



Office for
Nuclear Regulation



Environment
Agency

Principles for Flood and Coastal Erosion Risk Management

Office for Nuclear Regulation and Environment Agency Joint
Advice Note

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Contents

1. Purpose of this document	3
2. Principles	4
Principle 1 – Dutyholder responsibilities	4
Principle 2 – Management arrangements	4
Principle 3 – Fit for purpose flood risk assessment	5
Principle 4 – Fit for purpose flood and coastal risk management	7
3. Appendices	10
A. Definitions	10
B. Roles and responsibilities	11
C. Adapting to climate change	15
D. Environment Agency and Office for Nuclear Regulation flood risk interests for nuclear new build sites	18

1. Purpose of this document

This document will be of interest to any party interested in understanding the approach to flood risk in the nuclear new-build programme in England.

It provides advice on how flood and coastal erosion risk issues are taken into account when considering proposals for new build developments. This advice is intended to be risk based, pragmatic and proportionate in its approach. It will be reviewed and updated as necessary.

This document:

- Identifies in one place all the relevant legislation, regulatory authorities, dutyholders and high level principles applicable to flood risk management for a new nuclear site.
- Sets out principles based on good flood risk management practice that minimises the impact of a new nuclear site on existing flood risk elsewhere, whilst keeping the risk of nuclear consequences arising from extreme flooding events entering the site, as low as reasonably practicable (ALARP).
- Sets out jointly the relevant advice from the Office for Nuclear Regulation (ONR) and the Environment Agency (EA) on flood and coastal risk management issues.
- Provides a standardised framework and starting point for EA and ONR staff involved in pre-planning / early nuclear safety discussions and relevant consultations.

The underpinning legislation and working arrangements of both these organisations are different and there is a potential for inconsistency in the advice and guidance offered to dutyholders. This document helps to bring consistency and clarity to the regulators' approach.

We also make clear the expectations of the EA and the ONR in respect of flood and coastal risk management, and provide a basis for regulatory decision making and advice (under our statutory consultee role in the planning process) to Local Planning Authorities and the National Infrastructure Directorate of the Planning Inspectorate (PINs).

Ultimately it will be for PINS and the ONR to make the decisions on the safety of the development and residual flood risk.

Flood hazard analysis and the necessary protection and management arrangements should be captured and reported by the developer (referred to as the dutyholder) in different documents:

- for the EA - in planning submissions and Flood Risk Assessments, and
- for the ONR - in relevant nuclear safety case(s)

The individual submissions may differ in detail but there should be consistency between them. 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. The analyses and protection arrangements that best address EA's requirements, for

example, should be consistent with those needed to address nuclear safety criteria as regulated by the ONR.

These principles reflect the guidance within other regulatory guidance/planning documents¹ and should be read alongside them.

2. Principles

Principle 1 – Dutyholder responsibilities

Prime responsibility for the assessment and management of Flood and Coastal Erosion Risk rests with the dutyholder².

Considerations

- Flood risks posed to the site should be fully assessed from all potential sources of flooding, or any joint combination of sources, where appropriate.
- Any flood or coastal risks arising from the site are the responsibility of the dutyholder and must 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 burdens to future generations, and their 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 and operation 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
 - Early engagement and the establishment, at the outset, of joint working by the dutyholder with the EA and the ONR; and - where appropriate - other risk management authorities 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 the EA and the ONR at the earliest opportunity. This should include:
 - Flood modelling requirements.
 - Outline design criteria.

¹ National Policy Statement EN6 – New Nuclear, EN1 – Energy (NPS), CLG - National Planning Policy Framework (2012)

² The term “dutyholder” is used in here to refer generally to include those with responsibilities under relevant legislation and includes “licensee” and “licence applicant” under nuclear legislation. See also Appendix B.

- Approaches to the assessment of climate change.
 - Approaches to the management/maintenance of flood defences.
- Capability
 - 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 should be informed by the most appropriate scientific knowledge.
 - Decisions should take into account uncertainties and a precautionary approach should be adopted where there is potential for adverse consequences to people, property and the environment, both off-site and on-site.
- Learning
 - Dutyholders (and other relevant organisations) 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 learn lessons from flood reviews and emergency planning exercises - such as the 2011 Exercise Watermark.
 - Maintaining an awareness of flooding events to nuclear and other facilities so that relevant learning can be taken from such events.

Principle 3 – Fit for purpose assessment of flood risk

A fit for purpose assessment of flood risk should be undertaken to inform the detailed siting, design, management and safety case requirements of any new nuclear facility. The principle documents through which flood risk is reported are the Flood Risk Assessment (FRA) that is prepared for the planning process and assessed by the EA and the nuclear safety case(s). These documents must consider all sources of flooding and coastal erosion risk.

Considerations

- The expectation is that all flood risk analysis work is undertaken in a manner that makes it suitable for both the FRA and the nuclear safety case(s). As noted in Section 1, if separate assessments are required, then appropriate consistency of data input, modelling and analysis is required, so that flood predictions by both analysis streams can be reconciled. Any differences should be clearly explained and justified.
- Both the EA and ONR expect the assessment of flood and coastal erosion risk to be:
 - Consistent with relevant guidance from the EA, ONR, other relevant regulators and government.

- Consistent with Cabinet Office guidance on Critical Infrastructure Resilience. For example, assess and demonstrate explicitly at what point the nuclear facilities and supporting infrastructure - including critical transport links/routes - cease to be operable, in terms of flood return period³.
- Consistent with, and take advantage of, relevant good practice, for example the International Atomic Energy Agency⁴.
- 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 3).
- 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.
- Flood and coastal risk assessments should provide analysis to address the following matters:
 - The potential for flooding due to pluvial, surface water, groundwater, high tides, storm surges and tsunamis.
 - The combined effects of high tide, wind effects, wave actions, duration of the flood and flow conditions.
 - The potential for coastal erosion due to the above factors and other geological and geo-morphological considerations.
 - The probability of failure of flood risk management measures, for example, blocked drainage channels, or the breach / over-topping of flood defences, and the associated consequences
 - The risk of foreshore lowering due to coastal processes undermining sea protection works.
 - The effects of climate change over the full life-time of the station assessed using the most up to date credible projections.
 - Off-site flood and coastal erosion risks, for example, to site access and egress routes.
 - Studies to address any significant uncertainties (as determined for example by sensitivity studies) that exist.
 - Any changes to flood and coastal erosion risk elsewhere as a result of works.
- 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 developments full life-time⁵.
 - Demonstrate that all works associated with development of a nuclear site will not cause unacceptable increases in flood risk elsewhere,

³ <http://www.cabinetoffice.gov.uk/sites/default/files/resources/natural-hazards-infrastructure.pdf>

⁴ See especially guide SSG-18, available from IAEA, http://www-pub.iaea.org/MTCD/publications/PDF/Pub1506_web.pdf

⁵ National Planning Framework: Flood Risk and coastal change : <https://www.gov.uk/guidance/flood-risk-and-coastal-change>

- cause detriment to other flood or coastal erosion assets, or prevent any other flood and coastal erosion risk operator from maintaining or improving any assets in the future - taking into account climate change over the full life-time of the station.
- Take account of relevant plans or strategies which 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 risk is adequately managed) from coastal change/erosion taking into account climate change over the full life-time of the station.
- Demonstrate that all works associated with development of a proposed nuclear site will not cause unacceptable coastal change/erosion risk elsewhere, taking into account climate change.
- Demonstrate that where development is undertaken in areas at risk from coastal change, the detrimental effects presented by coastal change can be mitigated, taking into account climate change.
- The nuclear safety case(s) should consider the principles above where relevant to nuclear safety and in addition:
 - Consider the approach to platform height carefully. Nuclear facilities should be protected against the design basis flood by the adoption of a plant layout that incorporates the 'dry site concept'⁶, where reasonably practicable.
 - Demonstrate that the nuclear safety risks from flood and coastal erosion hazards are adequately controlled and these risks are ALARP.

Principle 4 – Fit for purpose flood and coastal risk management

A fit for purpose plan/strategy should be produced 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 assessments and flood management regimes.
- Include both on-site and off-site management arrangements.
- Management arrangements should be designed, operated and tested to ensure reliability, for example, by exercising the nuclear site's emergency arrangements.

⁶ ONR Safety Assessment Principles (SAPs) para. 261.

- Any flood or coastal erosion risk measure implemented by the operator should not increase risk elsewhere, cause detriment to other flood or coastal erosion assets, or prevent any other flood and coastal erosion risk operator from maintaining or improving any assets in the future.
- Structures, systems, components 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.
- All relevant flood and coastal risk management measures required to provide a nuclear safety function must remain in the control, and be the sole responsibility of, the operator, or adequate arrangements must exist with 3rd parties who own these measures, so that the dutyholder has adequate confidence that any nuclear safety benefits claimed for them 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 risk management measures are planned, designed and implemented so that they are capable of being modified/adapted to maintain adequate safety in light of climate change over the full life-time of the station.
- The design and operation of flood emergency plans and management measures, including communications, should be such that response arrangements are enacted in the event of a flood warning, or a flood.
- The plan/strategy should allow for the dutyholders to receive tailored flood warnings for the site and associated infrastructure.
- The plan/strategy should enable the flood emergency procedures to be tested and operated at appropriate intervals.
- The plan/strategy should enable dutyholders to engage with local resilience forums.
- Flood and coastal risk management should be managed to avoid placing a burden on the public purse, or increasing flood risk elsewhere.
- 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 risks off site, for example, access and egress routes required for staff.
 - 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 an operator is seeking to provide a defence that could also benefit the community, public funds may be available to support this providing that the public contribution is, at most, proportional to the whole life benefits gained by the public.
 - Dutyholders should discuss with the EA 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 upgrading of an operator owned asset (which will already provide adequate protection to the nuclear site) to extend the level of protection to existing communities for the life-time 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 EA flood coastal risk management external contributions policy.

3. Appendices

Appendix A – Definitions

Operational Life – the period commencing with the transfer of nuclear materials to site. Operational life should be specified by the operator, but is generally understood to be at least 60 years.

Full life-time of the station – operational life, plus the time taken for the decommissioning and interim storage of spent fuel and waste, prior to disposal. Again, this should be specified and justified by the operator, but is generally understood to be 160 years.

Critical Transport Link/Route - that which is identified as necessary to address the requirements of Cabinet Office guidance on Critical Infrastructure.

Appendix B – Roles and responsibilities

Responsibility relating to controlling and regulating flood hazard and coastal erosion around each new nuclear site is vested in various national and local authorities (Includes 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.

Dutyholder

The principal responsibilities of a company which plans to build, operate and decommission new nuclear power stations are:

- To undertake a flood and coastal erosion risk assessment covering all relevant areas both on and off site before seeking any relevant consents for a new nuclear power station. The assessment should cover the facility's full life-time where relevant.
- To maintain and operate any flood and coastal erosion risk control measures necessary to meet claims in the FRA and relevant nuclear safety case(s).

Different legislation uses different terms to describe the organisation responsible for compliance; in particular the Health & Safety at Work etc. Act. 1974 (HSW74) refers to dutyholders; the Nuclear Installations Act 1965 as amended (NIA65) identifies the responsible organisation as a licensee, holding a nuclear site licence to operate a nuclear reactor or undertake other prescribed nuclear operations.

Office for Nuclear Regulation

The ONR's principal responsibility is to regulate nuclear safety on nuclear licensed sites, including the safety implications – both off-site and on-site – associated with hazards arising from flood and coastal erosion. This role is defined in the Energy Act 2013,, in which ONR is defined as the enforcing authority for the following purposes:

- Nuclear safety
- Nuclear site health and safety (conventional health and safety)
- Nuclear security (on civil nuclear premises)
- Nuclear safeguards (related to UK's treaty obligations covering non-proliferation etc.)
- Civil transport of radioactive materials.

Flood and coastal erosion hazards are covered by the first of these purposes. Two existing statutes, the NIA65 and HSW74, facilitate ONR's ability to licence nuclear sites, permission nuclear significant activities on them, and to set standards that the dutyholder must meet to ensure its activities are safe.

The NIA65 enables ONR to grant nuclear site licences to competent organisations and to attach conditions to those licences. At the present time there are 36 standard licence conditions attached to every Nuclear Site Licence (NSL) covering different safety related issues, such as maintenance, the need for safety cases, emergency arrangements and the need to control modifications to existing plant. The licence

conditions provide ONR with powers to permission nuclear significant activities on the site. Permissions relevant to flood hazards can be granted when the licensee submits an adequate safety case to the ONR; the safety case demonstrates that the activities for which permission is sought can be carried out safely. The NIA65 is a relevant statutory provision under the Energy Act 2013. ONR's powers under NIA65 only extend to the licensee itself, although the licensee is expected to have arrangements to ensure that other organisations upon which it depends, such as support contractors, themselves operate safety when working on the site.

The HSW74 requires dutyholders to ensure that risks to the public and workers are reduced so far as is reasonably practicable; this principle is absorbed into nuclear regulation as the ALARP principle. HSW74 is also a relevant statutory provision under the Energy Act 2013 and applies to all organisations and individuals undertaking safety duties relevant to the site.

ONR's principal role in relation to flood and coastal erosion hazards is to permission nuclear significant activities at nuclear licensed sites on the basis of a safety case(s) submitted by the licensee. ONR does this after assessing the safety case(s) to ensure it is adequate. In broad terms, a safety case(s) is adequate if it demonstrates that the risks arising from the activities for which permission is sought are ALARP.

ONR's regulatory remit strictly only applies once an organisation has formally applied for a NSL, and extends from this point to final de-licensing 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 NSL, including consideration of technical issues relevant to the viability of the site. Flood and coastal erosion hazards are an example of this.

ONR is a statutory consultee on all new nuclear build applications for Development Consent Orders (DCO) made to the PINS. The relationship between PINS and the nuclear regulators, which includes ONR⁷ and EA, is set out in sect. 2.7 of the National Policy Statement (NPS) for nuclear power generation, EN-6⁸. Flood risk is identified as a nuclear impact in sect. 3.4 of EN-6 and anticipates liaison between the nuclear regulators and PINS.

Based on the advice of the relevant nuclear regulators, the PINS should be satisfied that the applicant is able to demonstrate suitable flood risk mitigation measures. These mitigation measures should take account of the potential effects of climate change in the most recent marine and coastal flood projections. Applicants should demonstrate that future adaptation/flood mitigation would be achievable at the site, after any power station is built, to allow for any future credible predictions that might arise during the life of the station and the interim spent fuel stores.

In the case of planning applications to local authorities, the 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 hazards such as flooding.

In the assessment of risk, ONR should:

⁷ Note that prior to the Energy Act 2013 coming in to force, ONR was an agency of the Health and Safety Executive (HSE). The powers and responsibilities formerly lodged with HSE and discharged by ONR on its behalf have, through the EA13, been transferred to ONR in its new role as a stand-alone public corporation.

⁸ DECC, National Policy Statement for Nuclear Power Generation (EN-6), Vol I of II, July 2011.

<http://www.decc.gov.uk/assets/decc/11/meeting-energy-demand/consents-planning/nps2011/2009-nps-for-nuclear-volume1.pdf>

- 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 keep nuclear risks from flooding hazard ALARP.
- Review and assess the adequacy of the licensee's nuclear safety arrangements in relation to flood and coastal erosion hazard by a mixture of inspection and assessment, in summary:
 - Inspection should examine the site's operational arrangements (processes, procedures, work instructions etc.) for maintaining the effectiveness of the flood and coastal erosion defences in line 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 the Safety Assessment Principles (SAPs) and Technical Assessment Guide (TAG) 13.

Environment Agency

The EA is the principal flood risk management authority in England providing a strategic overview relating to all forms of flood risk. The EA is responsible for forecasting and mapping flood risk, providing warnings, taking part in emergency planning and response and advising on development in the flood-plain; and has permissive powers for building and keeping defences in good order.

The EA is a consenting authority for flood and coastal risk management and land drainage, for example:

- Works in, over, under, main rivers; or likely to affect the integrity of fluvial and tidal defences.
- Raising ground levels in the floodplain beside a main river.
- Coastal works undertaken by local authorities.
- Other works covered by local byelaws.

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

The EA is the regulator for environmental permits for new nuclear build.

In the assessment of risks, the Environment Agency should:

- Review the flood risk assessment and associated flood risk management measures against the requirement for safe occupancy, and access for staff, for the full life-time of the station where relevant.
- Review the food risk assessment and associated flood risk management measures against the requirement to not cause adverse harm to others through any alteration to the characteristics of flooding in the area, leading to increased off-site impacts for the full life-time of the station.
- Provide advice on its review of the flood risk assessment and associated flood risk management measures to PINS and the relevant planning authorities.

National Infrastructure Directorate of the Planning Inspectorate (PINS)

The Planning Inspectorate responsibilities include:

- Examining Development Consent Order applications under the Planning Act 2008 (and amended by the Localism Act 2011).
- Providing recommendations to the Secretary of State for their decision. (The decision of the acceptability of the safety of site users/occupants would lie with the Secretary of State).

Local Authority

The local authorities' responsibilities include:

- To provide advice on issues of safety relating to emergency planning during a flooding incident. This will be supported by other category one responders, for example, emergency services, through the local resilience forum and set out in a local emergency preparedness framework.
- Examining and determining planning applications under the Town and Country Planning Act 1990.
- Consenting authority for the majority of coastal protection works⁹.

Prepare an Emergency Plan under the Radiation Emergency Preparedness and Public Information Regulations 2001 (REPPPIR):

Lead Local Flood Authorities

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

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

Highways Authority

The Highways Authority is responsible for managing the road drainage from roads on the adopted local road network.

The Highways Agency England / is responsible for managing road drainage from the trunk road and motorway network in England. The upper tier of local authorities (county councils and unitary authorities) is generally responsible for other public roads.

Internal Drainage Boards

Internal Drainage Boards (IDBs) operate under the Land Drainage Act 1991 and have permissive powers to undertake works to secure drainage and water level management of their districts. They may also undertake and regulate flood defence works on ordinary watercourses within their district (that is, watercourses other than 'main river').

⁹ The Marine Management Organisation has responsibility for Flood and Environmental Protection Act 1985 (FEPA) licensing duties for all works below Mean High Water Springs (MHWS) .

The IDB is responsible for consenting works on an ordinary watercourse within their drainage district. Prior written consent is required for the erection of flow control structures or any culverting of an ordinary watercourse within the IDB's drainage district.

Appendix C – Adapting to Climate Change

Climate change potentially impacts all sources of flood risk and is expected to increase coastal erosion rates, cliff instability and sea defence fragility. Preparing for, or adapting to, these impacts is therefore a necessity. Although the broad impacts of climate change on UK flood risk is 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. Operators should use the most up to date advice and ensure that this advice remains valid. For example, when any major new research is published applications should be reviewed in the light of the new information

Consideration of Climate Change in Nuclear Safety Assessments

ONR guidance on assessment of external hazards and the control of the associated risks, including flooding and the effects of climate change is set out in Technical Assessment Guide (TAG) 13. TAG 13 currently states that for new build, ONR expects the designs to incorporate due consideration of the effects of climate change over the life-time of the facility. To this end, ONR expects the designs to be capable of accommodating the emissions scenario that is considered on the basis of relevant good practice to be most consistent to demonstrating that the risk arising from climate change effects is ALARP. An important consideration is that flood protection measures are made adaptable to cover possible changes to future estimates of climate change effects, as a way of managing the large uncertainties inherent in flood hazard predictions over the life-time of new nuclear reactor sites. A range of scenarios should also be considered to assess the implications of any disproportionate increase in consequences (i.e. “cliff-edge” effects) where a small increase in flood risk will result in a significant increase in the flood hazard and to assess the potential need for adaptation options. This is consistent with TAG 13 which states that the design of new facilities would also be expected to be able to accommodate a wider range of emissions scenarios including conservative scenarios, although not necessarily the most conservative. In addition, it is prudent to ensure that there are no features of the design which are completely undermined by more radical changes to the climate. In this context the maximum credible scenario may be used, see next section.

Consideration of Climate Change in Energy Infrastructure Planning and Operation

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 and for nuclear power stations specifically in EN-6. Climate change guidance for general planning applications is provided in the National Planning Policy Framework and Planning Practice Guidance..

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.

EN-1 states that the Planning Inspectorate (PINS) - should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections available at the time the Environmental Statement (ES) was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the estimated life-time of the new infrastructure. Should a new set of UK Climate Projections become

available after the preparation of the ES, PINS should consider whether they need to request further information from the applicant.

The National Policy Statement provides guidance on how to consider the changing flood and coastal erosion risks. They also discuss how to manage those risks both within the initial design but also over the life-time of the site. It describes how PINS may consider requiring the applicant to 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”.

The ONR and EA will assess the evidence provided by applicants that demonstrate external hazards to the proposed nuclear power station have been considered. This will include consideration of the projected impacts of climate change over the life-time of the power station.

Consideration of Government Guidance and Data to Support Adaptation within Flood and Coastal Erosion Management

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”¹⁰. For those nuclear sites and infrastructure on the coasts, the impacts from sea level rise, change to storm surges and wave climate (wave heights, period and direction) need to be considered over the life-time of the facilities. This includes operation, decommissioning and waste storage phases.

The **credible maximum scenario** described in EN-1 is a peer-reviewed, high end, plausible, scenario. A current example of the credible maximum scenario for sea level rise and storm surge for the period to 2100 is provided by Government’s UKCP09, and is termed the H++ scenario¹¹.

The Department for Environment, Food and Rural Affairs (DEFRA)), the EA and the ONR encourage a “**managed adaptive approach**” to flood and coastal erosion risk management when planning for climate change. The approach is described by the Environment Agency within its document called, ‘*Adapting to Climate Change: Advice for Flood and Coastal Risk Management Authorities*’. The approach sets out a way of dealing with the significant uncertainty around the projections of future climate change for the UK.

The aim of the managed adaptive approach is to build flexibility into 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 approach is to build in the ability to adjust an option should it be required - flexible options. 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.

A complementary approach is to build flexibility into the decision process itself through waiting and learning - flexible plans. For example, sequencing options so that no or low regret options are taken earlier and more inflexible measures are delayed in anticipation of better information.

¹⁰ Climate Resilient Infrastructure: “Preparing for a Changing Climate” Defra 2011 Cm8065

¹¹ UK Climate Projections 2009 UKCP09 Defra ukclimateprojections.defra.gov.uk/content/view/1805/690/

Not all of the options to manage future climate change will be suitable for a managed adaptive approach of waiting and learning, for instance some of the options will be more cost-effectively implemented during initial construction. So, a mix of precautionary design and managed adaptive approach is likely to be the most suitable approach for nuclear sites.

Given the potentially significant risks that climate change presents and the significant uncertainty over the very long life of nuclear sites, we expect site applications will contain precautionary elements within the initial design, flexibility designed into flood measures and a plan for the whole life of the site detailing future options and the triggers that would lead to their implementation. This should be an integral part of the on-going periodic safety review following construction.

What are the elements of a managed adaptive approach?

- Understanding the full range of risks that might need to be managed. This comes from understanding the full range of climate change as described by the credible maximum scenario.
- Understanding how much flexibility and what options might be needed - and when - depending on the different climate change projections.
- 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.

For the managed adaptive approach to be suitable, it will be necessary to demonstrate that it is made up of:

- Technically feasible and viable options - i.e. that the future cost of the options can be accounted for.
- 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.

Appendix D – ONR and EA Flood risk interests for Nuclear New Build development proposals in England *:

(* Please note that this is not a prescriptive list of the requirements of the ONR and EA rather an indication of the differences between the ONR and EA remit.)

Nuclear New Build site	Environment Agency (Construction, operation and decommissioning),	ONR (Construction, operation and decommissioning)	Comment
Flood Risk Remit	Environment Agency (Construction, operation and decommissioning),	ONR (Construction, operation and decommissioning)	Both EA and ONR have an interest in all stages of site development.
Identification of all forms of flooding and coastal erosion	<p>On-site and off-site risks and impacts</p> <p>Tidal flooding - 0.5% annual probability (event with and without climate change allowances</p> <p>Fluvial flooding- 1% annual probability event with and without climate change allowances</p> <p>Fluvial and Tidal flooding – 0.1% annual probability event with and without climate change allowances</p>	<p>On-site impacts only, but on-site and off-site effects from these impacts to ensure dutyholder risks are as low as reasonably practicable, (ALARP)</p> <p>Design basis analysis - 0.01%¹² annual probability flood event (SAPs EH.4, para. 239¹³</p> <p>Beyond design basis analysis - assess cliff-edge effects etc. (SAPs EHA.7 & 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>Focus of the EA is to ensure that existing and future flood risks and coastal erosion risk is fully understood and robustly defined as part of the assessment, to inform site design and decision makers. EA is also concerned with understanding the potential of the development to impact on flood risk to third parties (e.g. loss of floodplain storage). ONR focus is on the safety case.</p>
Breach	<p>Yes</p> <p>Tidal defence breach - 0.5% and 0.1% annual probability event with climate change allowances. Duration of breach (i.e. no. of tidal cycles to be considered) will need to be agreed with local EA FCRM teams.</p>	<p>Dependent on the claims made in dutyholders safety case</p>	<p>ONR focus is on the safety case. EA's role will ensure the modelling/assumptions are appropriate under the EA remit.</p>

¹² The ONR SAPS refer to the 1 in 10000 year event the two are understood to be the same.

¹³ Consideration can be given to design basis events at higher frequencies (less onerous) where the facility cannot give rise to high unmitigated consequences (SAPs para. 241). 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.

	Fluvial defence breach - 1% and 0.1% annual probability event with climate change allowances		
Overtopping	Yes Defence overtopping – 0.1% annual probability event with climate change allowances	Yes Defence overtopping should not occur at the Design Basis flood level and there should be some margin available above this to cover the possibility of Beyond Design Basis cliff edge effects. Overtopping may be possible at flood hazard levels significantly beyond the Design Basis, but would need to be managed by site staff through e.g. emergency arrangements. The risk arising from such low probability events should be assessed by the licensee and shown to be risk ALARP.	Focus of the EA is on the lead time/ ability to 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. ONR is concerned with the safety case.
Debris	Yes	Yes The safety significance of flood borne debris hazard should be covered in the licensee's safety case(s).	EA 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. ONR is concerned about the potential of flood debris to affect operations in respect of the reactor and hence safety case.
Blockage of systems	Yes	Yes The safety significance of blockage to safety significant systems should be covered in the licensee's safety case(s).	EA 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 (e.g. ensuring that there is a strategy to maintain conveyance through culverts through appropriate design of trash screens and a maintenance strategy). ONR's focus is on

			ensuring that the release of radiological material is managed – there may be a link to ensuring that flood risk critical systems are kept clear of debris.
How residual risks are managed	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 licensee to be ALARP.</p>	<p>EA focus is on the residual risk of flooding from coastal and fluvial and how the applicant has demonstrated in their design/ mitigation that there is sufficient flexibility/ redundancy in the design to cope with the residual risks of flooding (e.g. breach of defences).</p> <p>ONR's 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 on-site Emergency Arrangements to be exercised periodically and demonstrated annually. These demonstrations can include extreme flooding scenarios.</p>	<p>The NSL requires licensees to put in place a site based Emergency Plan. Although these are not flood hazard specific, they should account for plant states that extreme flooding might cause.</p> <p>The Local Authority is responsible under REPPiR for creating and exercising an off-site Emergency Plan, which should account for extreme flooding scenarios. The Licensee, ONR and EA have obligations under these Emergency Plans.</p>
Where possible reducing overall risk in the area	Yes	No	EA's focus is on compliance with national policy on development and flood risk whereby developers should attempt to reduce flood risk to third parties where possible.
Within the site, the most vulnerable development is located in areas of lowest flood risk unless there	Yes – development not related to safety case	Only those areas related to safety case	Note 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

are overriding reasons to prefer a different location;			which has not been informed by the SSA process for these developments a sequential test is required.
Safe access/ egress and escape routes	<p>Yes</p> <p>Tidal flooding - safe access/ egress in 0.5% annual probability event with climate change allowances</p> <p>Fluvial flooding - safe access/ egress in 1% annual probability event with climate change allowances</p> <p>Tidal and fluvial flooding – safe means of escape (or sufficient time available) up to the 0.1% annual probability event</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>Beyond the Design Basis, the licensee's emergency plan should address safe access/egress</p>	<p>Focus of the EA is on the lead time/ ability to evacuate the site safely in the event of a 0.1% annual probability event and safe access/ egress during a 0.5% annual probability event (tidal/ 1% annual probability event (fluvial), with climate change allowances.</p> <p>ONR is concerned with the safety case and ensuring that there is a safe and achievable means of access to the safety critical elements of the design.</p>
Flood Warning process	<p>Yes: but limited e.g. Provide supporting providing data on request:</p> <p>E.g. identifying what flood warning services are available in the area/ flood level information.</p>	<p>Yes</p>	<p>There is an obvious link between flood warning coverage/ capability and safe evacuation of the site – which the EA will be concerned with. ONR may have a focus on flood warning of 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</p> <p>For non-safety critical elements up to 2080s and beyond we advise both the medium and high emissions scenarios be assessed based on the 90th percentile for the development life-time.</p> <p>For safety critical elements sensitivity test using to credible maximum (H++ upper end) for whole development life-time should also be applied.</p>	<p>Yes</p> <p>Safety critical infrastructure Covered by the licensee's safety case(s) analysed by Design Basis Analysis (DBA), Beyond Design Basis Analysis (BDBA) and Probabilistic Safety Analysis (PSA) methods.</p>	<p>EA's focus is on risk to the site and occupants (level of protection from flooding and mitigation against any off-site flood risk impacts) Implications on third parties for the full life-time of the development, incorporating climate change allowances. ONR is concerned with the safety case and the applicant would need to demonstrate that the reactor and associated infrastructure was safe (risk ALARP) for the operational life-time.</p>

	The managed adaptive approach can be used to develop a flood risk management approach to balance the risks and costs, in particular avoiding a 'cliff edge' effect.		
Adaptation	Yes Focus is on strategy - Anything a developer does in terms of mitigation needs to be designed so it doesn't prevent future adaptation up to credible maximum	Yes The Licence's safety case(s) should demonstrate that flood defences are adaptable to cover potential changes in climate change predictions over the life of the site.	EA's focus is on if the strategy allows room for future adaptation. And considers off site flood risk impacts in the adaptation scenario For those adaptation/ mitigation measures outside the scope of the FRA (i.e. beyond 0.1% annual probability event or not included in the DCO) we would not expect these to be covered in the FRA for the DCO other than a couple of lines outlining the general principle to these mitigation/ adaptation measures and that the detail will be considered by the ONR. The ONR will pick up on the technical detail of adaptation.

Associated development sites

	Environment Agency	ONR	Comment
Approach to Climate change for associated development sites	More onerous (i.e. sensitivity testing to H++ upper end) required if associated infrastructure is critical to the day to day running of the site. If the infrastructure is not critical (e.g. 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.	Outside remit unless associated development linked to the Nuclear Licensed Site	EA is concerned with ensuring climate change has been incorporated appropriately and proportionately in line with the category/ type of associated development. ONR is concerned about ensuring the development is appropriately resilient to climate change for the full life-time of the development if the associated development is critical to the operation of the site.

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