as they take off and pass overhead. If mitigations are not in place to limit the impact of noise, these events could lead to hearing loss or cause structural damage.

The Secretary of State has set an environmental objective for the regulator to 'protect people and wildlife from the impacts of noise from spaceflight activities.'

The [Environmental Protection Act 1990](#) controls noise through statutory nuisance provisions, from which road traffic, rail and aviation are exempt. Whilst the EPA 1990 doesn't include reference to a new spaceport, once the spaceport is operational the noise arising from the spaceport would be subject to statutory noise nuisance unless exempted



like road traffic, rail and aviation. Even if spaceflight noise is exempted from statutory noise nuisance provisions, noise emitted by ground-based spaceflight infrastructure is treated like any other industrial noise and subject to statutory noise nuisance.

Noise is often defined as an 'unwanted sound'. Whether sound can be considered as noise depends on its acoustic properties, its interference with intended activities and reactions to it. Furthermore, where and when the sound occurs can be contributing factors to it becoming a noise. Noise has the potential to cause significant impacts on human health, environmental quality, and amenity.

There are existing standards, guidelines and guidance for assessing the impact of noise, published by the BSI British Standards, the International Organisation for Standardisation (ISO) standards and the World Health Organization (WHO). The [WHO Environmental Noise Guidelines](#) provide guidance on protecting human health from harmful exposure to environmental noise. They set health-based recommendations on average environmental noise exposure of five relevant sources of environmental noise. These sources are road traffic noise, railway noise, aircraft noise, wind turbine noise and leisure noise.

The character of spaceflight noise will depend on the propulsion method, but irrespective, will be very infrequent. As a result, the noise generated is not covered by WHO guidelines, ISO or BSI assessment methods. Fixed spaceport support facilities should be assessed in accordance with British Standards BS 4142, as apply to any other type of industrial noise.

The [Noise Policy Statement for England](#) (NPSE) highlights that while it is possible to use standards to guide decisions on acceptable noise levels, it is not possible to have a single noise-based measure that defines when noise will have a significant adverse effect that would be appropriate for all noise sources, in all situations. As a result, the level at which noise will have a significant adverse effect will be different for different noise sources, receptors and times. This is in line with the approach taken in both Scotland ([planning advice note on noise](#)) and Wales ([planning policy](#)) with regard to managing noise and its impact on people and the environment.

The Noise Policy Statement for England (NPSE) sets out the following aims:

- avoid significant adverse impacts on health and quality of life
- mitigate and minimise adverse impacts on health and quality of life
- where possible, contribute to the improvement of health and quality of life

The noise sources for horizontally launched launch vehicles, such as spaceplanes can be attributed to combustion, exhaust plume noise and flight parameters. All these types of launch vehicle would reach supersonic speeds creating a sonic boom during launch. For jet and rocket-powered spaceplanes, the initial noise would be jet noise followed by rocket noise (combustion and exhaust plume noise). For rocket-powered only spaceplanes, the noise would be dominated by rocket noise. For spacecraft using a carrier aircraft, the initial dominant noise source is the turbofan engine jet noise from the carrier aircraft, followed by rocket noise from the launch vehicle. Spacecraft re-entering the Earth's atmosphere will also generate a sonic boom.

Unlike horizontal launch operations, which may be more like conventional aircraft in terms of noise, the sound generated by launch vehicles with vertical take-offs will be considerably louder. Although the noise sources from spacecraft will vary according to the type of spacecraft,<sup>14</sup> for most vertical launches the first few minutes of noise will be lift-off noise caused by the engine firing and high jet exhaust velocity required to boost the launch vehicle during lift-off.<sup>15</sup> After this initial period, the noise source will predominantly be the jet noise associated with the rocket engine, and the intensity will vary depending upon the size of the rocket, its exhaust velocity and nozzle exit diameter. Vibration from a rocket going supersonic will create another noise source shortly after lift-off. Noise will also be created by any jettisoned objects impact with the Earth's surface.

When assessing distinct and infrequent noise, such as rocket noise, measures of single events such as the maximum noise level ( $L_{Amax}$ ) and the sound exposure level (SEL or  $L_{AE}$ ) are most appropriate. Unweighted maximum noise level ( $L_{max}$ ) may also be appropriate for assessing risk of structural damage to surrounding buildings and properties. To avoid acute damage to the human inner ear resulting from impulsive sounds, WHO noise guidelines suggest that the maximum sound level ( $L_{Amax}$ ) should never exceed 110 dB  $L_{ASmax}$ . To avoid and minimise the risk of structural damage the maximum unweighted noise level ( $L_{ASmax}$ ) should not exceed 120 dB (unweighted). **When considering an assessment provided of the impacts of noise from launch operations as part of an AEE, the regulator should ensure that these measurements have been made and their significance assessed against accepted standards.**

The levels recommended, thus far, to protect from short-term acute effects are nevertheless high. Noise levels more than 10 dB below these levels will occur at considerable distance from a launch site. While these will not result in acute health effects, they will disturb activity and therefore have the potential to cause indirect risks. Equally, vulnerable groups, sensitive to high noise levels, may also be at risk of indirect effects.

Appropriate communication of launch times and affected areas will be crucial to managing these risks. **The regulator must therefore ensure that where the rocket launch noise footprint could result in exposures in excess of 80, 85, 90, 95 and 100 dB  $L_{ASmax}$ , that these areas are published on suitable maps and used to communicate with local stakeholders.**

The noise events arising from spaceflight activities in the UK are likely to be infrequent, of short duration but very loud events, including the potential for sonic booms. Therefore, in addition to the assessment of individual noise events, **the regulator should also ensure that any noise assessment takes into account the impacts of long-term exposure to repeated noise events over time for both human and wildlife receptors. This may include noise events which differ in duration, magnitude, and frequency.**

Whether to avoid potential conflict with civil aircraft operations or for meteorological reasons, some launch operators may prefer night-time launches. **Where a night-time launch has been proposed by an applicant, the regulator should ensure that the**

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<sup>14</sup> 'Spacecraft' means a space object, or a craft used for spaceflight activities.

<sup>15</sup> Civil Aviation Authority ['Emerging Aircraft Technologies and their potential noise impacts'](#) 2019

**applicant has assessed the risks to sleep disturbance in the vicinity around the launch using the following probability of awakening:<sup>16</sup>**

$$Probability = \frac{\exp(-2.5511 + 0.0112 \times (L_{ASmax} - 15))}{\left(1 + \left(\exp(-2.5511 + 0.0112 \times (L_{ASmax} - 15))\right)\right)}$$

The method assumes a 15 dB  $L_{ASmax}$  transmission loss from outdoors to indoors, representative of partially open windows. The number of awakenings should be aggregated by applying the probability function in 5dB  $L_{ASmax}$  noise bands.

Local meteorological conditions can influence the propagation of noise. Therefore, when taking account of the meteorological conditions in a noise assessment, consideration should be made to the favourable launch conditions as well as the seasonal prevailing meteorological conditions. **The regulator should ensure that any noise assessment provided takes into account an assessment of noise under predominant meteorological conditions and favourable weather conditions for launch where they differ.**

**The regulator should ensure that any noise assessment provided clearly identifies the sources of noise and establishes what levels of noise have no observed effect,<sup>17</sup> which have low observed adverse effects<sup>18</sup> and which have significant observed adverse effects.<sup>19</sup> This should be done in light of the environmental topics identified in the AEE associated with the proposed spaceflight activities, both before and after mitigation.**

The noise assessment carried out for a spaceport should also include any noise arising from the ground operations and ancillary services. These activities could include:

- increased vehicle movement
- generators and on-site equipment use
- assembly of launch vehicle
- launch vehicle and payload processing activities
- propellant loading
- static fire testing

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<sup>16</sup> In absence of rocket noise specific awakening probability function, the probability of awakening is based on that proposed by Elmenhorst (2012), adapted for the faster event rise time typical of a rocket noise event.

<sup>17</sup> This is the level of noise exposure below which no effect can be detected. Below this level, there is no detectable effect on health and quality of life for people and wildlife.

<sup>18</sup> This is the level of noise exposure above which adverse effects on health and quality of life for people and wildlife can be detected.

<sup>19</sup> This is the level of noise exposure above which significant adverse effects on health and quality of life for people and wildlife occur.

A sonic boom consists of a shock wave in the air created when an object, such as a launch vehicle, travels through the air at a speed greater than the speed of sound. Sonic booms can be heard over a large distance. **The regulator should ensure that the impacts of sonic boom from the launch vehicles and any stage return operations are taken into account in any noise assessment provided.**

There is no internationally agreed noise metric to quantify the human response to sonic booms and A-weighted measurements may not be sufficient to capture the total impact.<sup>20</sup> Nor is there an internationally agreed acceptable sonic boom level or dose-response function. In general, sonic booms over land should be avoided; where this is not possible, the maximum overpressure should not exceed 47.88 pascals (Pa) or 1 pounds per square foot (psf). **When considering an assessment of the impacts of sonic boom, the regulator should ensure that a range of noise metrics have been assessed in addition to A-weighted measurements.**

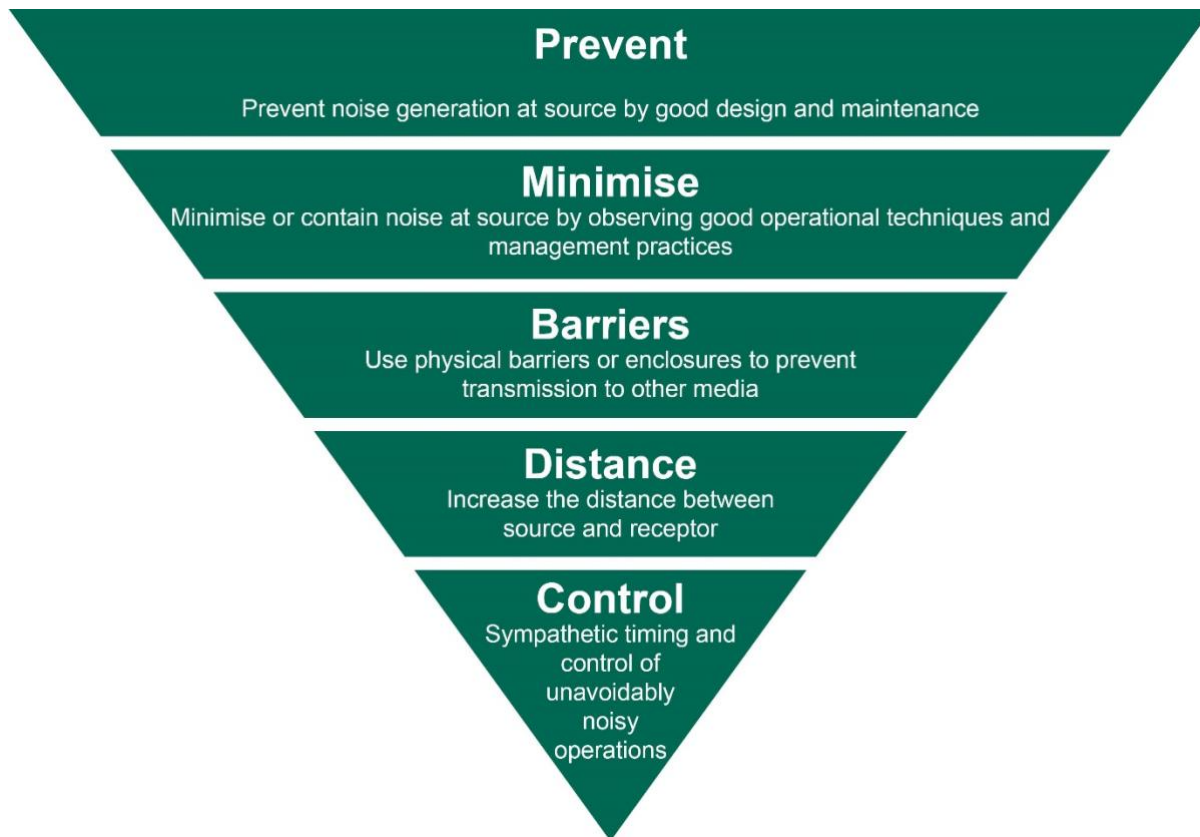
Horizontal space launches will use aerodrome runways. As these launches will be hosted by aerodromes, these operations will be subject to the rules and regulations applicable to that aerodrome. **The regulator should ensure that launch operator licensees using horizontally-launched launch vehicles adhere to the requirements set out for aerodromes, including the Air Navigation Guidance 2017, and take into account any additional noise considerations associated with horizontal launches or return operations, including sonic booms, in any noise assessment provided.**

In seeking to mitigate the adverse effects of noise, a hierarchy of noise control (Figure 1) should be implemented. This includes reductions in noise at the source by encouraging developments in launch vehicle design and the use of noise-reducing technologies. This should also include:

- careful site selection for launch activities, away from sensitive receptors
- applying noise abatement operational procedures such as operating restrictions (e.g. night-time restrictions)
- identified sensitive seasonal restrictions
- implementing launch caps

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<sup>20</sup> Alexandra Loubeau, Sara R Wilson and Jonathan Rathsam '[Updated evaluation of sonic boom noise metrics](#)' The Journal of the Acoustical Society of America 2018: volume 144



**Figure 1: Hierarchy of noise controls**

When considering the design and operation of a spaceport, there are numerous ways to control the adverse impacts of noise, including:

- the use of inherently quieter processes or lower noise options
- site selection away from sensitive receptors
- site layout to maximise natural screening and separation distances from noise sources
- use of noise barriers and bunding
- routine maintenance of any on-site equipment
- good operational practices, for example, arranging delivery or on-site vehicles away from sensitive receptors
- restricting operating hours, for example, no night-time launches or during sensitive breeding/migratory months
- ongoing management of noise, for example, through a noise plan that applies to important areas as established by strategic noise maps

**The regulator should ensure that all reasonable steps have been taken by operators to mitigate and minimise the adverse effects of noise events on human health and sensitive wildlife receptors.**

## **The marine environment**

The Secretary of State has set an environmental objective for the regulator to ‘protect the marine environment from the impacts of spaceflight activities.’

Threats to the marine environment extend beyond UK waters, and to adequately protect and improve the marine environment requires cooperation and collective action. Threats to the marine environment and the wider marine domain include adverse impacts on:

- marine ecology and biodiversity
- air quality
- noise impacts
- water quality and resources
- seascape
- historic environment
- climate change adaptation
- coastal change and flooding
- marine activities and users

The UK government is committed to protecting the marine environment, as reflected in the international treaties it is signed up to, such as the [London Protocol](#), the [Convention for the Protection of the Marine Environment of the North-East Atlantic](#) (the ‘OSPAR Convention’) and the [United Nations Convention on the Law of the Sea](#) (UNCLOS); as well as national legislation such as the [Marine and Coastal Access Act 2009](#), and strategies such as the UK [Marine Strategy Regulations 2010](#), the UK Marine Policy Statement (MPS), the 25 Year Environment Plan and [Maritime 2050](#).

The UK Marine Strategy provides the framework for delivering marine policy at a UK level. It consists of a three-stage framework ([part 1](#), [part 2](#) and [part 3](#)) for achieving a good environmental status and sets out how those targets will be delivered. The strategy covers 11 descriptors including: biodiversity, non-indigenous species, commercial fish, food webs, eutrophication, sea-floor integrity, hydrographical conditions, contaminants, contaminants in seafood, marine litter and underwater noise. To achieve a ‘good environmental status’ means:

- protecting the marine environment
- preventing its deterioration and restoring it where practical

- using marine resources sustainably

The Marine Policy Statement (MPS) is a combined policy statement from across the UK which sets high-level marine environmental objectives for 'clean, healthy, safe, productive and biologically diverse oceans and seas'.

The MPS links to the previous topics discussed, namely air quality, climate change and the impacts of noise. With regards to the marine environment, the MPS addresses:

- protection of marine ecology and biodiversity, including the halting or reversal of biodiversity loss
- air quality impacts, including emissions from shipping, oil and gas platforms and vehicle emissions as a result of increased coastal activity
- man-made noise sources, including the potential cumulative effects of noise and vibration across sensitive receptors in the marine and coastal area, balanced against potential socio-economic benefits
- impacts on water quality, quantity and physical modifications to the water environment and ensuring no deterioration in status of any water to which the Water Framework Directive applies
- the impacts of climate change on the marine environment (relative sea level rise, increased seawater temperatures, ocean acidification and changes in ocean circulation) over the lifetime of a project, facilitating mitigations such as carbon capture and storage and offshore renewables
- account for shipping as an essential and valuable economic activity for the UK
- account for the increased competition from marine resources which may affect the sea space available for the safe navigation of ships

The MPS facilitates and supports the formulation of marine plans to ensure marine resources are used in a sustainable way and that put into practice the objectives for the marine environment that are identified in the MPS. Marine plans inform and guide marine users and regulators, to encourage sustainable development of marine industries or industries that can impact the marine environment, alongside the need to conserve and protect marine species and habitats.

A marine plan:

- sets out priorities and directions for future development within the plan area
- informs sustainable use of marine resources
- helps marine users understand the best location for their activities

Public authorities have a duty to make decisions in accordance with marine policy documents where proposed activities are in, or impact, the marine environment. The AEE

should conform with all relevant policies of the marine plan, taking account of economic, environmental and social considerations and demonstrate how the proposals will contribute to achieving objectives in the marine plan.

The following marine plans cover the UK: 11 identified [marine plans in England](#), [Scotland's National Marine Plan](#), [Welsh National Marine Plan](#) and Northern Ireland are currently drafting their marine plan. The [Marine Information System](#) (MIS) provides information on England's marine plans and their policies.

Where there is no marine plan in place, the MPS sets the direction for decisions that affect the marine areas, such as granting licences for all public bodies.

**The regulator should ensure that any marine environment assessment takes into account the marine plan associated with the location of the proposed activities and that the assessment demonstrates how the proposals are in line with this. Where there is no identified marine plan, assessments should take the MPS into account. The regulator should also consider the relevant marine plan or MPS (where there is no marine plan in place) when taking decisions about the proposed activities that could affect the marine environment.**

Where marine plans adjoin the geographic area of another sovereign state or affect another sovereign state's waters, consideration should be made to that state's requirements and obligations on the management of the marine area. **The regulator should ensure that any marine environmental assessment takes into account the international obligations<sup>21</sup> associated with the location of the proposed activities and that such assessments demonstrates how the applicant's proposals are in line with this.**

Spaceflight activities have the potential to impact the marine environment through two primary channels: the development of spaceports along coastal areas, and through launch operations. The latter may result in components of the launch vehicle being jettisoned into national and/or international waters.

Jettisoned objects have the potential to cause both direct and indirect impacts on the marine environment, activities and users. These impacts include, but are not limited to:

- direct strike from jettisoned objects with marine wildlife, vessels or offshore installations and infrastructure
- acoustic disturbance (including underwater noise) from the impact of the jettisoned objects hitting the sea surface
- toxic contaminants from jettisoned objects
- thermal effects of jettisoned objects

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<sup>21</sup> Including but not limited to London Protocol, the OSPAR Convention and the United Nations Convention on the Law of the Sea.



- ingestion of jettisoned objects by marine animals and seabirds
- smothering of marine organisms on the seabed
- sediment quality
- floating debris providing cover for marine animals and/or impacting shipping and safe navigation
- changes to seabed topography reducing vessel under clearance
- re-routing of vessel traffic to avoid a Space Launch Hazard Area
- reef effect, providing new habitats for attachment
- displacement of fish

**The regulator should therefore ensure that any marine environment assessment provided considers the likely effects of jettisoned objects reaching the marine environment, over a specified period of time, for a range of likely debris types, on the basis of the launch vehicle and trajectories proposed by the applicant. The regulator should also ensure the potential cumulative effects of jettisoned objects in the marine environment, taking into consideration multiple launches over the lifetime of the licence, have been accounted for. Where significant effects have been identified, the regulator should ensure that the applicant has addressed potential mitigations to prevent these effects.**

Any marine environment assessment should consider the potential movement of jettisoned objects due to oceanic tides, wave and current movements.

Where launch will result in jettisoned objects, applicants for a launch operator licence should make every effort to avoid using marine protected areas and high-density shipping areas<sup>22</sup> as drop-zones. They should also take account of other marine activities and users and the impacts of seasonality on the marine environment when deciding the launch schedule. **The regulator should take account of the location of any proposed marine drop-zones and the time of year they will be used when considering an AEE submitted with a launch operator licence application.**

As a minimum, launch operator licensees will be expected to provide the coordinates of any jettisoned objects to the relevant marine authority<sup>23</sup> after the objects have been jettisoned and establish whether separate marine licences will be required. In addition, licensees should consider the retrieval of any objects where practical to do so.

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<sup>22</sup> Such as internationally agreed routing measures (IMO).

<sup>23</sup> The UK marine licensing administrators are, Marine Management Organisation, in England (0 to 200 nautical miles); Marine Scotland (0 to 200 nautical miles); Natural Resources Wales (0 to 200 nautical miles) and Department of Agriculture, Environment and Rural Affairs in Northern Ireland (0 to 12 nautical miles) and Marine Management Organisation, in Northern Ireland (12 to 200 nautical miles).

Spaceports located in coastal areas also have the potential to cause both direct and indirect impacts on the marine environment including, but not limited to:

- acoustic disturbance (including underwater noise) from spaceport activities and from launch and flight paths passing overhead
- toxic contaminants from any discharges arising from spaceport or launch activities into coastal areas or the marine environment
- thermal effects from any discharges arising from spaceport or launch activities into coastal areas or the marine environment
- displacement of animals and seabirds
- changes to seascape, coastal change or flooding

**Where spaceports are located along the coast, the regulator should ensure any assessment of the marine environment provided, as part of a spaceport AEE, considers the likely effects of the operation of the spaceport on the marine environment, which includes the shoreline, estuaries, tidal areas and all internal waters as well as the sea. Where significant effects are identified, the regulator should ensure that the proposals include mitigation for these impacts.**

Launch activities in close proximity to the marine environment or which have flight paths over the marine environment also have the potential to cause both direct and indirect impacts, including but not limited to:

- air quality from emissions arising from the launch vehicle having adverse impacts on human health, biodiversity and the wider marine environment
- acoustic disturbance (including underwater noise) from launch activities and flight paths overhead adversely affecting marine biodiversity

**The regulator should ensure that any marine environment assessment submitted as part of a spaceport or launch operator AEE takes into consideration the likely direct and indirect effects of launch activities and flight paths over the marine environment and includes proposals to mitigate these impacts.**

## 5. Revision of guidance and enquiries

### Revision of guidance

This guidance will be reviewed by the Department for Transport on a regular basis and may be amended or replaced as deemed necessary by the Secretary of State. This will help to ensure that the guidance remains in line with any evolving standards or best practice. Minor amendments may not need to be consulted on but it would be the intention to consult on any substantial changes to this document in line with the current government policy on consultations at the time the change was proposed.

### Enquiries about this guidance

Any enquiries about this guidance should be directed to: [SpaceTeam@dft.gov.uk](mailto:SpaceTeam@dft.gov.uk)

## 6. Annex A: Section 2(2) Space Industry Act 2018

Section 2(2) of the Space Industry Act 2018 sets out the following legislative framework for the regulator of spaceflight activities:

### **2 Duties and supplementary powers of the regulator**

- (1) The regulator must exercise the regulator's functions with regard to spaceflight activities with a view to securing public safety. That duty has priority over the application of subsections (2) and (3).
- (2) The regulator must exercise the regulator's functions under this Act in the way that the regulator thinks best calculated to take into account –
  - (a) the interests of persons carried by spacecraft or carrier aircraft;
  - (b) the requirements of persons carrying out spaceflight activities;
  - (c) the interests of any other persons in relation to the use of land, sea and airspace;
  - (d) the requirements of persons with interests in property carried by spacecraft;
  - (e) any environmental objectives set by the Secretary of State;
  - (f) the interests of national security;
  - (g) any international obligations of the United Kingdom;
  - (h) any space debris mitigation guidelines issued by an international organisation in which the government of the United Kingdom is represented.
- (3) If in a particular case there is a conflict in the application of the provisions of subsection (2), in relation to that case the regulator must apply them in whatever way the regulator thinks reasonable having regard to the provisions as a whole.

- (4) The regulator may do anything that is calculated to facilitate, or is conducive or incidental to, the performance of any of the regulator's functions under this Act.
- (5) The power in subsection (4) is subject to any restrictions imposed by or under any enactment.

(6) In this Act -

'carrier aircraft' means an aircraft that is not capable of operating above the stratosphere and is used, or (as the case may be) is to be used, to carry a spacecraft;

'public safety' means the health and safety of members of the public (see subsection (7)) and the safety of their property;

'the regulator' has the meaning given in section 16(8);

'spacecraft' means a space object, or a craft to which section 1(5) applies, that is used or (as the case may be) is to be used for the purpose of spaceflight activities.

- (7) Regulations may prescribe the meaning of 'members of the public' for the purposes of any provision of this Act that refers to public safety. The regulations may provide that a person who is voluntarily in close proximity to a source of danger is not a member of the public for any such purposes.