



Office for
Nuclear Regulation



Environment
Agency



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Naturiol**
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Wales

USE OF UK CLIMATE PROJECTIONS 2018 (UKCP18) BY GB NUCLEAR INDUSTRY

**POSITION STATEMENT –
MARCH 2019**

INTRODUCTION

This position statement sets out the Office for Nuclear Regulation, the Environment Agency, and Natural Resources Wales (referred to hereafter as the regulators) expectations in regards to UK Climate Projections 2018 (UKCP18) and their application by dutyholders in the nuclear industry when undertaking climate change assessments in support of safety cases.

Released in November 2018, UKCP18 is a set of climate model projections for the UK produced by the UK Meteorological Office (Met Office) and partners. UKCP18 builds on the UK Climate Projections 2009 (UKCP09) based on evolutions in science and computing capabilities. For dutyholders in the nuclear industry, the impacts of climate change on hazard magnitude and frequency for some natural hazards could be significant over the lifetime of nuclear sites. The use of UKCP18 is considered to be relevant good practice in determining climate change allowances for relevant natural hazards at GB licensed sites.

This position statement also provides dutyholders in the nuclear industry with some background on UKCP18 and information on some of the most significant areas of change from UKCP09, namely:

- the use of Representative Concentration Pathways (RCPs) instead of the Special Report on Emission Scenarios (SRES) used in UKCP09; and
- provision of projections at a higher spatial and temporal resolution in UKCP18 than has been previously available, for example daily and sub-daily (although the sub-daily projections will not be available until later in 2019).

WHAT IS UKCP18?

The UK Climate Projections 2018 have been produced by the Met Office with expert input from the Environment Agency and funded by Defra and BEIS. UKCP18 projections have been developed from recent advances in modelling the climate system, and the use of the new Met Office supercomputing facilities has enabled higher resolution climate projections to be produced compared with UKCP09. UKCP18 updates the UKCP09 projections over UK land areas and updates UKCP09 projections of sea level rise, giving greater regional detail and providing more information on potential extremes of climate change.

UKCP18 provides information on temperature, precipitation, wind, sea level rise and storm surge (Ref.1). UKCP18 provides the latest information on our future climate – however, it is not within the scope of the UKCP18 project to provide information on impacts. This information will need to be derived by others and could be commissioned by dutyholders.

THE REGULATORS' EXPECTATIONS ON THE USE OF UKCP18

TRANSITIONING TO UKCP18

The regulators (ONR, EA and NRW) expect that operators of all nuclear licensed sites and disposal sites for radioactive waste¹ will take account of UKCP18 when assessing the impacts of climate change. This includes taking UKCP18 into account at all stages of the facility lifecycle, from design, planning, construction, operation, and through to decommissioning and eventual release from regulation². Although we do not consider it necessary to transition from UKCP09 to UKCP18 immediately, any new analysis of climate change should make use of UKCP18. For existing sites, its implications for climate change considerations should be taken into account during Periodic Safety Reviews (PSRs).

At the end of December 2018, the service providing UKCP09 closed. The UKCP09 website is available in an archived format and the underlying UKCP09 data is available from the Centre for Environmental Data Analysis (CEDA) catalogue but there will be no further updates to material on the UKCP09 website (Ref.5). There is no longer access to the UKCP09 helpdesk or User Interface and the associated weather generator that was part of UKCP09 has been shut down.

The Environment Agency's advice for planners and developers preparing strategic and site specific flood risk assessments is provided in Flood Risk Assessments: Climate Change Allowances published in 2016 (Ref. 6). In Wales, climate change allowances in relation to flood risk are set out in Welsh Government guidance produced by NRW (Ref. 7). These allowances remain the best national representation of how climate change is likely to affect flood risk for peak river flow and peak rainfall intensity, however research to be published in 2019 may result in some changes to these allowances. Allowances for sea level rise for major infrastructure projects such as nuclear installations is covered below and in Table 3.

REPRESENTATIVE CONCENTRATION PATHWAYS

UKCP18 uses Representative Concentration Pathways (RCPs), which were used in the most recent Intergovernmental Panel on Climate Change (IPCC) report to develop projections. These replace the emissions scenarios used in UKCP09 (Special Report on Emissions Scenarios (SRES)).

RCPs specify the concentrations of greenhouse gases that will result in the total radiative forcing³ increasing by a specified amount by 2100, relative to pre-industrial levels (Ref.0). Radiative forcing scenarios for 2100 have been set at 2.6, 4.5, 6.0 and 8.5 W/m² and these are reflected in the four RCPs; RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5 (Ref. 0). Each RCP results in a different range of global mean temperature

¹ Facilities on land for the disposal of solid radioactive wastes permitted or to be permitted under the Environmental Permitting (England and Wales) Regulations 2016.

² Environmental permit holders should ensure that site-wide environmental safety cases and post-closure risk assessments take into account the potential consequences of climate change (see Refs.2, 3 and 4).

³ Total radiative forcing is the difference between the incoming and outgoing radiation at the top of the atmosphere (Ref.0).

increases until 2100 (Table 1). Each RCP can be met by a combination of different socioeconomic assumptions (Ref. 0).

In UKCP18, probabilistic projections at 25km spatial resolution over land are available for RCP 2.6, 4.5, 6.0 and 8.5 as well as for SRES A1B. SRES A1B has been included in the probabilistic projections to allow direct comparison between UKCP09 and UKCP18. Marine and coastal projections are available for RCP 2.6, 4.5 and 8.5 in UKCP18. RCP 6.0 has not been included in marine and coastal projections for UKCP18.

Table 1: The increase in global mean surface temperature averaged over 2081-2100 compared to the pre-industrial period (average between 1850-1900) for the RCPs (best estimate, 5-95% range). From IPCC AR5 WG1 Table 12.3 (Ref.9).

RCP	Change in temperature (°C) by 2081-2100
2.6	1.6 (0.9-2.3)
4.5	2.4 (1.7-3.2)
6.0	2.8 (2.0-3.7)
8.5	4.3 (3.2-5.4)

As SRES scenarios and RCPs were derived using different methods, it is not possible to directly compare the two. There are some similarities between SRES scenarios and RCPs in terms of median global temperature increase by 2100 (Table 2).

Table 2: SRES scenarios that are most similar to RCPs, in terms of median global temperature increase by 2100 (Ref.0).

RCP	Most similar SRES scenario (in terms of temperature)
2.6	None
4.5	SRES B1 (low emissions scenario in UKCP09)
6.0	SRES B2 (between the low and medium emission scenarios in UKCP09)
8.5	SRES A1F1 (high emissions scenario in UKCP09)

Advice from both ONR and EA (and endorsed by NRW) on the use of RCPs, return periods, and sensitivity studies is provided in the table below (Table 3). The subsequent text after Table 3 outlines how dutyholders could meet the expectations of both regulators.

Table 3: The use of RCPs, return periods, and sensitivity studies in climate change assessments – ONR and EA expectations.

Expectation	ONR	EA
RCP to select	<p>ONR does not prescribe the use of a particular RCP to define a design basis event⁴. The dutyholder will need to provide evidence that the RCP that they have selected is adequately conservative in line with ONR's Safety Assessment Principles (SAPs) and that uncertainty has been taken into account. ONR expects that there would not be a reduction in conservatism from the approaches that have been used in UKCP09 (ONR has generally accepted the UKCP09 medium emissions scenario at the 84th percentile as adequately conservative for defining a design basis (More information on this is available in Ref.10)).</p>	<p>The Environment Agency flood risk and climate change guidance states a range of likely climate change scenarios should be assessed. Typically, this range of allowances is premised on scenarios across the medium and high emissions scenarios⁵. The EA guidance is due to be updated in 2019 to reflect UKCP18 projections.</p>
Return period	<p>Design basis analysis – 0.01% annual probability flood event (SAP EHA.4, para. 239)</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</p>	<p>Tidal flooding - 0.5% annual probability event</p> <p>Fluvial flooding- 1% annual probability event</p> <p>Fluvial and Tidal flooding – 0.1% annual probability event</p>

⁴ In addition, dutyholders are expected to ensure that there is no disproportionate increase in risk for events more severe than the design basis. Dutyholders are also required to provide enhanced protection against even more severe events and provisions for recovery in the unlikely event that the protection capability is exceeded. Further information can be found in ONR's External Hazards SAPs (Ref.12) and ONR's External Hazards TAG (Ref. 10 & 11).

⁵ Currently for sea level rise, a single figure allowance is provided in EA's climate change and flood risk guidance (Ref. 6). However, since publication of UKCP18, EA's interim preferred position is for developments sensitive to flood risk such as infrastructure projects (i.e. high impact should they flood) the 95th percentile for RCP8.5 should be assessed alongside the current single figure allowance.

	(SAP EHA.18, para. 246(e))	
Sensitivity Studies	Regardless of the RCP selected, sensitivity studies are also needed against more onerous scenarios including the H++ scenario, which is outside or on the margins of the 10 th -90 th percentile of UKCP09 (see the section on H++ below for more detail). Further information can be found in ONR's External Hazards Technical Assessment Guide (TAG 13) (Ref. 10 and 11).	H++ should be assessed for developments that will be highly vulnerable to the impact of climate change, such as major infrastructure projects.

Dutyholders need to satisfy the requirements of the regulators and the planning authorities with respect to their consideration of climate change for nuclear new build. The submissions will respond to different regulatory requirements and expectations as set out in the table above, but where they overlap they should be consistent; differences in data, methods used and judgments should be reconcilable and justified between the two analyses. This is set out in ONR and EA's 'Principles for Flood and Coastal Erosion Risk Management' (Ref. 13).

A dutyholder could satisfy both regulators while maintaining this consistency by, for example, performing an analysis of climate change using a range of RCPs, return periods, and sensitivity studies. This should include consideration of RCP 4.5 and 8.5 and H++ scenarios. This analysis would then feed into individual submissions to each regulator in accordance with their expectations.

H++ SCENARIOS

More extreme climate change scenarios outside or on the margins of the 10th-90th percentile range of UKCP09 were developed and are known as the H++ scenarios. These can be used to assess the impacts of low probability, high impact climate events including heatwaves, drought, extreme winds, sea level rise and storm surge. H++ scenarios can also be used for sensitivity testing different adaptation options over time periods appropriate for the nuclear industry. ONR and EA's 'Principles for Flood and Coastal Erosion Risk Management' (Ref. 13) states that the current H++ scenarios based on UKCP09 for sea level rise and storm surge are an example of the credible maximum scenario.

The UKCP18 project will not be producing an updated H++ scenario. The wider scientific community will, however, aim to update the H++ scenario for sea level, as a minimum, but the information will not be available until later in 2019 at the earliest. In the interim, the H++ scenario developed from UKCP09 remains available and applicable.

EXPLORATORY POST-2100 SEA LEVEL RISE SCENARIOS

There is now a large body of literature that suggests that increasing sea level is likely to continue beyond 2100 for a considerable period of time even if global greenhouse gas emissions are restricted. Therefore, UKCP18 has produced some extended projections for sea level rise beyond 2100 for RCP 2.6, 4.5 and 8.5 – these are referred to as “exploratory post-2100 sea level rise scenarios” (Ref. 14). These scenarios are based on idealised assumptions about emissions (rather than being linked to specific technologies and societal actions) and extend to 2300. These extended projections show uncertainty increasing with time and have much lower confidence than projections up to 2100 (Ref. 14). Dutyholders may choose either to use the exploratory post-2100 sea level rise dataset provided by the UKCP18 project or to extrapolate the UKCP18 sea level rise dataset beyond 2100 themselves. Regardless of the methodology selected, dutyholders should be aware that a high degree of uncertainty is present and the use of climate change data beyond 2100 should proceed with caution, taking into account the managed adaptive approach (see below).

EXTREME VALUE ANALYSIS

In UKCP09, many dutyholders used the weather generator facility to generate data that could be used to undertake Extreme Value Analysis (EVA). The weather generator is not included in UKCP18 and is no longer being updated. Dutyholders may still wish to undertake EVA and one way of doing this in UKCP18 could be to use the 2.2km sub-daily data for RCP 8.5, although this will not be available until later in 2019.

MANAGED ADAPTIVE APPROACH

The regulators encourage a ‘managed adaptive approach’ to flood and coastal erosion risk management when planning for climate change (Ref. 13). The managed adaptive approach sets out a way for dealing with the significant uncertainty surrounding climate change in the future. 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 future.

There are two key elements of the managed adaptive approach. One approach is to build in the ability to adjust an option should it be required. A complementary approach is to build flexibility into the decision process itself through waiting and learning as scientific understanding of climate-related risks increases, and by developing flexible plans by dutyholders.

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.

There are a number of elements of a managed adaptive approach (Ref. 13):

- 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. A current example of the credible maximum

scenario for sea level rise and storm surge for the period to 2100 is the H++ scenario provided by UKCP09.

- 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.

More information on the managed adaptive approach can be found in ONR and EA's 'Principles for Flood Risk and Coastal Erosion Risk Management' (Ref. 13).

STATUS OF REGULATORS' POSITION ON UKCP18

The regulators anticipate that further information about the capabilities and limitations of UKCP18 will be released by the UKCP18 project in due course. The regulators will keep the position under review, and if appropriate, reconsider this statement in light of any such developments.

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