

Principles for Flood and Coastal Erosion Risk Management



July 2022 – Revision 2

Principles for Flood and Coastal Erosion Risk Management

Office for Nuclear Regulation and Environment Agency Joint Advice Note

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The ‘Principles for Flood and Coastal Erosion Risk Management’ has been updated to incorporate the UK Climate Projections 2018 (UKCP18) and to provide further guidance on climate change resilience and adaptation. The ‘Principles for Flood and Coastal Erosion Risk Management’ has also been aligned with revised regulatory guidance including the ‘Use of UKCP18 Position Statement’ [1].

Purpose of this Document

This joint advice note sets out the expectations of the Office for Nuclear Regulation (ONR) and the Environment Agency in respect of flood and coastal erosion risk management in the nuclear new build programme in England. It also provides a basis for regulatory decision making and advice (under our statutory consultee role in the planning process) to Local Planning Authorities and the Planning Inspectorate (PINS).

This joint advice note also provides guidance to dutyholders¹ in the nuclear new build programme in England who will need to analyse the risks to their site and plant from flooding and coastal erosion. For example, in support of planning permission/development consent, environmental permit applications or safety cases. This advice is intended to be risk based, pragmatic and proportionate in its approach. It will be reviewed and updated as necessary.

ONR is the UK’s independent nuclear regulator for safety, security and safeguards. Operators of nuclear sites have an obligation to protect their workforce and the public from risks, so far as is reasonably practicable (SFAIRP). For flood and coastal erosion risk management, ONR inspectors assess the safety case(s) that demonstrate that the nuclear safety risks from those hazards are as low as reasonably practicable (ALARP).

The Environment Agency is the principal flood risk management authority in England providing a strategic overview relating to all forms of flood and coastal erosion risk. The Environment Agency is responsible for managing flood risk from main rivers, the sea and reservoirs.

The term ‘risk’ is used interchangeably throughout this document to refer to both the risk of flooding and coastal erosion, and also to the radiological risks to workers and the public that may result as a consequence of flooding and coastal erosion. When reading this document, the differences in ONR and the Environment Agency’s regulatory purposes, which are presented in Appendix A, should be considered.

¹ The term ‘dutyholder’ is used in this document to refer to nuclear site licensees, potential licensees, current and potential environmental permit holders for radioactive waste disposal and applicants for planning consents. For Requesting Parties undergoing the Generic Design Assessment (GDA) process, characterisation and assessment of the coastal flooding hazard is not possible but the protection against flooding and resilience to climate change of the design will be considered. For more information, see Appendix B.

This document provides consistency and clarity to dutyholders on the regulators' approach. In particular it:

- Identifies in one place all the relevant legislation, regulatory authorities, dutyholders and high-level principles applicable to flood and coastal erosion risk management for new nuclear sites in England.
- Defines principles based on flood and coastal erosion risk management good practice that minimise the impact of new nuclear sites on existing flood and erosion risk elsewhere in the local environment while ensuring that dutyholders have reduced risks to their workforce and members of the public ALARP.
- Provides joint advice from ONR and the Environment Agency on flood and coastal erosion risk management issues relevant to nuclear sites and their local surrounding area.
- Provides a standard framework and starting point for ONR and Environment Agency staff involved in pre-planning and early nuclear safety discussions and relevant consultations.

Structure of this Document

The Principles section of this document details ONR and the Environment Agency's joint principles for flood and coastal erosion risk management.

[Appendix A](#) of this document describes the roles and responsibilities of different organisations involved in flood and coastal erosion risk management.

[Appendix B](#) of this document provides ONR and the Environment Agency's expectations for climate change resilience and adaptation, including the use of a managed adaptive approach and credible maximum scenarios.

[Appendix C](#) describes ONR and the Environment Agency's flood risk interests for nuclear new build development proposals in England.

Principles

Overview

Flood hazard analysis, and the necessary protection and management arrangements should be identified, and recorded by the dutyholder in different documents:

- for ONR – in relevant nuclear safety case(s), and
- for the Environment Agency – in planning submissions and Flood Risk Assessments (FRAs).

Overarching principle

Submissions made for different regulatory and planning purposes may differ in detail, but there should be consistency between them.

Submissions to ONR and the Environment Agency will respond to different regulatory requirements and expectations, but where they overlap in their predictions of flooding and associated effects on the site (for example, coastal erosion or changes to geomorphology), the predictions should be consistent. Differences in data, methods used, and judgments should be reconcilable and justified between the two analyses.

The analyses and protection arrangements that best address the Environment Agency's requirements, for example, should be consistent with those needed to address nuclear safety criteria as regulated by ONR.

The principles set out in this document reflect the guidance within other regulatory guidance and planning documents [2] [3] [4] and should be read alongside them.

Principles for Flood and Coastal Erosion Risk Management

Principle 1 – Dutyholder responsibilities

Responsibility for the assessment and management of flood and coastal erosion risks rests with the dutyholder.

Considerations

- Flood and coastal erosion risks posed to the site should be fully assessed from all potential sources, or any joint combination of sources, where appropriate.
- Any flood or coastal erosion risks arising from the site are the responsibility of the dutyholder and should be managed appropriately.

- Current and future flood and coastal erosion risk should be managed so that it does not cause unacceptable increases in risk or burden to future generations, and the environment.

Principle 2 – Management arrangements

It is the responsibility of the dutyholder to put in place the necessary management arrangements to ensure that appropriate flood and coastal erosion risk management measures are delivered at all stages of the design, construction, operation and decommissioning of the nuclear site.

Management arrangements should be established based on the following four areas:

- Leadership by the dutyholder
- Capability and competence
- Clarity of decision making
- Learning from experience.

Considerations

Leadership by the dutyholder

- Early engagement and the establishment, at the outset, of joint working by the dutyholder with ONR and the Environment Agency; and, where appropriate, other risk management authorities² [5] and the local planning authority.
- Develop and maintain a plan or strategy for the assessment and management of flood and coastal erosion risk and present it to ONR and the Environment Agency at the earliest opportunity. This should include:
 - Flood modelling requirements.
 - Coastal change modelling and assessment requirements
 - Protection strategy (for example, dry site or protected site³) and outline design criteria.

² The Flood and Water Management Act 2010 places a statutory duty on the Environment Agency to develop a National Flood and Coastal Erosion Risk Management Strategy for England. This strategy describes what needs to be done by all risk management authorities (RMAs) involved in flood and coastal erosion risk management for the benefit of people and places. This includes: the Environment Agency, lead local flood authorities, district councils, internal drainage boards, highways authorities and water and sewerage companies. More information is available in [5] [6] and Appendix A.

³ In the dry site concept, all vulnerable structures, systems and components should be located above the level of the design basis flood, together with an appropriate margin. This may be accomplished by locating the plant at a sufficiently high elevation, or by structural arrangements that raise the ground level. Where it is not practicable to adopt the dry site concept, the design should include permanent external barriers such as levees, sea walls and bulkheads. For more information, see [7], Safety Assessment Principles EHA.7 and EHA.12.

- Approaches to the assessment of a range of climate change scenarios, annual exceedance probabilities⁴ and sensitivity studies.
- Approaches to the management and maintenance of flood defences.
- Strategy for built-in resilience.
- Strategy for a managed adaptive approach.

Capability and competence

Those involved in the assessment and management of flood and coastal erosion risks should have sufficient capabilities and training to undertake the required tasks and/or make decisions.

Decision making

Decisions made at all levels that might affect safety or environmental protection should be informed, rational, objective, timely, transparent and prudent. Decisions should take into account uncertainties in assessments. For the Environment Agency, this would include taking a precautionary approach to mitigation, especially where there is potential for adverse consequences to people, property and the environment, both off-site and on-site.

Learning from experience

Dutyholders should learn from their own and others' experience so as to continually improve their ability to manage and where reasonably practicable reduce flood and coastal risk. Examples include:

- Engaging with local resilience forums.
- Reviewing and learning lessons from flood reviews and emergency planning exercises.
- Maintaining an awareness of flooding events and erosion issues to nuclear and other facilities so that relevant learning can be taken from such events.

ONR expects a demonstration of how the regulatory expectations of the Safety Assessment Principles (SAPs) for leadership and management for safety (SAPs MS.1-MS.4) [7] have been met with respect to flooding and coastal erosion risk management.

The Environment Agency expects a demonstration of how the regulatory expectations of the Radioactive Substances Regulation Environmental Principles

⁴ An annual exceedance probability (or annual probability of exceedance) is the probability of an event being exceeded in a given year. Typically, ONR refers to annual frequency of exceedance which is the frequency with which a particular hazard severity is predicted to be exceeded in a given year. For low frequency events (below 0.01 per year), the two terms are numerically equivalent. On this basis, this document uses the terminology 'annual exceedance probability' for consistency.

(REPs) for management and leadership for the environment (REPs MLDP1-MLDP5) [8] have been met with respect to flooding and coastal erosion risk management.

Principle 3 – Fit for purpose assessments of flood risk and coastal erosion

Dutyholders should undertake fit for purpose assessments of flood risk and coastal erosion. This should be used to develop the detailed design, management arrangements, site licensing and safety case of any new nuclear facility. The principal documents through which these risks are reported are:

- the Flood Risk Assessment (FRA) that is prepared for the planning process;
- coastal erosion vulnerability assessment; and
- the nuclear safety case(s).

These documents should consider all sources of flooding and coastal change and potential interactions between the documents.

Considerations

ONR and the Environment Agency expect that all flood risk and coastal erosion analysis work is undertaken in a manner that makes it suitable for the FRA, coastal erosion vulnerability assessment and the nuclear safety case(s). As noted in the overarching principle above, the submissions will respond to different regulatory requirements and expectations but where they overlap in their predictions of flooding effects on the site, the predictions should be consistent. Differences in data, methods used and judgments should be reconcilable and justified between the two analyses.

- Both ONR and the Environment Agency expect the assessments of flood and coastal erosion risk to be:
 - Consistent with relevant guidance from the Environment Agency, ONR, other regulators and government.
 - Consistent with Cabinet Office guidance on Critical Infrastructure⁵ Resilience [9]. For example, assess and demonstrate explicitly at what point the nuclear facilities and supporting infrastructure, including critical transport networks/routes, cease to be operable, in terms of flood annual exceedance probabilities⁴ [9].
 - Consistent with, and take advantage of, relevant good practice, for example the guidance and standards published by the International Atomic Energy Agency [10].

⁵ Critical infrastructure is a term used to describe critical national infrastructure and other infrastructure of national significance as well as infrastructure and assets of local significance [9].

- The findings of the coastal change assessment must be consistent and consistently applied across work streams, for example Flood Risk Assessment, Habitats Regulations Assessment and planning.
- Any assessment should be timely, transparent and comprehensive based on sufficient good quality data and properly documented (including a non-technical summary).
- Any assessment should include the consideration of climate change using relevant good practice and best available information (see Appendix B and [1]). This should include consideration of climate change effects on both flooding and coastal erosion risks using a range of climate change scenarios (including a credible maximum scenario), annual exceedance probabilities⁴ and sensitivity studies over the full lifetime⁶ of the site. For more information on climate change, see Appendix B and [1].
- Flood and coastal erosion characteristics of the site and surrounding area should be kept under review and assessments made of the effects of natural and man-made changes. For nuclear licensed sites, this requirement is captured by Licence Condition 15: Periodic review [11].
- Flood and coastal erosion risk assessments should provide an analysis of the following matters, including but not limited to:
 - The potential for flooding from all potential sources including fluvial, pluvial, surface water, groundwater, high tides, storm surges, tsunamis and artificial sources such as reservoirs and canals.
 - The combined effects of high tide, wind effects, surge, wave actions, duration of the flood and flow conditions. This should include compound flood events.
 - The potential for coastal erosion due to the above factors and other geological and geomorphological considerations, as well as the risk posed by clustering of events.
 - The residual risk of failure and exceedance of flood risk management measures, for example, blocked drainage channels, or the breach/overtopping of flood defences, and the associated consequences.
 - The risk of foreshore lowering and/or recession due to coastal processes and failure of sea protection works, for example due to undermining.
 - Off-site flood and coastal erosion risks, for example, to site access and exit routes or to routes for fuel/waste transportation. The impact of such disruption on safety and operability needs to be considered.
 - Studies to address any significant uncertainties (as determined, for example, by sensitivity studies) that exist.

⁶ The 'facility lifecycle' is described in the 'Use of UKCP18 Position Statement' [1] as "...from design, planning, construction, operation, and through to decommissioning and eventual release from regulation". For the purpose of this document, the meaning of the terms 'facility lifecycle' and 'full lifetime' are considered to be the same.

- The Environment Agency expects that a FRA should address all relevant matters including those above, and based on this analysis should:
 - Assess and demonstrate that staff and visitors on the site are safe from the effects of flooding over the development's full lifetime.
 - Demonstrate that all works associated with development of a nuclear site will not cause unacceptable increases in flood risk or coastal erosion elsewhere and will not cause detriment to other flood or coastal erosion risk management assets, including preventing or hindering access to inspect, maintain, repair or replace such assets. Any land likely to be needed for future flood or coastal erosion risk management assets (taking into account climate change over the full lifetime of the development) should also be safeguarded from development that could prevent or hinder such works from taking place.
 - Where relevant, dutyholders will also have to comply with the Habitats Regulations⁷ in relation to the impact of flood or coastal risk management plans or projects on European designated sites.
 - Take account of relevant plans or strategies that will affect the site, for example, Shoreline Management Plans (SMP).
 - Demonstrate that the site proposed for nuclear development is not at risk (or that the detrimental effects presented by coastal change are adequately mitigated) from coastal change/erosion, taking into account climate change over the full lifetime of the site. This should include how the development can be adapted to be resilient to the credible maximum scenario and the procedures in place to monitor if further adaptation is needed. For more information, see Appendix B and [1].

This list of considerations is not exhaustive and dutyholders are responsible for ensuring all aspects are considered in their planning and assessment activities.

- ONR expects that the nuclear safety case(s) should take into account the considerations above, where relevant to nuclear safety, and in addition:
 - Demonstrate that facilities can withstand flooding conditions up to and including the design basis event. Nuclear facilities should be protected against the design basis flood by the adoption of a plant layout that incorporates the 'dry site concept' [7], where reasonably practicable. Where it is not practicable to adopt the dry site concept, the design should include permanent external barriers such as levees, sea walls and bulkheads. The design parameters for these barriers may need to be more onerous than those derived from the design basis flooding event. For more information, see [7] [12] [13].
 - Demonstrate that hazards that might occur in combination with flood and coastal erosion hazards have been identified and considered. Combined

⁷ Conservation of Habitats and Species Regulations 2017

events may simultaneously affect all exposed structures, systems and components (SSCs) important to safety on a nuclear site. For more information on combinations of hazards, see [7] [12] [13] [14].

- Demonstrate that the nuclear safety risks from flood and coastal erosion hazards are adequately controlled and that these risks are ALARP.

This list of considerations is not exhaustive and dutyholders are responsible for ensuring all aspects are considered in the nuclear safety case(s).

Principle 4 – Fit for purpose flood and coastal risk management

A fit for purpose plan/strategy should be prepared and appropriately implemented so that all identified flood and coastal risks can be adequately managed.

Considerations

- The plan/strategy should be informed by other relevant flood and coastal risk management plans, such as: catchment flood management plans, shoreline management plans, strategic flood risk assessments, preliminary flood risk assessments, flood warning and emergency planning protocols, local flood management studies/improvement schemes.
- Consideration should be given to all of the significant uncertainties, risks, assumptions, exclusions and key decision points.
- Arrangements required to support claims made by the nuclear safety case(s) including those for beyond design basis, cliff edge effect⁸ assessments and flood management regimes.
- Include both on-site and off-site management arrangements.
- Management arrangements (including flood emergency arrangements) should be designed, operated and tested to ensure reliability, for example, by exercising the nuclear site's emergency arrangements. For nuclear licensed sites, this requirement is captured by Licence Condition 11: Emergency arrangements [11].
- SSCs and mitigation measures that are, or comprise part of, the flood management measures should receive regular and systematic examination, inspection, testing, maintenance and, if necessary, renewal/replacement. For nuclear licensed sites, this requirement is captured by Licence Condition 28: Examination, inspection, maintenance and testing [11].
- All relevant flood and coastal erosion risk management measures required to provide a nuclear safety function must remain in the control, and be the sole

⁸ Cliff edge effects are described in ONR Safety Assessment Principle (SAP) EHA.7 and the supporting guidance [7]. Paragraph 247 of the ONR SAPs [7] provides the following definition: "A cliff edge is where a small change in analysis assumptions, such as those relating to design basis hazard severity, facility response, or design basis analyses is predicted to lead to a disproportionate increase in radiological consequence."

responsibility of, the dutyholder. In the case of measures for the management of off-site risks to infrastructure (for example, critical transport links/routes [9]) with the potential to affect safe operation, adequate arrangements must exist with third parties who own these measures, so that the dutyholder has adequate confidence that any nuclear safety benefits claimed can be provided. Where these items consist of physical measures, they should be listed in the dutyholder's relevant maintenance schedule.

- Ensure that all relevant flood and coastal erosion risk management measures are planned, designed and implemented so that they are capable of being modified or adapted to maintain adequate safety in light of credible maximum climate change scenarios over the full lifetime of the facility.
- The plan/strategy should allow for the dutyholders to receive tailored flood warnings for the site and associated infrastructure. On receiving a warning, the flood emergency plans and management measures should be implemented.
- The plan/strategy should enable dutyholders to engage with local resilience forums.
- Flood and coastal erosion risk management should be managed to avoid placing a financial burden on the public, or increasing flood or erosion risk elsewhere.
- The Environment Agency expects that flood and coastal erosion risk management should avoid environmental impacts, as far as reasonably practicable.
- Funding arrangements:
 - Dutyholders should plan, design, implement and fully fund the necessary flood and coastal erosion risk management measures for a site and its associated infrastructure. This may include arrangements for the management of off-site risks, for example, access and exit routes required for staff and resources needed for the safe operation of the site.
 - Dutyholders should not call on public money to provide flood and coastal erosion risk management measures for their site, associated infrastructure and access. However, where a dutyholder is seeking to provide a defence that could also benefit the community, public funds may be available to support this, providing the public contribution is, at most, proportional to the whole life benefits gained by the public.
 - Dutyholders should discuss with the Environment Agency on a case-by-case basis those instances where, based on the benefits received by the public, some public money may be available towards the enhancement of a dutyholder owned asset (which should already provide adequate protection to the nuclear site) to extend the level of protection to existing communities for the lifetime of the development. This contribution should be, at most, proportional to the whole life benefits that will be gained by the public and in line with the Department for Environment, Food and Rural Affairs' (Defra's) Flood and Coastal Resilience Partnership Funding policy [15].

Appendix A – Roles and responsibilities

Overview

Responsibility relating to controlling and regulating flood hazard and coastal erosion around each new nuclear site is vested in various national and local authorities (including the Lead Local Flood Authority), the site operator and local landowners. These responsibilities and the duties and obligations they confer on the various organisations, although covered by several unconnected legislative instruments, are complementary. In general, the ability to satisfy individual responsibilities can have an effect on others. These principles recognise the synergies that exist between these individual responsibilities and seek to provide advice that recognises this.

The relationship between the Planning Inspectorate (PINS) and the nuclear regulators, which includes ONR and the Environment Agency, is set out in the current National Policy Statement (NPS) for nuclear power generation, EN-6 [2]⁹. Flood risk is identified as a nuclear impact in EN-6 [2] and anticipates liaison between the nuclear regulators and PINS.

These principles identify some of the key roles and responsibilities associated with flood and coastal erosion risk management. This list is not exhaustive.

Dutyholder

The principal responsibilities of a dutyholder, in relation to flood and coastal erosion risk management are:

- To comply with legal duties and obligations relating to flood and coastal erosion risk management.
- To address legal expectations in relation to the Development Consent Order (DCO) and nuclear site licence, including, for example:
 - To undertake a flood and coastal erosion risk assessment covering all relevant areas both on-site and off-site before seeking any relevant consents for a new nuclear facility. The assessment should cover the facility's full lifetime until the final release from regulatory requirements under the Nuclear Installations Act 1965 (NIA65) and the Environmental Permitting (England and Wales) Regulations 2016 (EPR16).
 - To implement, maintain and, where necessary, enhance any flood and coastal erosion risk control measures necessary to meet claims in the FRA, coastal erosion vulnerability assessment and relevant nuclear safety case(s).

Dutyholder responsibilities are also set out above in Principles 1-4.

⁹ At the time of publication, the UK Government's National Policy Statements for energy infrastructure were in the process of being reviewed so this may be subject to change in future. A review of EN-6 has concluded that EN-6 will not be amended as there are no changes material to the limited circumstances in which it will have effect. EN-6 will continue to have effect for any nuclear electricity generation infrastructure deployable before 2025, or for applications to amend development consent for such generation.

Office for Nuclear Regulation

ONR regulates the safety of nuclear installations (including conventional safety) and the transport of radioactive materials in Great Britain. It also regulates nuclear security and safeguards in the United Kingdom.

ONR's regulatory remit strictly only applies once an organisation has formally applied for a nuclear site licence and extends from this point to final delicensing of the site, covering all construction, operation, and decommissioning activities relevant to nuclear safety. In practice, ONR engages with organisations before a formal licence application is made to provide advice on matters relevant to obtaining a nuclear site licence. This includes consideration of technical issues relevant to the viability of the site. Flood and coastal erosion hazards are an example of this. For further information on ONR's role, see [16].

ONR is a statutory consultee on all new nuclear build applications for DCOs made to PINS.

In the case of planning applications to local authorities, ONR is consulted in relation to the effects of a new development proposal on an existing site whenever it may have a bearing on nuclear safety, including the effects of external hazards such as flooding [17].

In the assessment of risk, ONR should:

- Provide advice to PINS (or the relevant planning authority) on request, on whether the applicant is likely to be able to demonstrate suitable flood risk protection and mitigation measures to reduce nuclear risks from flood and coastal erosion hazards ALARP.
- Review and assess the adequacy of the licensee's nuclear safety arrangements in relation to flood and coastal erosion hazards by a mixture of inspection and assessment. In summary:
 - Inspection should examine the site's operational arrangements (for example, processes, procedures, work instructions) for maintaining the effectiveness of the flood and coastal erosion defences in accordance with safety case claims. This may also include testing the emergency arrangements using emergency exercises.
 - Assessment should examine the safety case(s) and supporting documents that together demonstrate the risk from flood and coastal erosion hazards are ALARP. Claims made on physical protection measures and operator actions to maintain or activate these should be assessed according to the guidance in ONR Safety Assessment Principles (SAPs) [7] and the ONR External Hazards Technical Assessment Guide (TAG), NS-TAST-GD-013 [12] [13] [14].

Environment Agency

The Environment Agency is the principal flood risk management authority in England providing a strategic overview relating to all forms of flood and coastal erosion risk but is responsible for managing flood risk from main rivers, the sea and reservoirs. The Environment Agency also provides and operates flood warning systems, takes part in emergency planning and response, and advises on development in the floodplain. It also has permissive powers for building and keeping flood defences in good order where these relate to flood risk from main rivers or the sea.

The Environment Agency is a consenting authority for flood risk activities under the Environmental Permitting (England and Wales) Regulations 2010 (EPR10) for works:

- on or near a main river;
- on or near a main river flood defence or flow control structure;
- in a main river floodplain which could affect flood flow or storage; and
- on or near a sea defence.

For more information, see [5] [18]. However, the DCO process may disapply these regulations where the Environment Agency agrees to this. Such disapplication is only likely to be acceptable where equivalent protective provisions are included in the DCO.

The Environment Agency is a statutory consultee on planning applications for new nuclear sites and a statutory consultee on all applications for DCOs made to PINS.

The Environment Agency is the regulator for environmental permits for new nuclear build.

In the assessment of risk, the Environment Agency should:

- Review and advise on the adequacy of the FRA and associated measures to address flood risk (including interactions with coastal erosion) to and from the development throughout the full lifetime of the site.
- Provide advice on its review of the FRA and associated flood risk management measures to PINS and the relevant planning authorities.
- Provide flood risk advice to the dutyholder, where requested and subject to a discretionary charged advice agreement.
- Provide advice on other parties who may need to be consulted such as other risk management authorities (for example, lead local flood authorities), relevant experts (for example, local authority emergency planning teams, coast protection authority) or associated asset owners (for example, reservoir owners).

Planning Inspectorate

The Planning Inspectorate responsibilities include:

- Validating DCO applications to ensure they contain the necessary supporting information.
- Examining DCO applications under the Planning Act 2008 (and amended by the Localism Act 2011).
- Providing recommendations to the Secretary of State for its decision on DCO applications. The decision of the acceptability of the safety of site users/occupants would lie with the Secretary of State.

Based on the advice of the relevant nuclear regulators, PINS should be satisfied that the applicant is able to demonstrate suitable flood and erosion risk mitigation measures. These mitigation measures should take account of climate change effects [1]. Applicants should demonstrate that future managed adaptation/flood mitigation would be achievable at the site, after any new nuclear facility is built, to allow for any future credible predictions that might arise during the lifetime of the facility and the interim spent fuel stores.

Local Authority

Local authorities' responsibilities include:

- Providing advice on issues of safety relating to emergency planning during a flooding incident. This will be supported by other Category 1 responders, for example, emergency services, through the local resilience forum and set out in a local emergency preparedness framework.
- Determining planning applications under the Town and Country Planning Act 1990.
- District and unitary authorities in coastal areas are Coast Protection Authorities. They lead on coastal erosion risk management activities in their area. They are usually members of the Coastal Groups which jointly prepare Shoreline Management Plans (SMPs) [19]. SMPs provide a long term holistic framework for managing the risk of coastal change on their section of the coast [20].
- Preparing an adequate off-site emergency plan under the Radiation (Emergency Preparedness and Public Information) Regulations (REPPPIR) 2019.

Lead Local Flood Authorities

The Lead Local Flood Authorities (LLFAs) are county or unitary councils who, under the Flood and Water Management Act 2010, have the responsibility for the management of local flooding including surface water, ordinary watercourses and groundwater.

LLFAs are responsible for the regulation (consenting and enforcement) of particular activities on ordinary watercourses.

Other relevant organisations

Consultation may be needed with other organisations including:

- Marine Management Organisation
- Natural England
- Highways England
- Water and Sewerage Companies
- Internal Drainage Boards.

Appendix B – Climate change resilience and adaptation

Overview

Climate change potentially impacts all sources of flood risk and is expected to increase sea level, which in turn will increase coastal erosion rates, cliff instability and sea defence fragility. Preparing for, or adapting to, these impacts is a necessity. Although the broad impacts of climate change on UK flood and erosion risk are understood, there is significant uncertainty on the rate of change and the eventual magnitude of change at any specific location. This is an area of active research. Dutyholders should be aware of updates to climate science that may affect relevant good practice and ensure that this is taken into account in any new analysis of climate change. For example, when any major new research or projections are published, the implications for safety should be taken into account.

Dutyholders will need to satisfy the requirements of the regulators and, where relevant, the planning authorities, with respect to their consideration of climate change. The submissions will respond to different regulatory requirements and expectations, but where they overlap they should be consistent; differences in data, methods used and judgments should be reconcilable and justified. More information is available in [1].

National Policy Statements

Guidance on how climate change should be taken into account in planning for new energy infrastructure is given in the overarching National Policy Statement EN-1 [3] and for nuclear power stations this is currently in EN-6 [2]⁹. Climate change guidance for general planning applications is provided in the National Planning Policy Framework and Planning Practice Guidance [21]¹⁰.

EN-1 states that applicants must consider the impacts of climate change when planning the location, design, build, operation and where appropriate, decommissioning of new energy infrastructure [3].

The National Policy Statements [2] [3] provide guidance on how to consider the changing flood and coastal erosion risks. They also discuss how risks should be managed, both within the initial design but also over the full lifetime of the site. They describe how the applicant should ensure that an adaptation measure could be implemented should the need arise, rather than at the outset of the development (for example increasing height of existing, or requiring new, sea walls). More detail on this type of approach is given below, described as a ‘managed adaptive approach’.

¹⁰ For the purpose of this document, the Planning Practice Guidance on flood risk and coastal change and climate change sections are likely to be of most relevance. These can be accessed from [21].

Consideration of Government Guidance

Government policy on adapting infrastructure to climate change is set out in its vision: “An infrastructure network that is resilient to today’s natural hazards and prepared for the future changing climate” [23]. For those nuclear sites and infrastructure on the coast, the impacts from sea level rise, change to storm surges and wave climate (wave heights, period and direction) need to be considered over the full lifetime of the facilities.

More information on the regulators’ expectations for consideration of climate change is set out in [1].

Managed Adaptive Approach

Dutyholders may consider a managed adaptive approach (sometimes referred to as an adaptive approach) to flood and coastal erosion risk management when planning for long term climate change or more extreme climate scenarios. The managed adaptive approach is based on taking action when particular trigger points are observed. It is most likely to be appropriate in cases where ongoing responsibility is assigned to tracking the change in risk, and managing that risk through pre-determined interventions. The managed adaptive approach sets out a way for dealing with the significant uncertainty surrounding climate change in the future. The approach is described by the Environment Agency within [24].

Managed Adaptive Approach

The aim of the managed adaptive approach is to build flexibility into options and decisions today so that they can be adjusted depending on what happens in the future.

There are two elements of the managed adaptive approach. One element is to build in the ability to adjust an option should it be required. Examples include allowing an additional strip of land to the rear of a new flood bank to enable it to be raised if necessary or providing larger foundations to a flood wall to enable later raising with minimal work and disruption.

The second element is for dutyholders to develop flexible plans that build flexibility into the decision process itself through waiting and learning as scientific understanding of climate-related risks increases. For example, sequencing options so that ‘no regrets’ or ‘low regret’ options are taken earlier, and more inflexible measures are delayed in anticipation of better information.

Not all of the options to manage future climate change will be suitable for a managed adaptive approach of waiting and learning, so a combination of a design containing precautionary elements and the managed adaptive approach is likely to be the most suitable approach for nuclear sites.

Given the risk that climate change presents and the significant uncertainty over the long lifetime of nuclear sites, both the Environment Agency and ONR expect site applications to contain precautionary elements within the initial design, flexibility

designed into flood measures and a plan/strategy for the whole lifetime of the site detailing future options and the triggers that would lead to their implementation. This should be an integral part of the ongoing periodic safety review following construction. For nuclear licensed sites, this requirement is captured by Licence Condition 15: Periodic review [11].

Components of a managed adaptive approach

- Understanding the full range of risks that might need to be managed. This comes from performing analysis of climate change using a range of climate scenarios, annual exceedance probabilities⁴, and sensitivity studies. This should include consideration of the credible maximum scenario. ONR and the Environment Agency expect dutyholders to use the most up to date credible maximum scenarios in any new analysis of climate change. For more information on credible maximum scenarios, see the following sub-section and [1].
- Understanding how much flexibility and what options might be needed, and when, depending on the different climate change projections, so as to not foreclose modifications needed to enhance resilience in the future.
- Iterative decision-making (evaluating results and adjusting actions on the basis of what has been learned).
- Feedback between monitoring and decisions (learning). Knowing when a decision will be needed given the changing risks and the lead time to make an adjustment, or implement a new option.
- The sustainability of the managed adaptive approach must be demonstrated. In other words, that the responsibility for adaptation can reasonably and effectively be passed on to future dutyholder(s).

For the managed adaptive approach to be suitable, it will be necessary to demonstrate that:

- It comprises technically feasible and viable options. In other words that the future cost of the options can be accounted for, including taking into account the potential impacts of these options.
- The lead time between the need for an option being triggered and implemented is achievable.
- The fullest range of risks has been accounted for through the use of the credible maximum scenario.

For aspects covered by the nuclear safety case, these can be controlled on an ongoing basis by the nuclear site licence and attached licence conditions. For aspects outside the nuclear safety case, in other words, non-safety critical elements, appropriate planning controls would be needed, such as DCO planning requirements or legal agreements, to ensure the approach is implemented, as needed, at the required time.

Credible Maximum Scenario

Credible maximum scenarios described in EN-1 [3] are peer-reviewed, high end, plausible scenarios of climate change. The current set of credible maximum scenarios are used to assess the impacts of low probability, high impact climate events including heat waves, drought, extreme winds, sea level rise and storm surge. Credible maximum scenarios can also be used for sensitivity testing different adaptation options over time periods appropriate for the nuclear industry. ONR and the Environment Agency expect dutyholders to use the most up to date credible maximum scenarios in any new analysis of climate change. For more information on credible maximum scenarios, see [1].

Appendix C – Indication of ONR and Environment Agency flood risk interests for nuclear new build development proposals in England*

(*This is not an exhaustive list. Dutyholders are responsible for ensuring all aspects are considered in their planning and assessment activities.)

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Nuclear new build site	Construction, operation and decommissioning.	Construction, operation and decommissioning.	Both the Environment Agency and ONR have an interest in all stages of site development and operations.
Identification of all forms of flooding and coastal erosion	<p>On-site and off-site risks and impacts.</p> <p>Tidal flooding – 5%, 0.5% and 0.1% annual exceedance probability⁴ with and without climate change allowances.</p> <p>Fluvial flooding – 5%, 1% and 0.1% annual exceedance probability with and without climate change allowances.</p> <p>Surface water flooding – 3.3%, 1% and 0.1% annual exceedance probability with</p>	<p>Risks of flooding and coastal erosion to the site should be considered to demonstrate that dutyholder risks are as low as reasonably practicable (ALARP).</p> <p>For all forms of flooding and coastal erosion the following should be assessed:</p> <p>Design basis analysis for events that have an annual frequency of exceedance⁴ of 10^{-4} for the design basis flood</p>	<p>Focus of the Environment Agency is to ensure that existing and future flood risks (including interactions with coastal erosion risks) are fully understood and robustly defined as part of the assessment, to inform site design and decision makers. Flood characteristics should include speed of onset, extent, depth, velocity, hazard and duration.</p> <p>The Environment Agency is also concerned with understanding the potential of the development to impact on flood risk to third parties (for example, loss of floodplain storage, changes to extent, flood frequency,</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Identification of all forms of flooding and coastal erosion	<p>and without climate change allowances.</p> <p>Groundwater flooding where relevant.</p> <p>Reservoir flooding, where relevant, from dam failure and emergency draw-down.</p> <p>Any other artificial sources of flooding, where relevant.</p>	<p>(SAPs EHA.4, para. 239¹¹ and EHA.12) including (where relevant) the reasonably foreseeable effects of climate change over the lifetime of the facility.</p> <p>Beyond design basis analysis – assess cliff edge effects etc. (SAPs EHA.7 and EHA.18, paras. 246-248).</p> <p>Probabilistic safety analysis – (SAP EHA.18, para. 246(c)).</p> <p>Severe accident analysis – (SAP EHA.18, para. 246(e)).</p>	<p>depths, flood hazard and flood flows throughout the lifetime of the development).</p> <p>The Environment Agency is likely to advise the dutyholder to consult with the Lead Local Flood Authority for advice on surface and groundwater flooding and on the management of surface water.</p> <p>The Environment Agency is likely to advise the dutyholder to consult with the Coast Protection Authority for advice on the impacts of coastal erosion on and from the development.</p> <p>ONR focus is on the safety case and the demonstration that the nuclear safety risks from flood and coastal erosion hazards are adequately controlled and that these risks are ALARP.</p>

¹¹ Consideration can be given to design basis events at higher frequencies where the facility cannot give rise to high unmitigated consequences (ONR SAPs para. 241 [7]). This situation may apply, for example, to a reactor site near its end of life when most of the nuclear material has been removed or stored passively. The safety case must still demonstrate that the hazards are adequately controlled and that the risk from flooding is ALARP.

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Breach	<p>Yes</p> <p>Tidal defence breach - 0.5% and 0.1% annual exceedance probability with climate change allowances.</p> <p>Duration of breach (in other words, the number of tidal cycles to be considered) will need to be agreed with local Environment Agency Flood and Coastal Erosion Risk Management teams.</p> <p>Fluvial defence breach - 1% and 0.1% annual exceedance probability with climate change allowances. For guidance on how to characterise the consequences of flooding in the event of a breach, see [25].</p> <p>Flood characteristics should include speed of onset, extent, depth, velocity, hazard and duration.</p>	<p>Dependent on the claims and arguments made in dutyholder's safety case.</p> <p>Wave action can progressively cause damage to flood defences directly leading to breaches. Coastal erosion and/or changes in local morphology can lead to the undermining of the site platform and offshore structures (seawater pipework, intakes and outfalls).</p> <p>Direct breach of the sea defences may lead to the inundation of the local area and the site.</p> <p>For any breach, the nuclear safety consequences need to be understood and justified, with a demonstration that risks are reduced ALARP.</p> <p>For more information, see [12] and supporting Annexes.</p>	<p>The Environment Agency's role will ensure the modelling/assumptions are appropriate under the Environment Agency remit.</p> <p>ONR focus is on the safety case and the demonstration that the nuclear safety risks from flood and coastal erosion hazards are adequately controlled and that these risks are ALARP.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Breach	<p>Breach of proposed defences and breach of any future raised defences (as part of managed adaptive approach) should be assessed to ensure residual risks can be safely managed.</p> <p>The impact of the development on flood hazard and flood flow routes elsewhere in the event of a breach should be considered.</p>		
Overtopping	<p>Yes</p> <p>Defence overtopping – 1% fluvial and 0.5% tidal annual exceedance probability with climate change allowances.</p> <p>0.1% annual exceedance probability with climate change allowances.</p> <p>Flood characteristics should include speed of onset, extent, depth, velocity, hazard and duration.</p>	<p>Yes</p> <p>The consequences of the design basis flood being exceeded should be taken into account in the design of the facility, the protection strategy and in the safety case. Particular attention should be paid to overtopping of defences and cliff edge effects. The impacts of overtopping on defences (for example, breach) and any nuclear safety consequences need to be understood.</p>	<p>Focus of the Environment Agency is on the lead time/ability to forewarn and evacuate the site safely in the event of an overtopping scenario, as well as understanding the potential off-site impacts as a result of the development.</p> <p>ONR focus is on the safety case and the demonstration that the nuclear safety risks from flood and coastal erosion hazards are adequately controlled and that these risks are ALARP.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Debris	Yes	<p>Yes</p> <p>The nuclear safety significance of flood-borne debris hazard should be covered in the dutyholder's safety case(s).</p>	<p>The Environment Agency is concerned with the potential of flood risk debris from the site to affect third parties and occupants during a flood event – thereby affecting UK Flood Hazard ratings.</p> <p>ONR focus is the potential for flood debris to affect operations in respect of the reactor and hence the safety case and the demonstration that the nuclear safety risks from flood and coastal erosion hazards are adequately controlled and that these risks are ALARP.</p>
Blockage of systems	<p>Yes</p> <p>Modelling should assess the impacts of blockages on flood risk and ensure these residual risks can be safely managed.</p>	<p>Yes</p> <p>The nuclear safety significance of blockage to safety significant systems should be covered in the dutyholder's safety case(s).</p>	<p>The Environment Agency is concerned with ensuring that there is a strategy to deal with/avoid/clear debris from flood risk critical systems to ensure standards of flood protection are maintained (for example, ensuring that there is a strategy to maintain conveyance through culverts through appropriate design of trash screens and a maintenance strategy).</p> <p>ONR focus is on ensuring that the release of radiological material is minimised. There may be a link to ensuring that flood risk critical systems are kept clear of debris.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
How residual risks are safely managed (residual risks are defined in Planning Practice Guidance [26])	Yes	<p>Yes</p> <p>Managed through arrangements for monitoring the potential for flooding and through implementation of preventative measures, and the site emergency plan if flooding occurs.</p> <p>The residual risk should be shown by the dutyholder to be ALARP.</p>	<p>The Environment Agency focus is on the residual risk of flooding from coastal and fluvial sources and how the applicant has demonstrated in their design/mitigation that there is sufficient flexibility/redundancy in the design to ensure the residual risks of flooding on-site and off-site can be safely managed (for example, breach of defences) to ensure people will not be exposed to hazardous flooding [25].</p> <p>ONR focus is on the management of the residual risk of flooding in the design basis and approaches specified in the safety case.</p>
Emergency arrangements	Yes	<p>Yes</p> <p>ONR requires adequate on-site emergency arrangements to be developed and implemented by the dutyholder in accordance with Licence Condition 11: Emergency arrangements [11]. Demonstrations of these arrangements can include extreme flooding scenarios.</p>	<p>The Local Authority is responsible under REPPiR for creating and exercising an off-site emergency plan. The Licensee, ONR and the Environment Agency have obligations under these emergency plans.</p> <p>The Civil Contingencies Act (CCA) 2004 (Contingency Planning) Regulations 2005 also place a responsibility on Local Authorities to produce plans for responding to any emergency. As CCA was introduced after the previous version of REPPiR (REPPiR 2001), CCA states that where REPPiR applies, CCA does not.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Emergency arrangements		<p>ONR also regulates under REPIR 2019. This puts duties on operators to have an on-site emergency plan to respond to all radiation emergencies.</p> <p>The dutyholder's emergency arrangements are expected to recognise that the provision of supplies and staff from off-site may be hindered for the duration of, and following, a severe coastal flood event and often associated meteorological event and identify ways of mitigating the adverse effects on nuclear safety if this occurs.</p> <p>After the Fukushima accident following the Great Japan Earthquake in 2011, ONR recommended the establishment of off-site stores of emergency backup and recovery equipment, capable of recovering basic safety functions following a severe external hazards event. The</p>	<p>The Environment Agency is likely to advise the dutyholder to consult with the local authority emergency planning team and with the local resilience forum.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Emergency arrangements		site's emergency arrangements should refer to such equipment where appropriate, and the type of equipment should be justified by the types of severe accidents that external hazards could generate. For more information, see [7] [12] [13] [14].	
Where possible reducing overall risk in the area	Yes	No	<p>The Environment Agency focus is on compliance with national policy on development and flood risk whereby developers would need to reduce flood risk overall where possible, in order to satisfy the second part of the Exception Test.</p> <p>Examples could include the provision of defences that reduce the risk of flooding or coastal erosion to existing communities. Consideration should be given to the use of natural flood management approaches as a way of delivering multiple benefits.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Sequential test for developments not informed by the Strategic Siting Assessment process	Yes, but limited to aspects of the development that are not related to the safety case.	Outside remit unless development is linked to the nuclear licensed site.	<p>The sequential test for the principle of the site has been agreed in the Strategic Siting Assessment (SSA). However, this does not include any development which has not been subject to the SSA process. For these developments a sequential test is required.</p> <p>The Environment Agency's role is likely to be limited to ensuring the test has been undertaken and supported with appropriate evidence. It will be for the Secretary of State to make the final determination of whether the test has been satisfied.</p>
Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location	Yes, but limited to aspects of the development that are not related to the safety case.	Yes, but only those areas related to safety case.	A sequential approach should also be applied at the site layout level, steering the most vulnerable aspects of the development to the lowest risk parts of the site, unless there is evidence of why this would be inappropriate. This approach should also be applied to important routes in and out of the site.

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
<p>Safe access/exit and escape routes</p>	<p>Yes</p> <p>Tidal flooding - safe (preferably dry) access/exit in 0.5% annual exceedance probability with climate change allowances.</p> <p>Fluvial flooding - safe (preferably dry) access/exit in 1% annual exceedance probability with climate change allowances.</p> <p>Tidal and fluvial flooding – safe means of escape (or sufficient time available) in advance of the 0.1% annual exceedance probability with climate change allowances.</p>	<p>Yes</p> <p>Where safe means of access to the reactor and associated site infrastructure is required to meet design basis safety claims.</p> <p>For beyond design basis events, the licensee’s emergency plan should address safe access/exit routes.</p>	<p>Focus of the Environment Agency is on the lead time/ability to evacuate the site safely in advance of a 0.1% annual exceedance probability and safe access/escape during a 0.5% annual exceedance probability (tidal)/1% annual exceedance probability (fluvial), with climate change allowances. Dutyholders should refer to [27].</p> <p>ONR focus is on the safety case and ensuring that there is a safe and achievable means of access to the safety critical elements of the design.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
Flood warning process	<p>Yes, but limited.</p> <p>For example, provide supporting data on request or identifying what flood warning services are available in the area/flood level information.</p>	<p>Yes</p> <p>ONR expects the dutyholder to have in place adequate monitoring arrangements to provide sufficient warning of potential flooding events (SAP EHA.12 para. 266) [7].</p>	<p>There is an obvious link between flood warning coverage/capability and safe evacuation of the site, which the Environment Agency will be concerned with. If existing warning systems are inadequate, dutyholders will be expected to cover the cost of any necessary improvements.</p> <p>ONR may have a focus on flood warnings if the safety case is contingent on receiving flood warnings to enact measures to protect the reactor and prevent the release of radiological material.</p>
Climate change assessment	<p>Yes – follow flood risk assessment climate change allowance guidance [22]. Also refer to [1].</p> <p>For aspects of the development with lifetimes beyond 2125, the dutyholder should use the UKCP18 exploratory method for assessing sea level rise for the remaining lifetime of the development.</p> <p>For non-safety critical elements up to 2125, the dutyholder</p>	<p>Yes</p> <p>Safety critical infrastructure.</p> <p>Climate change allowances should be included in the dutyholder’s safety case(s).</p> <p>Climate change effects should be analysed by Design Basis Analysis (DBA), Beyond Design Basis Analysis (BDBA) and Probabilistic Safety Analysis (PSA) methods.</p>	<p>The Environment Agency focus is on risk to the site and occupants (level of protection from flooding and mitigation against any off-site flood risk impacts) and implications on third parties for the full lifetime of the development, incorporating climate change allowances, including any managed adaptive approach.</p> <p>ONR focus is on the safety case and the applicant would need to demonstrate that risks from the reactor and associated infrastructure have been reduced ALARP for the operational lifetime.</p>

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
<p>Climate change assessment</p>	<p>should assess climate change as set out in [22] [24].</p> <p>For safety critical elements, sensitivity tests for the whole development lifetime should be applied, that account for credible maximum scenarios. For more information, see [1]. The development will either need to have built-in measures to be resilient to the credible maximum scenario or have pre-planned adaptation measures and agreed triggers to ensure resilience to the credible maximum scenario can be achieved in future – or combinations of both.</p>	<p>The dutyholder’s safety case(s) should demonstrate that flood protection is adaptable to uncertainties in climate change predictions over the lifetime of the site.</p> <p>For more information on climate change, see [1] [7] [12] [13] [14] and Appendix B of this document.</p>	<p>Dutyholders may consider a managed adaptive approach to flood and coastal erosion risk management when planning for long term climate change and extreme climate scenarios. The managed adaptive approach sets out a way for dealing with the significant uncertainty surrounding climate change in the future. For more information, see [1] and Appendix B of this document.</p>

Associated development sites

Consideration	Environment Agency	Office for Nuclear Regulation	Comment
<p>Approach to climate change for associated development sites</p>	<p>More onerous (in other words, sensitivity testing to the credible maximum scenario – see [1]) required if associated infrastructure is critical to the day to day running of the site. If the infrastructure is not critical (for example, in the case of a road that has been constructed as part of the new build to assist with local transport capacity improvements), then the most relevant climate change criteria must be applied in accordance with national planning policy.</p>	<p>Outside remit unless associated development linked to the nuclear licensed site.</p>	<p>The Environment Agency is concerned with ensuring climate change has been incorporated appropriately and proportionately in line with the category/type of associated development.</p> <p>ONR focus is ensuring the development is appropriately resilient to climate change for the full lifetime of the development if the associated development is critical to the operation of the site.</p>

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