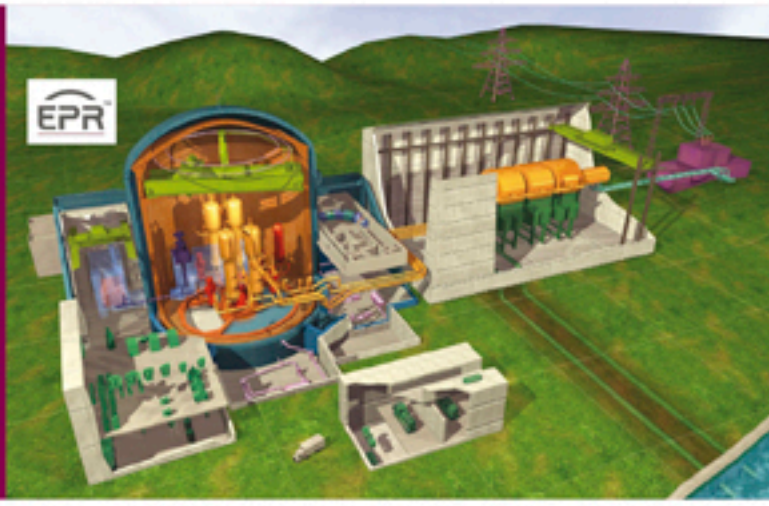
Generic design assessment

UK EPR™ nuclear power plant design by Electricité de France SA and AREVA NP SAS

Supplement to the decision document



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Foreword

Our work on generic design assessment (GDA) began in 2007 and it has enabled us to engage with nuclear reactor designers and developers at an early stage in the development of new nuclear power station designs before any construction begins. This is when we can have the most effective influence to help ensure that any new nuclear power stations would achieve high standards of environmental protection and waste management.

In December 2011 we completed our planned assessment of EDF and AREVA's UK EPR™ reactor design, published our conclusions in a decision document and issued an interim Statement of Design Acceptability (SoDA) for this reactor design. The interim SoDA identified two "GDA Issues" that the companies must resolve before we would consider issuing a full SoDA for the UK EPR™. At the same time the Office for Nuclear Regulation, with whom we have worked very closely, completed its planned assessments and issued an Interim Design Acceptance Confirmation for the UK EPR™ that identified 31 GDA Issues to be resolved, including the two above that we specified jointly.

Over the last 12 months EDF and AREVA have worked to resolve all of the GDA Issues and have provided supplementary information that we have assessed. We have now concluded that we are content with the generic environmental case for their reactor design and that it should meet the high standards we expect, and I am pleased that we are now issuing a full SoDA for the UK EPR™ reactor. This is the first full SoDA we have issued for the reactor designs that we have been assessing in our GDA work.

The SoDA does not in itself permit the construction and operation of a nuclear power station at a specific site. This would require many other approvals such as a Development Consent Order from the Department of Energy and Climate Change's Secretary of State, a nuclear site licence and other permissions from the Office for Nuclear Regulation and a number of site-specific environmental permits from ourselves.

This document is a supplement to our earlier decision document for the UK EPR™ and explains how we have concluded that the GDA Issues are resolved and that we can now issue a SoDA. It includes sections on changes and additions to the information provided by EDF and AREVA since the decision document was published, and our assessment for any impact on environmental matters associated with EDF and AREVA's responses to ONR's safety related GDA Issues.

The supplement identifies a number of assessment findings that are additional to those we set out in our decision document. Assessment findings are requirements for future operators to provide further information and address technical issues for our consideration at the appropriate stage of site-specific design, construction, commissioning or early operation of a new build project.

David Jordan

Director of Operations, Environment Agency, December 2012

Executive summary

Our role

As the principal environmental regulator for the nuclear industry in England and Wales, the Environment Agency's role is to regulate discharges and waste disposals from nuclear power stations and to ensure that their impact on air, water and land is acceptable and minimised.

Generic design assessment

In response to growing interest in nuclear power and potential applications to build new nuclear power stations in England and Wales, in 2007 we developed a new approach, generic design assessment (GDA), for assessing the environmental acceptability of new reactor designs.

Electricité de France SA and AREVA NP SAS ('EDF and AREVA') submitted their UK EPR™ nuclear power plant design to us for assessment in August 2007. In 2011 we issued an interim Statement of Design Acceptability (iSoDA) for the UK EPR™ and published our decision document, which provides full details of the GDA process. We have now issued a full Statement of Design Acceptability (SoDA) and this supplement to the 2011 decision document that explains developments since 2011 and why we are issuing a SoDA.

GDA means that we assess the acceptability of the generic environmental aspects of the nuclear reactor design before individual site applications are made. This approach allows us to get involved at the earliest stage where we can have most influence and where lessons can be learnt for site-specific applications.

The new GDA approach has given us the opportunity to work more closely with the Office for Nuclear Regulation (ONR), providing effectively a 'one-stop-shop' for nuclear regulation. The process has allowed a rigorous and structured examination of detailed environmental, safety and security aspects of the reactor designs, over approximately five years. We believe that GDA has improved efficiency both for the regulators and the nuclear industry, and is delivering greater protection for both people and the environment.

Our 2011 decision

By issuing an iSoDA for the UK EPR™ design, we confirmed to industry that we were content that the environmental aspects of the design would meet the high standards we expect but that particularly significant, but still resolvable, issues remained that would need to be resolved before we would consider issuing a SoDA. The two GDA Issues we raised, jointly with the ONR, were:

- GI-UKEPR-CC-02: Provide a consolidated final GDA submission, including agreed design changes for the UK EPR™.
- GI-UKEPR-CC-03: Consider and action plans to address the lessons learnt from the Fukushima Event.

Our decision document set out our detailed assessment of environmental aspects of the UK EPR™ nuclear power plant design. We used the comments and issues raised in our 2010 consultation to help inform our decisions.

Update to our decision

For both GDA Issues, we asked EDF and AREVA to provide resolution plans to show how they would be addressed and, since December 2011, we have been assessing the

supplementary information provided by EDF and AREVA. We are satisfied that EDF and AREVA have now fully resolved the two GDA Issues, and we are issuing a full SoDA.

This supplement to our 2011 decision document summarises our assessment of EDF and AREVA's response to the GDA Issues, and details the changes to their submission. This supplement also summarises our assessment of the work undertaken by EDF and AREVA to address the other nuclear safety related GDA Issues raised by ONR, where it has informed our final decision.

Changes to the submission

EDF and AREVA published their submission on their website in 2007 (http://www.epr-reactor.co.uk) and invited people to comment. The submission has been revised during GDA as would be expected to reflect developments. The submission comprises a pre-construction environment report (PCER) together with supporting documents. Our decision document references the PCER dated March 2011. The PCER has since been updated by EDF and AREVA to reflect additional information provided in response to the GDA Issues. This document includes a summary of the changes made to the submission since March 2011. The changes confirm our assessment and conclusions in the decision document. However, the changes have led us to make minor changes or clarifications to a small number of paragraphs in our decision document and final assessment reports; these are set out in Annex 4 of this document. We consider that the changes are not so significant as to require re-issue of revised documents. The documents we published in 2011 should now be read with the changes listed in Annex 4 of this document.

When reviewing the additional information provided by EDF and AREVA in response to the GDA Issues, we considered whether further consultation was necessary to help inform our assessments. We concluded that the additional information was not significant enough to benefit from further consultation.

GDA Issues raised by the Office for Nuclear Regulation

ONR also raised 29 safety related GDA Issues in addition to the two we issued jointly with them. We reviewed the information provided by EDF and AREVA in response to these GDA Issues and the associated ONR assessment reports to assess if there was any potentially significant impact on environmental matters or on our decision of 2011. We noted that, while modifications to the UK EPR™ design were proposed in response to some nuclear safety related GDA Issues, these did not adversely affect the environmental impact and in some cases they were beneficial. We conclude that the additional information provided does not change the conclusions or assessment findings in our decision document.

In parallel with our issue of a SoDA, ONR has concluded that it is satisfied with the design and safety cases presented by EDF and AREVA for the UK EPR™ reactor, and has issued its equivalent approval in the form of a Design Acceptance Confirmation (DAC). Further information on the ONR assessment is available at: www.hse.gov.uk/newreactors

Further assessment findings

GDA is not intended to provide a complete assessment of the final reactor design, as there will be other issues, operator-specific or site-specific, that we would expect to be considered during the environmental permitting and site licensing stages. In some instances the safety case can only be validated by procurement or later testing or commissioning. This validation process is normal regulatory business and will be subject to appropriate regulatory controls. We highlighted a number of these assessment findings in the 2011 decision document.

We would expect these findings to be addressed either by the designer or by a future operator / licensee, as appropriate, during the detailed design, procurement, construction, commissioning or early operational phases of a new build project. As a result of our

assessment of EDF and AREVA's response to the GDA Issues, including those raised by ONR, we have identified further assessment findings. The full list of assessment findings is published as Annex 5 in this document.

Our decision

We have completed a detailed assessment of EDF and AREVA's GDA submission for the UK EPR™ nuclear power plant design, including their response to the GDA Issues that we identified in our December 2011 decision document. We conclude that the environmental aspects of the design would meet the high standards we expect, and have decided to issue a Statement of Design Acceptability (SoDA) for the UK EPR™.

Next steps

The detailed design of the UK EPR™ and the safety and environment cases that support it will evolve if operators take forward site-specific proposals. We expect that the generic reactor design submitted for GDA and the SoDA would be used to underpin the permissions to construct reactors of the UK EPR™ type that are more or less identical, except for site-specific and operator-specific requirements.

As an example, the generic UK EPR™ design assessed in GDA forms the basis of the application by EDF Energy's and Centrica's joint venture company, NNB Generation Company Limited for environmental permits to operate a proposed new nuclear power station it wishes to build at Hinkley Point in Somerset. Further information on our role in permitting the proposed power station and associated developments can be found on our website at: http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

The issue of both a SoDA by the Environment Agency and a DAC by ONR do not in themselves allow any additional activity in terms of nuclear power station construction as that requires both approval of a Development Consent Order by the Department of Energy and Climate Change's Secretary of State, and a specific regulatory permission given by ONR under a Nuclear Site Licence Condition.

The SoDA will remain valid for ten years from the date of issue, after which time the UK EPR™ design would need to be reviewed and reassessed.

Contents

1 Introduction

1.1 Introduction to GDA

1 As the principal environmental regulator for the nuclear industry in England and Wales, the Environment Agency's role is to regulate discharges and waste disposals from nuclear power stations and to ensure that their impact on air, water and land is acceptable and minimised.

2 In response to growing interest in nuclear power and potential applications to build new nuclear power stations in England and Wales, we developed a new approach, generic design assessment (GDA), for assessing the environmental impacts of new reactor designs. GDA means that we begin assessing the acceptability of the generic environmental aspects of the nuclear reactor design before individual site applications are made. This approach allows us to get involved at the earliest stage where we can have most influence and where lessons can be learnt for site-specific applications.

3 The new GDA approach has given us the opportunity to work closely with the Office for Nuclear Regulation[1] (ONR), providing effectively a 'one-stop-shop' for new nuclear regulation. The process has allowed a rigorous and structured examination of detailed environmental, safety and security aspects of the reactor designs, over approximately five years. We believe that GDA has improved efficiency both for the regulators and the nuclear industry, and is delivering greater protection for both people and the environment. GDA cannot provide a complete assessment of a final 'site-specific' design as there will be other issues, operator-specific or site related, that we would expect to be considered as site-specific proposals come forward.

4 Electricité de France SA and AREVA NP SAS ('EDF and AREVA') submitted their UK EPR™ nuclear power plant design to us for assessment in August 2007. In 2011 we issued an interim Statement of Design Acceptability (iSoDA) for the UK EPR™ and published our decision document, which provides full details of the GDA process. We have now issued a full Statement of Design Acceptability (SoDA) and this supplement to the 2011 decision document that explains developments since 2011 and why we are issuing a SoDA.

5 GDA was carried out primarily in two stages: preliminary assessment and detailed assessment. We completed the preliminary assessment and published our findings in March 2008 (Environment Agency, 2008a). On 28 June 2010, our consultation began on the views we had formed following our detailed assessment of the UK EPR™ reactor design (Environment Agency 2010a). This consultation closed on 18 October 2010. We carefully considered all of the comments received and used them to help inform our decision.

6 We conducted our GDA work in an open and transparent way and communicated with industry, academics, trade unions, non-Governmental Organisations and other interested groups and individuals during the process.

7 Generation of radioactive waste is intrinsically linked to the detailed design of a reactor, together with its associated plant. We require generation of radioactive waste to be minimised, and so GDA has focussed on radioactive waste design

[1] The Office for Nuclear Regulation (ONR) was created on 1st April 2011 as an Agency of the Health and Safety Executive (HSE). It was formed from HSE's Nuclear Directorate and has the same role.

issues. Permitting the disposal and discharge of radioactive wastes has also traditionally been the area of regulation that has had the longest lead time for our permitting of nuclear power stations. Additionally, we have also looked at key aspects of the design relating to other areas such as abstraction and discharges to water, pollution control issues and management of non-radioactive waste.

8 In December 2011 we published our detailed assessment of environmental aspects of the UK EPR™ nuclear power plant design in our decision document (Environment Agency, 2011a). We were content that the environmental aspects of the design would meet the high standards we expect.

9 We identified jointly with ONR two GDA Issues to carry forward, so we could only issue an interim Statement of Design Acceptability (interim SoDA, or iSoDA). The GDA Issues were:

a) GI-UKEPR-CC-02: Provide a consolidated final GDA submission, including agreed design changes for the UK EPR™.

b) GI-UKEPR-CC-03: Consider and action plans to address the lessons learnt from the Fukushima event.

1.2 About this supplement to the decision document

10 The two GDA Issues have now been resolved to our satisfaction and so we are issuing a SoDA for EDF and AREVA's nuclear power plant design, the UK EPR™. This supplement to the decision document sets out how we assessed EDF and AREVA's response to the GDA Issues and how we concluded that these were resolved.

11 We provided in December 2011 a decision document that gave:

a) An introduction to our role in nuclear regulation and the basis for GDA.

b) An outline of the UK EPR™ design.

c) A guide to our detailed assessment.

d) A summary of our detailed assessment and conclusions.

e) Our decision based on our assessment up to that time.

f) Annexes supporting the decision document.

12 Also we published 14 final assessment reports (FARs) that provided the full details of our detailed assessment (Environment Agency, 2011 b – o).

13 In this document we have not repeated information provided in the 2011 decision document or FARs but we have concentrated on explaining why the additional information provided by EDF and AREVA was sufficient to allow us to close-out the two GDA Issues and now issue the SoDA. See Sections 2 and 3 of this supplement.

14 The iSoDA we issued references the pre-construction environmental report (PCER) issued by EDF and AREVA in March 2011 and its supporting and reference documents. EDF and AREVA had to provide additional information to address the two joint GDA Issues and the 29 other ONR Issues. They consolidated the additional environmental information in a 2012 version of the PCER (as referenced in the SoDA at Annex 1 of this document), along with some other minor revisions and corrections. We have summarised the changes from the 2011 submission and our assessment of them in Section 4 and Annex 3 of this supplement.

15 We assessed the responses provided by EDF and AREVA in response to the 29 nuclear safety related GDA Issues raised by ONR to see if there was any impact on environmental matters or consequences for the decision we published in 2011. We have summarised our consideration of the relevant ONR GDA Issues in Section 5 of this supplement, where they helped inform our final decision.

16 Our assessments led us to make some revisions to our 2011 documents and add additional assessment findings. The decision document and its supporting FARs should be read with the revisions listed in Annex 4 of this document. Annex 5 provides a consolidated list of all our assessment findings.

17 After GDA, the assessment findings will be subject to appropriate control as part of normal regulatory oversight, and it will be the responsibility of the future operator to ensure they are addressed at the appropriate stage of site-specific design, construction, commissioning or early operation of a new build project.

1.3 Additional information received since the issue of the decision document

18 As noted above we have received supplementary information from EDF and AREVA, primarily to address the two GDA Issues. We highlight in this document the additional information that has helped inform our decision on the acceptability of the UK EPR™ design.

19 When reviewing the additional information provided by EDF and AREVA in response to the GDA Issues, we considered whether further consultation was necessary to help inform our assessments. We concluded that the additional information was not significant enough to benefit from further consultation.

1.4 Governance of GDA Issue close-out

20 With ONR, we have completed our assessment of the responses to the two joint GDA Issues. The associated assessment reports are being produced by us jointly and will be published shortly after they have completed our publication process.

21 With ONR, we have implemented a robust, effective and efficient close-out process for all of the GDA Issues. This has an additional level of internal challenge to moderate and decide on GDA Issue closure.

22 The GDA Issue close-out process requires confirmation that:

a) All the information committed within EDF and AREVA's resolution plan had been delivered.

b) This information had been reviewed.

c) All responses to Technical Queries had been received.

d) All related modifications had been identified (if appropriate).

e) The information provided was judged to provide an adequate response to the GDA Issue.

23 We set up the joint regulators' Assessment Review Group (ARG) to provide peer review, challenge and moderation, of this confirmation and to be the final arbiters on GDA Issue closure. Only when the ARG agreed that a GDA Issue was closed, could a confirmation letter be sent to EDF and AREVA. These letters are also posted on our new reactors' website http://www.hse.gov.uk/newreactors/gda-issue-close-out-uk-epr.htm#close-out-reports.

24 All of the 31 GDA Issues have been closed using this process. The first GDA Issue was closed on 28 March 2012 and the last was closed on 7 December 2012.

25 When available, all of the assessment reports for the GDA Issues, including those for GI-UKEPR-CC-02 and GI-UKEPR-CC-03 will be published on the regulators' new reactors' website http://www.hse.gov.uk/newreactors/gda-issue-close-out-uk-epr.htm#close-out-reports.

1.5 After GDA

26 Now that a SoDA has been issued future work will be related to site-specific permitting. The detailed design of the UK EPR™ and the safety and environment cases that support it will evolve if operators take forward site-specific proposals. We expect that the generic reactor design submitted for GDA and the SoDA will be used to underpin the permissions to construct reactors of the UK EPR™ type that are more or less identical, except for site-specific and operator-specific requirements.

27 As an example, the generic UK EPR™ design underpins the basis of the application by EDF Energy's and Centrica's joint venture company, NNB Generation Company Limited for environmental permits to operate a proposed new nuclear power station it intends to build at Hinkley Point in Somerset. Further information on our role in permitting the proposed power station and associated developments can be found on our website at:
http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

28 The issue of both a SoDA by the Environment Agency and a DAC by ONR do not in themselves allow any additional activity in terms of nuclear power station construction as that requires both approval of a Development Consent Order by the Department of Energy and Climate Change's Secretary of State, and a specific regulatory permission given by ONR under a Nuclear Site Licence Condition.

29 The SoDA will remain valid for the UK EPR™ generic design for ten years from the date of issue. This would be subject to no significant new information arising during that period which might call into question our original assessment of the design. This period of validity is based upon the existing ONR requirement for licensees to undertake periodic safety reviews of their existing nuclear facilities every ten years.

30 If EDF and AREVA wish to seek renewal of the SoDA and DAC towards the end of this ten-year period, we will require them to review the submission in the manner of a periodic safety review. It is envisaged that SoDA / DAC renewal would be much less resource intensive than the original assessment, but some design improvements might be needed to gain renewal if these were found to be reasonably practicable at that time, for example in the light of emerging international practices.

2 GDA Issue GI-UKEPR-CC-02

2.1 Summary of joint GDA Issue GI-UKEPR-CC-02

31 GDA Issue GI-UKEPR-CC-02, issued jointly by ourselves and ONR, required EDF and AREVA to produce a consolidated final GDA submission which included agreed design changes for the UK EPR™. The aim of this GDA Issue was to seek assurance that the final consolidated GDA submission documentation was appropriately controlled, maintained and updated to reflect changes to the reference design arising during GDA. EDF and AREVA were required to continue to control, maintain and develop the GDA submission documentation, including the PCER (as referenced in the SoDA at Annex 1), submission master list (SML) and reference design configuration, taking account of any design changes agreed for inclusion in GDA and provide final versions of these documents to the regulators. It was particularly important that any changes that arose during the GDA Issue resolution were captured appropriately and consistently in these documents, because they are references in the SoDA. More detailed information can be found in our joint close-out report for this GDA Issue (ONR and Environment Agency, to be published).

2.2 Additional information provided

32 EDF and AREVA's resolution plan published in response to this GDA Issue identifies the deliverables that were produced, which included:

a) The reference design configuration which includes design changes agreed for inclusion in GDA.

b) The SML which lists all of the documentation included in the GDA submission.

c) The specification of the schedule, responsibilities and scope of work for updating the safety, security and environmental report (SSER) and for undertaking consistency checks throughout the final SSER.

d) The final SSER, which includes the PCER and supporting documents, controlled to ensure consistency of claims, arguments and evidence submitted in GDA.

e) The definition of the arrangements for the control of design changes for inclusion in GDA, which includes a description of the design change management form (CMF) procedure used to raise and track design changes.

33 Some design changes agreed for inclusion in GDA were fully incorporated into GDA documentation during GDA. Certain design changes agreed in GDA require work by future operators to fully update documentation to be consistent with these agreed changes. We assessed the following deliverables produced by EDF and AREVA to help any future operators in this task:

a) The specification for the update of system design manuals (SDMs) after GDA. This provides a high level description of the work that future operators will need to undertake to update SDMs at the detailed design stage, to align with design changes that have been included in GDA.

b) The handover document for GDA design changes. This consists of a document containing a handover form for each design change agreed for inclusion in GDA. This will ensure that any future operators appropriately identify and

update site-specific documentation to align with design changes that have been included in GDA.

2.3 Assessment

34 Our assessment has focussed on the deliverables produced by EDF and AREVA in response to this GDA Issue, and on inspection of EDF and AREVA's GDA project arrangements for control of GDA submission documents. We reviewed and inspected EDF and AREVA's process for control of updates to the SSER, SML and reference design to ensure consolidation across these important GDA deliverables. We also considered information provided by EDF and AREVA on the environmental impact of proposed design changes to inform our decision on inclusion of these design changes in the GDA reference design. Some of the design documents (for example system design manuals) have not been fully updated by EDF and AREVA to incorporate design changes that were agreed during GDA and certain design changes agreed for inclusion in GDA are agreed in principle but will require further work by any future operator. We have therefore assessed EDF and AREVA's handover documentation produced to help future operators to update affected documentation to incorporate these design changes at the site-specific phase. We found EDF and AREVA's project arrangements to be robust and we are satisfied that the final GDA deliverables, including the PCER, SML and reference design, are consistent. We are satisfied that handover documentation is sufficient to help any future operators to update relevant documents affected by agreed design changes.

35 We have raised four assessment findings jointly with ONR in relation to this GDA Issue. The assessment findings are aimed at confirming that the design changes agreed in GDA and the development of the site-specific design, including incorporation of design changes agreed in GDA, are implemented during the site-specific phase under appropriate management arrangements and use BAT. We believe that design changes included in GDA do not adversely affect the environmental performance of the design and we recognise that any future operators will need to fully assess and incorporate these design changes during development of the site-specific design.

36 **Hence we have added the following assessment findings:**

a) **AF-UKEPR-CC-08: A future licensee shall use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15.**

b) **AF-UKEPR-CC-09: A future licensee shall use relevant arrangements under the licence and environmental permits to demonstrate that the impact of design changes raised after 31 May 2012 and included in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15 are As Low As Reasonably Practicable (ALARP) / Best Available Techniques (BAT), and confirm their categorisation in terms of significance to nuclear safety and environment prior to their implementation into the site-specific detailed UK EPR™ design.**

c) **AF-UKEPR-CC-10: A future licensee shall ensure that the development of the site-specific detail of the UK EPR™ design from the GDA UK EPR™ design, including work that is undertaken by vendors / contractors, is carried out under relevant arrangements as required by the licence and environmental permits.**

d) **AF-UKEPR-CC-11: A future licensee shall use relevant arrangements under the licence and environmental permits for implementing the design changes listed in the GDA Reference Design Configuration UK EPR-I-002 Rev. 15 and described in the design change handover package documentation (see UKEPR-0020-001 Issue 01).**

As these are joint assessment findings with ONR, we have used the ONR numbering system above.

2.4 Conclusion

37 **We are satisfied that EDF and AREVA's arrangements for the control of updates to the final GDA submission documentation including the PCER, SML and reference design for the UK EPR™ are adequate. We are satisfied that the GDA Issue has been addressed appropriately and that these documents can be used as the key references to the SoDA. Therefore we have closed this GDA Issue.**

38 As noted in chapter 1.4, the GDA Issue close-out assessment reports will be published shortly once they have completed our publication process. The regulators agreement to close GDA Issue GI-UKEPR-CC-02 was made at the Assessment Review Group (ARG) on 7 December 2012, and the close-out letter is available at http://www.hse.gov.uk/newreactors/reports/step-four/close-out/gi-ukepr-cc-02.pdf. The full report will be available in due course on our new reactors' website at http://www.hse.gov.uk/newreactors/gda-issue-close-out-uk-epr.htm#close-out-reports.

3 GDA Issue GI-UKEPR-CC-03

3.1 Summary of joint GDA Issue GI-UKEPR-CC-03

39 On 11 March 2011, the Fukushima Dai-ichi site was inundated by a large tsunami wave resulting from the worst earthquake to ever be recorded in Japan. Despite the efforts of the operators, external and standby power supplies and cooling was lost and reactor units 1, 2 and 3 overheated resulting in major releases of radioactivity and further damage to plant. This joint GDA Issue was identified to ensure that the lessons learnt from the Fukushima accident were considered within GDA for the UK EPR™ design. GDA Issue GI-UKEPR-CC-03 required EDF and AREVA to demonstrate how they will take account of the lessons learnt from the events at Fukushima. This included those arising from EDF and AREVA's own internal reviews and lessons, and recommendations identified in Her Majesty's Chief Inspector of Nuclear Installations' interim and final reports (ONR, 2011a, 2011b). More detailed information will be found in our joint close-out report for this GDA Issue (ONR and Environment Agency, to be published).

3.2 Additional information provided

40 EDF and AREVA's resolution plan published in response to this GDA Issue identifies the deliverables that were produced, which included:

a) Summary report of the results of EDF and AREVA's internal UK EPR™ robustness analysis.

b) Review of the robustness of the UK EPR™ design against beyond design basis seismic events.

c) Review of the robustness of the UK EPR™ design against beyond design basis flooding events.

d) Review of the robustness of UK EPR™ power sources and long-term cooling of the reactor and fuel pool.

e) Review of the design measures in place in the event of a postulated severe accident scenario.

f) Response to recommendations from Her Majesty's Chief Inspector of Nuclear Installations' reports on the Fukushima events.

g) Updated PCER submission as appropriate.

41 As a result of this work, EDF and AREVA also identified a number of design enhancements to improve the robustness of the UK EPR™.

3.3 Assessment

42 Our assessment focused on the deliverables received from EDF and AREVA in response to this GDA Issue. We considered the environmental implications of the robustness reviews and any resulting design changes. EDF and AREVA provided sufficient design reviews and supporting analyses to demonstrate the robustness of the generic UK EPR™ design at normal operating and shutdown states against severe seismic and flooding events. EDF and AREVA provided appropriate evidence to demonstrate the ability of the generic UK EPR™ to retain its radioactive inventory following events which result in loss of electrical power and / or cooling.

EDF and AREVA have identified a number of design changes from the Flamanville 3 (an EPR™ plant currently under construction in France) project to improve the capability of the UK EPR™ design to withstand severe accident events. EDF and AREVA have provided sufficient responses to the Chief Inspector's recommendations from the Fukushima lessons learnt reports. We are satisfied that the PCER submission has been updated appropriately, see Section 4 and Annex 3 of this report for a summary of the changes.

43 We recognise that any future operator will need to take account of design changes raised in response to the Fukushima GDA Issue and accepted in GDA as part of the reference design (see joint assessment findings AF-UKEPR-CC-09 and AF-UKEPR-CC-11 raised for GDA Issue GI-EPR-CC-02, Section 2.3 of this report).

44 **Hence we have not raised any further assessment findings in relation to this GDA Issue.**

45 We note that other design changes proposed by EDF and AREVA in response to other nuclear safety related GDA Issues will also have improved robustness of the design in response to extreme events.

46 We also note that there was a Multi-National Design Evaluation Project (MDEP) meeting held on 15 November 2012 to exchange information with overseas regulators on the impact of Fukushima on the EPR™ design.

47 More detailed information will be found in our joint close-out report for this GDA Issue (ONR and Environment Agency, to be published).

3.4 Conclusion

48 **From our assessment of deliverables associated with this GDA Issue, we are satisfied that the lessons learnt from Fukushima have been addressed within the scope of the GDA UK EPR™ design. Therefore we have closed this GDA Issue**.

49 As noted in chapter 1.4, the GDA Issue close-out assessment reports will be published shortly once they have completed our publication process. The regulators agreement to close GDA Issue GI-UKEPR-CC-03 was made at the Assessment Review Group (ARG) on 30 November, and the close-out letter is available at http://www.hse.gov.uk/newreactors/reports/step-four/close-out/gi-ukepr-cc-03.pdf. The full report will be available in due course on our new reactors' website at http://www.hse.gov.uk/newreactors/gda-issue-close-out-uk-epr.htm#close-out-reports.

4 Changes to EDF and AREVA's submission

4.1 Introduction

50 We issued the iSoDA with reference to the submission updated by EDF and AREVA in March 2011. Our main interest was in the pre-construction environmental report (PCER) and its supporting and reference documents.

51 EDF and AREVA had to provide supplementary information to address the two joint GDA Issues and the 29 other ONR nuclear safety related GDA Issues. This information was often in the form of reference documents (as detailed in the submission master list (SML) as referenced in the SoDA, Annex 1 of this supplement).

52 EDF and AREVA reviewed and revised the PCER and its supporting documents to bring in summaries of the supplementary information and include additional references. The revision also included some minor changes such as:

a) Update of the table of contents.

b) Minor formatting changes.

c) Minor changes to terminology, these are listed in Annex 2 of this document.

d) All the references listed under each numbered section or sub-section heading have been re-numbered to remove potential ambiguity.

e) Revision history amended with the changes.

53 EDF and AREVA published their revised submission on their website (http://www.epr-reactor.co.uk) in December 2012.

54 We note below where this has led to updates to our decision document and final assessment reports (FARs) that were published in December 2011. Other changes from the 2011 submission to the 2012 submission are summarised in Annex 3 of this supplement.

4.2 PCER changes

4.2.1 Chapter 3 – Aspects having a bearing on the environment during operation phase

55 The following modifications have been made to Chapter 3 of the PCER:

a) The following sentence has been added as a note under PCERsc3.3 Table 3 on expected annual performance for gaseous radioactive discharge and under PCERsc3.4 Table 1 on expected annual performance (excluding contingency) for liquid radioactive discharge and maximum annual liquid radioactive discharge: '*Note that International experience and numerical estimations show the absence of negative impacts on carbon-14 production from zinc acetate injection (see PCSR Sub-chapter 5.5 and [Ref-1[2]])'.*

[2] Zinc injection claims, arguments and evidences: overall balance for UK-EPR. ECEF110139. Revision A. EDF. March 2011

b) In PCERsc3.3, Section 4.2.1.1 on back-up generator tests, the following note has been added: '*These power rates are indicative and could be adapted to site-specific conditions (especially ultimate heat sink design). Moreover, these values do not include any potential additional diesel as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event*'. This has been added in response to our joint GDA Issue GI-UKEPR-CC-03 on '*Consider and action plans to address the lessons learnt from the Fukushima event*'. This note has also been added to Table 5 and Table 9 in PCERsc3.3.

c) Information has been added to be consistent with additional information provided in Sub-chapter 5.5 of the pre-construction safety report (PCSR). Hence, the following bullet points have been added with respect to what the primary circuit is conditioned with:

   i) '*zinc acetate to reduce the material corrosion and replace the cobalt of oxides deposited on ex-core surfaces*;'

   ii) '*hydrogen peroxide during shutdown in order to favour the dissolution of corrosion products and increase their removal via the demineralisers;* and'

   iii) '*hydrazine during shutdown and start-up in order to eliminate the oxygen.*'

d) The following sentence has been added to Section 5.3.2 in PCERsc3.4: '*The impact of zinc acetate injection is considered negligible on liquid chemical discharges (see PCSR Sub-chapter 5.5 and [Ref-1[2]])*'.

56 **We have reviewed these modifications to Chapter 3 of the PCER and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document**.

57 However, the additional information does indicate there may be changes made in the light of lessons learnt from the Fukushima event. We note, for example, that the addition of a high power mobile diesel generator may need to be included in any application for a combustion plant permit under the Environmental Permitting (England and Wales) Regulations 2010 (EPR 10) and the disposability of the batteries may need to be considered. We expect future operators to assess these changes in terms of their impact on the environment. This matter is covered by our new assessment findings detailed in the GDA Issue GI-UKEPR-CC-02 Section of this report (see Section 2).

58 We note that ONR has an assessment finding related to the rating of the emergency diesel generators, which we support. We recognise that the power rates in the PCER are indicative and are subject to site-specific studies.

4.2.2 Sub-chapter 6.1 – Sources of radioactive materials

59 The following modifications have been made to PCERsc6.1:

a) The following sentence has been added to Section 2.5: '*Carbon-14 is also produced from carbon activation but this production is very low compared to that formed by oxygen and nitrogen, even with zinc injection [Ref-1[3]].*' EDF and AREVA produced a number of additional reference documents (Ref-1 is one of them) regarding reactor chemistry mainly to address the ONR GDA Issue GI-

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[3] Zinc injection claims, arguments and evidences: overall balance for UK-EPR. ECEF110139 Revision A. EDF. March 2011

UKEPR-RC-02 '*Control and minimisation of ex-core radiation*' but also to provide more detail to us to confirm their claims that corrosion control measures minimise discharges. We assessed these reference documents and reviewed the content of them with EDF and AREVA at technical meetings. The additional information confirms our conclusions in the decision document that corrosion control measures, including zinc injection, contribute to BAT for the UK EPR™.

b) The following sentence has been added at the end of Section 2.6 and Section 2.7: '*Quantification of the RCP [RCS]* [reactor coolant system] *source term, based on calculations and considering specific materials and chemistry conditions of UK EPR [Ref-1[4]] [Ref-2[5]], shows the consistency of the nuclide source term specified in this sub-chapter*.'

c) Some additional text has been added to Section 2.6, to the effect that reductions in the creation of corrosion products, due to improvements to surface pre-treatment of the reactor coolant system (RCS) and in changing bearings and seals to reduce the use of silver and antimony have not been carried forward to source term evaluation. This is understandable, since without experience, the reductions are difficult to predict. Therefore, the source terms used for estimation of discharges may be pessimistic. This is acceptable in terms of dose assessment as dose is low anyway. However, this reinforces our challenge to the amount of contingency EDF and AREVA allowed between the '*expected performance*' and the '*maximum*' and supports our view that requested limits are too high for '*other radionuclides*'. The limits will be the starting point for any site-specific permit, but will be reviewed as part of the permitting process, taking account of any additional information provided by a future UK EPR™ operator.

60 **We have reviewed these modifications to PCERsc6.1 and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document**.

61 However, we have added the following sentence at the end of Paragraph 376 in the decision document:

a) '*EDF and AREVA have not reduced their estimates of discharges to gain benefit from the reduction in use of silver and antimony and use of pre-treatment corrosion control measures as the reductions are difficult to quantify without operational experience. (PCERsc6.1s2.6)*'. See Annex 4.

4.2.3 Sub-chapter 6.5 – Interim storage facilities and disposability for UK EPR™

62 The following modifications have been made to PCERsc6.5:

a) Clarification in Section 5.1 that solvents are expected to be incinerated.

b) Clarification in Section 5.2 that there are no datasheets for the reference case for evaporator concentrates since these are low level waste (LLW).

c) Clarification in Section 5.2 that should evaporator concentrates be intermediate level waste (ILW) they would not be incinerated but packaged for disposal as ILW.

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4 Analysis of UK EPR™ Source Term: Identification, Quantification and Characterisation. ECEF110448 Revision A. EDF. July 2011

5 Corrosion product characterization under PWR/EPR primary coolant conditions: thermodynamic assessments and power plant feedback. ECEF111022 Revision A. EDF. July 2011

63 **We have reviewed these modifications to PCERsc6.5 and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document**.

64 However, the following amendments should be taken into consideration when reading our decision document and FARs:

a) To be consistent with the PCER issued in 2012, we have added the words '*and solvents*' after the words '*waste oils*' in Paragraphs 651 and 652 in the decision document and Paragraphs 54 and 55 in the solid radioactive waste FAR. See Annex 4.

b) We have added some text in Paragraph 718 of the decision document saying that should evaporator concentrates be ILW they would not be incinerated but packaged for disposal as ILW. This change has also been made to Paragraph 123 in the solid radioactive waste FAR and to Paragraph 47 in the disposability of ILW and spent fuel FAR. See Annex 4.

4.2.4 Chapter 11 – Radiological impact assessment

65 The following modifications have been made to Chapter 11 of the PCER:

a) In Table 30 in PCERsc11.1, and Table A in Annex 6 in PCERsc11.1, the values of collective dose to UK and European populations from atmospheric discharges have been changed. The reason for this is that EDF and AREVA identified an error in their original estimates for collective doses in the previous versions of the PCER. This error was due to an issue with default assumptions in the modelling programme (PC CREAM 98). Collective dose calculations include consideration of the widespread dispersion of radionuclides in the UK, Europe and for global circulating nuclides, the world. For atmospheric releases this is modelled as a series of grids across the UK and Europe. The first pass assessment for the collective dose estimation only considered a small grid beyond the release point that did not take into account the whole populations concerned. In this revision of the PCER, more appropriate distances were used in the first pass assessment to reflect the UK and European populations. Therefore the collective dose from atmospheric releases to the UK and Europe increased and so did the total collective dose to the UK and Europe. Our contractor revisited the collective dose calculations they had originally performed and found the same issue. Our independent assessment of collective doses was amended for us. The revised collective doses are not exactly the same as EDF and AREVA predicts but they are similar.

66 **We have reviewed these modifications to Chapter 11 of the PCER and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document**.

67 However, the following amendments should be taken into consideration when reading our decision document and FARs:

a) EDF and AREVA's amended estimates of collective doses have been included in a new table in Paragraph 954 in the decision document. See Annex 4. As noted in the decision document the average per person doses are low, and we consider that additional measures to minimise discharges are not required to control collective doses.

b) Our amended estimates of collective doses have been included in a new table in Paragraph 956 in the decision document. See Annex 4.

c) EDF and AREVA's amended estimates of collective doses have been added to Paragraph 54 in the radiological impact on members of the public FAR. See Annex 4.

d) Our amended estimates of collective doses have been added to Paragraph 63 in the radiological impact on members of the public FAR. See Annex 4.

68 We have also reviewed our radiological impact on members of the public FAR, and the following amendments should also be taken into consideration when reading this FAR:

a) The dose criteria in Paragraph 35 have been reproduced as they appear in the Environmental Permitting Regulations 2010. See Annex 4.

b) Some extra text has been added at the end of Paragraph 36. See Annex 4.

c) The first recommendation from the Committee on Medical Aspects of Radiation in the Environment (COMARE) 14th report, '*Further consideration of the incidence of childhood leukaemia around nuclear power plants in Great Britain*' (published in 2011), has been included in Paragraph 85 as this is additional analysis for the UK that has been published since the FAR was issued. Additionally, the following sentences have been added to Paragraph 85: '*The Health Protection Agency (HPA) provides advice in the UK on the protection of the public from ionising radiation. The HPA have not indicated that any change is required in the radiation protection arrangements for the public as a result of the COMARE's 14th report.*' See Annex 4.

d) Some extra text has been added at the end of the last row in the last column in Section 6. See Annex 4.

69 **These additional amendments to our radiological impact on members of the public FAR do not lead us to change any of our conclusions or assessment findings given in our decision document**.

4.2.5 Chapter 12 – Non radiological impact assessment

70 The following modifications have been made to Chapter 12 of the PCER:

a) The following sentence has been added as a note under PCERsc12.1 Table 5 on sulphur and nitrogen dioxides release rates during operational phase, under PCERsc12.1 Table 8 on long-term impacts for sulphur and nitrogen dioxides emissions during operational phase and under PCERsc12.1 Table 9 on short-term impacts for sulphur and nitrogen dioxides emissions during operational phase: '*These values do not include any potential additional diesel as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event.*' This has been added in response to our joint GDA Issue GI-UKEPR-CC-03 on '*Consider and action plans to address the lessons learnt from the Fukushima event*'.

b) In Section 1.6.1 and Section 1.6.2 of PCERsc12.2, additional chemicals involved in commissioning are mentioned. These include ammonia and ethanolamine. This is consistent with the changes made to Chapter 4 of the PCER (see Annex 3). We will fully evaluate any future operator's assessment of the impacts of these chemicals as part of any future site-specific application for a water discharge activity.

71 **We have reviewed these modifications to Chapter 12 of the PCER and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document**.

72 However, as noted above in Section 4.2.1 (for Chapter 3 of the PCER), the additional information does indicate there may be changes made in the light of lessons learnt from the Fukushima event.

4.3 GDA UK EPR™ – Integrated waste strategy document

73 The following modifications have been made to the integrated waste strategy document, reference UKEPR-0010-001 Issue 03:

a) Text has been added to Section 1.2 to state that submission documents relating to environment undergo an independent peer review (IPR) process, and that all IPR comments are reviewed and addressed as needed.

b) A sentence has been added to state that the final treatment choice of individual waste streams results from consideration of the following: worker dose, practical feasibility of concentrating and containing all streams, best available techniques (BAT) / as low as reasonably practicable (ALARP) principles and costs.

74 **We have reviewed these modifications to the integrated waste strategy document and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document.**

75 However, the following additions should be taken into consideration when reading our decision document and FARs:

a) To be consistent with the PCER issued in 2012, we have added the sentence: '*EDF and AREVA also state that final treatment choice results from consideration of the following: worker dose, practical feasibility of concentrating and containing all streams, BAT / ALARP principles and costs*', at the end of Paragraph 252 in the decision document and Paragraph 36 in the integrated waste strategy FAR. See Annex 4.

5 ONR assessments

76 ONR had 29 other nuclear safety related GDA Issues as well as the two shared with us.

77 We considered all of the GDA Issues and worked closely with ONR on reviewing the responses provided by EDF and AREVA and the relevant ONR assessment reports to see if there was any potential impact on environmental matters or on the decision we published in 2011 (Environment Agency, 2011a).

78 The following sub-sections summarise our consideration of those ONR nuclear safety related GDA Issues whose closure has informed our assessment and contributed to our final decision. As a result of this, we have added new assessment findings which are set out in Annex 4 as revised paragraphs to the decision document. The decision document and its supporting FARs should now be read with the revisions listed in Annex 4 of this document. A full list of our assessment findings is given in Annex 5 of this document.

79 Full information on all the ONR nuclear safety related GDA Issues is available in the ONR close-out GDA Issue summary report and the ONR assessment reports (see ONR's website: http://www.hse.gov.uk/newreactors/reports.htm)

80 Note that when we permit the disposal and discharge of radioactive wastes, we only require consideration of events that are reasonably foreseeable during the lifetime of the reactor. Severe accident scenarios are well outside the scope of our environmental permitting.

5.1 Control and instrumentation (C&I)

5.1.1 GI-UKEPR-CI-04 - EDF and AREVA have yet to define a methodology to be used to qualify SMART devices for nuclear safety functions.

81 The aim of this GDA Issue was to seek additional assurance on a methodology for providing a justification for equipment that incorporates SMART devices. A SMART device is a component, often embedded in much larger electro-mechanical systems, that employs a high degree of complexity (large software modules and / or complex programmable devices). This is important because SMART devices are used in a wide range of safety and safety support systems. Therefore any failure in these devices could have a serious impact on the safety of the facility. Hence, establishing the correctness of design, manufacturing and testing processes is a critical activity.

82 To address this GDA Issue within the GDA process, a number of tasks were performed by EDF and AREVA as defined in the resolution plan.

83 ONR's assessment found that EDF and AREVA have developed a methodology based on the combination of production excellence and independent confidence building. The methodology comprehensively covers a wide range of design (hardware and software) and operational environment (electromagnetic, seismic and so forth) issues.

84 As a result of the work done in response to this GDA Issue, ONR considers EDF and AREVA now have a good understanding of the work that needs to be done to justify SMART devices for the UK EPR™ and can develop, together with a site licensee, a comprehensive plan to produce the necessary safety justifications during the site-specific detailed design and construction phase. ONR concluded

that the qualification of SMART devices at all safety classes has been adequately defined and therefore consider that the GDA Issue has been addressed satisfactorily.

85 **The resolution of this GDA Issue does not impact on the information presented in the PCER and supporting documentation. However, we would expect any future operators to apply the methodology developed in response to GI-UKEPR-CI-04 to SMART devices that provide an environmental protection function, and hence we have added the following assessment finding:**

a) **UK EPR-AF19 – Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CI-04) used to qualify SMART devices for nuclear safety functions, has been applied to relevant SMART devices that provide an environmental protection function.**

5.2 Essential electrical systems

5.2.1 GI-UKEPR-EE-01 - Provide a revised PCSR containing the requisite claims, arguments and evidence to substantiate the design of the plant electrical distribution system. The claims made for the electrical system need to be related to the overall safety claims for the plant.

86 ONR's Step 4 assessment concluded that there were no significant concerns regarding the electrical system integrity or basic architecture, but ONR were not satisfied that sufficient evidence had been provided to support EDF and AREVA's claims in the safety case. The aim of this GDA Issue was therefore to seek additional assurance to support EDF and AREVA's claims for the performance and integrity of the electrical systems by provision of a structured safety case that clearly identifies and substantiates the claims, arguments and evidence.

87 In response to this GDA Issue, EDF and AREVA provided a claims, arguments and evidence (CAE) document, and for consistency they also modified the relevant sections of the pre-construction safety report (PCSR).

88 Analysis has shown that the power rating of the emergency diesel generators (EDGs[6]) will need to increase from the reference design level. This analysis will have to be repeated once more detailed load information is known for the UK EPR™ specific loads during the site-specific design phase and ONR will monitor this as part of its normal regulatory activity.

89 ONR's assessment concluded that the evidence presented now supports the safety claims and arguments and substantiates the generic design and safety case for the electrical distribution system, and therefore ONR concluded that the response to this GDA Issue is satisfactory.

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[6] The UK EPR™ will include four main emergency backup electricity generators (emergency diesel generator – EDG). There will also be two ultimate diesel emergency backup generators (UDGs, but also known as station black-out (SBO) diesels). The emergency generators are all nuclear safety equipment to provide backup power supplies in the unlikely event of loss of off-site supply or if UK EPR™ load operation fails. They will not normally operate except for periodic testing.

90 Chapter 3 of the PCER already states that the power rates of the EDGs are indicative and may need to be adapted to site-specific conditions (such as ultimate heat sink design). In addition, it also states that the values do not include any potential additional EDGs as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event. For example, the addition of a high power mobile diesel generator may need to be included in any application for a combustion plant permit under the Environmental Permitting (England and Wales) Regulations 2010 (EPR 10) and the disposability of the batteries may need to be considered. We expect future operators to assess these changes in terms of their impact on the environment. This matter is covered by our new assessment findings detailed in the GDA Issue GI-UKEPR-CC-02 Section of this report (see Section 2).

91 We note that ONR has an assessment finding related to the rating of the EDGs, which we support. We recognise that the power rates in the PCER are indicative and are subject to site-specific studies.

92 EDF and AREVA expect that any future operator will ensure the appropriate level of security for electrical loads to relevant environmental protection plant and equipment. Given that the sizing of the back-up EDGs is a site-specific issue (due to factors such as heat sink design) this will be considered in site licensing / permitting.

5.3 Reactor chemistry

5.3.1 GI-UKEPR-RC-02 – EDF and AREVA to demonstrate that ex-core radiation levels in UK EPR™ are minimised so far as is reasonably practicable and can be controlled.

93 ONR's Step 4 reactor chemistry assessment concluded that the UK EPR™ safety case related to control and minimisation of radioactivity in the reactor systems required further work to support the claim that radioactivity could be appropriately controlled. This was mainly related to the fact that EDF and AREVA rely on their experience with current plants, whereas the design of the UK EPR™ has changed and evolved from these plants, which meant that more comprehensive consideration of the impact of these changes on the control and minimisation of radioactivity was needed. The aim of this Issue was to seek additional assurance on the control and minimisation of radioactivity in the reactor systems of the UK EPR™.

94 EDF and AREVA have provided additional information through a series of reports and technical meetings.

95 ONR's work concluded that:

a) EDF and AREVA have incorporated improvements in material selection, manufacturing techniques, and operating chemistry control of the primary circuit. The impact of these measures is to reduce the sources of radioactivity in the UK EPR™, minimising both the source term in the primary coolant and its transfer around the plant.

b) In addition, there are improvements, compared to current pressurised water reactors (PWRs), to the coolant treatment, storage and monitoring systems of the UK EPR™. EDF and AREVA have demonstrated that the UK EPR™ has appropriate design provisions for controlling and minimising radioactivity levels. As a result, the UK EPR™ should be capable of controlling radioactivity at least as well as, if not better than, other comparable plants.

c) From the information presented, it appears that the activity levels in the primary systems of the UK EPR™ are likely to be similar to the newest French PWRs (the N4 plants). At the moment this is a theoretical result only, as EDF and AREVA have used bounding estimates for their radioactive source estimations. While these activity levels would still be acceptable, ONR expects that more detailed calculations should reduce the predicted activity levels and clarify whether any additional controls are necessary to further minimise radioactivity. This is a topic on which ONR will seek further development during the site-specific phase when feedback from the first operational UK EPR™ plants becomes available.

96 ONR concluded that EDF and AREVA have provided sufficient evidence to demonstrate that radioactivity has been minimised and will be appropriately controlled in the UK EPR™. ONR is therefore satisfied that this GDA Issue has been addressed.

97 This topic was discussed in detail with the Environment Agency at a meeting on the 5 July 2012. As a result of this meeting there were a number of clarifications and minor amendments made to a number of chapters within the PCER, notably Chapters 6 and 8 and the BAT demonstration document (see Section 4 and Annex 3 of this supplement document for a summary of the changes).

98 **Therefore the impact of this GDA Issue has already been accommodated in the final versions of the documents provided to the Environment Agency. The changes to these documents do not lead us to change any of our conclusions or assessment findings given in our decision document.**

99 We note that ONR has an assessment finding related to analysis to be undertaken, which we support.

5.4 Human Factors

5.4.1 GI-UKEPR-HF-01 – Inadequate substantiation of human based safety claims and omission of a consolidated human factors safety case for the UK EPR™.

100 The aim of this GDA Issue was to seek a consolidated human factors (HF) safety case for the UK EPR™ that includes adequate substantiation of human based safety claims (HBSCs). In particular, ONR required EDF and AREVA to complete the identification and substantiation of human failure events, provide arguments to justify key elements of the UK EPR™ design relevant to HF claims, and provide evidence on how the design of the UK EPR™ prevents and mitigates the potential for operator violations.

101 In response to this GDA Issue, EDF and AREVA have undertaken a considerable amount of work to complete identification and substantiation of risk significant human failure events. They have provided additional qualitative arguments to support the case and supported this with appropriate evidence. These have been consolidated into a revised HF safety case.

102 ONR's assessment concluded that the identification and substantiation of risk significant human failure events has been completed sufficiently at this point in the design process. ONR considers that the substantiations provided by EDF and AREVA are based on reasonable assumptions about the detailed design, maintenance and operations, including the supporting procedures, although further work will be required to confirm this during the site-specific detailed design phase.

103 ONR considers that the submissions provided along with the material presented for GDA Step 4 now comprise an adequate HF safety case for the generic design that provides a clear presentation of all the significant claims, arguments and supporting evidence. ONR therefore concluded that EDF and AREVA have adequately addressed GDA Issue GI-UKEPR-HF-01.

104 The only area where there is considered to be a potential impact on the environmental assessment is in relation to the analysis of potential pre-fault human errors that could lead to failure of safety related structures, systems and components (SSCs). Some of these SSCs are of types that are also used in environmental systems. However the work is aimed at eliminating and / or reducing the likelihood of errors. Hence it should lead to improvement in environmental performance rather than any degradation.

105 **The resolution of this GDA Issue does not impact on the information presented in the PCER and supporting documentation. However, we would expect any future operators when undertaking detailed design of SSCs that deliver an environmental protection function, to provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised. Hence we have added the following assessment finding:**

a) **UK EPR-AF20 – When undertaking detailed design of structures, systems and components (SSCs) that deliver an environmental protection function, future operators shall provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised.**

5.5 Crossing-cutting topics

5.5.1 GI-UKEPR-CC-01 - EDF and AREVA to demonstrate that the methodology developed and applied for categorising safety function and classifying structures, systems and components is in line with UK and international standards and relevant good practice.

106 The aim of this GDA Issue was to seek additional assurance that the methodology developed and applied for categorising safety function (SF) and classifying structures, systems and components (SSCs) is in line with UK and international standards and relevant good practice.

107 In response to this GDA Issue, EDF and AREVA provided documents to show how they have further developed their methodologies for SF categorisation and SSC classification. They also provided examples of the application of these methodologies to different safety related systems within the UK EPR™ design. In addition, EDF and AREVA proposed a number of design changes to increase the safety classification of key SSCs above the level originally proposed.

108 ONR's assessment of the information and the proposed design changes provided by EDF and AREVA in response to this Issue concluded that the development of methodologies for categorising SF and classifying SSCs and the application of these methodologies within the UK EPR™ design, is sufficient at this stage of the design process, and that these are in line with UK and international standards and relevant good practice. ONR are therefore satisfied that GDA Issue GI-UKEPR-CC-01 has been addressed appropriately.

109 **The resolution of this GDA Issue does not impact on the information presented in the PCER and supporting documentation. However, we would expect any future operators to apply the methodology developed for categorising safety function and classifying SSCs (in response to GI-UKEPR-CC-01) to be applied to relevant SSCs that deliver an environmental protection function, and hence we have added the following assessment finding:**

a) **UK EPR-AF21 - Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.**

110 We also have a new assessment finding (listed in the GDA Issue GI-UKEPR-CC-02 Section of this report (see Section 2)), that requires a future licensee to use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15.

5.6 ONR's conclusion

111 ONR is confident that it has completed a meaningful assessment of the UK EPR™ reactor. In view of the safety case and design change improvements that EDF and AREVA have provided, ONR is now content, for this stage in the design process, that the current UK EPR™ generic reactor design and safety case has demonstrated that the risks to workers and the public are as low as reasonably practicable (ALARP).

112 In recognition of the fact that all the nuclear safety related GDA Issues are closed, and in accordance with its published guidance, ONR has therefore decided to issue a Design Acceptance Confirmation (DAC) for the UK EPR™ reactor. This has been issued alongside a summary report and means that ONR believes that the UK EPR™ reactor is suitable for construction on licensed sites in the UK, subject to site-specific assessment and licensing.

113 Design changes that have been agreed by the regulators are included in the final GDA reference design configuration which is referenced in the DAC.

114 ONR's summary report is available at http://www.hse.gov.uk/newreactors/reports.htm.

6 Our final decision

115 We have now concluded that we are content with the generic environmental case for the UK EPR™ reactor design and that it should meet the high standards we expect, and have issued a Statement of Design Acceptability (SoDA). This is reproduced at Annex 1. It is valid only for a site consistent with the identified generic site characteristics (see Chapter 13.1 of our decision document (Environment Agency, 2011a)).

116 We made our decision to issue a SoDA after we had carefully considered all responses to our consultation which took place in 2010 and assessed that EDF and AREVA had resolved the two outstanding GDA Issues identified in the iSoDA we issued in December 2011.

117 As part of our assessment we identified 25 assessment findings. We expect future operators to address these assessment findings during the detailed design, procurement, construction, commissioning or early operational phases of any new build project.

References

Reference	Author / Publication / Website
Environment Agency, 2008a	Environment Agency Generic design assessment of new nuclear power plant designs, Statement of findings following preliminary assessment of the submission by EDF and AREVA for their UK EPR design, March 2008 http://www.hse.gov.uk/newreactors/reports/epr.pdf
Environment Agency, 2010a	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Consultation document https://consult.environment-agency.gov.uk/portal/ho/nuclear/gda?pointId=1270818651893
Environment Agency, 2011a	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Decision document https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNO-E-E.pdf
Environment Agency, 2011b	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Management systems https://publications.environment-agency.gov.uk/pdf/GEHO1211BTMZ-E-E.pdf
Environment Agency, 2011c	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Integrated waste strategy https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNA-E-E.pdf
Environment Agency, 2011d	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Best available techniques to prevent or minimise the creation of radioactive wastes https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNB-E-E.pdf
Environment Agency, 2011e	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Gaseous radioactive waste disposal and limits https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNC-E-E.pdf
Environment Agency, 2011f	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Aqueous radioactive waste disposal and limits https://publications.environment-agency.gov.uk/pdf/GEHO1211BTND-E-E.pdf

Reference	Author / Publication / Website
Environment Agency, 2011g	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Solid radioactive waste (LLW and ILW) https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNE-E-E.pdf
Environment Agency, 2011h	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Spent fuel https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNF-E-E.pdf
Environment Agency, 2011i	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Disposability of ILW and spent fuel https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNG-E-E.pdf
Environment Agency, 2011j	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Monitoring of radioactive disposals https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNH-E-E.pdf
Environment Agency, 2011k	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Generic site https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNI-E-E.pdf
Environment Agency, 2011l	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Radiological impact on members of the public https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNJ-E-E.pdf
Environment Agency, 2011m	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Radiological impact on non-human species https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNK-E-E.pdf
Environment Agency, 2011n	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Other environmental regulations https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNL-E-E.pdf
Environment Agency, 2011o	Generic design assessment, UK EPR™ nuclear power plant design by AREVA NP SAS and Electricité de France SA: Final assessment report: Independent dose assessment https://publications.environment-agency.gov.uk/pdf/GEHO0510BSKA-E-E.pdf

Reference	Author / Publication / Website
ONR, 2011a	Japanese earthquake and tsunami: Implications for the UK nuclear industry – Interim report http://www.hse.gov.uk/nuclear/fukushima/interim-report.htm
ONR, 2011b	Japanese earthquake and tsunami: Implications for the UK nuclear industry – Final report http://www.hse.gov.uk/nuclear/fukushima/final-report.htm
ONR, 2012	Assessment Report: GDA Close-out for the EDF and AREVA UK EPR™ Reactor – GDA Issue CC-01 Revision 1 – Categorisation and Classification of Systems Structures and Component http://www.hse.gov.uk/newreactors/reports.htm
ONR and Environment Agency, to be published	Assessment Report: GDA Close-out for the EDF and AREVA UK EPR™ Reactor – GDA Issue CC-02 Revision 3 – Consolidated Final GDA Submission including agreed Design Changes for the UK EPR™ Available at http://www.hse.gov.uk/newreactors/reports.htm, when published
ONR and Environment Agency, to be published	Assessment Report: GDA Close-out for the EDF and AREVA UK EPR™ Reactor – GDA Issue CC-03 Revision 3 – Consider and action plans to address the lessons learnt from the Fukushima event Available at http://www.hse.gov.uk/newreactors/reports.htm, when published

While every effort has been made to ensure the accuracy of the references and website addresses listed in this report, their future availability cannot be guaranteed.

List of abbreviations

ALARP	As low as reasonably practicable
BAT	Best available techniques
CMF	Change management form
C&I	Control and instrumentation
COMARE	Committee on Medical Aspects of Radiation in the Environment
DAC	Design Acceptance Confirmation
DBA	Design basis accident
DECC	Department of Energy and Climate Change
EDF and AREVA	Electricité de France SA and AREVA NP SAS
EDG	Emergency diesel generator
EPR 10	Environmental Permitting (England and Wales) Regulations 2010
FAR	Final assessment report (14 published in December 2011 by the Environment Agency to support the decision document)
FA3	Flamanville 3 (an EPR under construction in France)
GDA	Generic design assessment
HF	Human factors
HPA	Health Protection Agency
HSE	Health and Safety Executive
HVAC	Heating, ventilation and air-conditioning
IAEA	International Atomic Energy Agency
ILW	Intermediate level (radioactive) waste
INSA	Independent nuclear safety assessment
IPR	Independent peer review
iSoDA	Interim Statement of Design Acceptability
IWS	Integrated waste strategy
LLW	Low level (radioactive) waste
LLWR	Low level waste repository
LoC	Letter of compliance
MOX	Mixed oxide fuel
ONR	Office for Nuclear Regulation, an Agency of the HSE (formerly HSE's Nuclear Directorate)
PCER	Pre-construction environmental report – unless stated otherwise this refers to the PCER as referenced in the SoDA at Annex 1 of this document
PCERsc3.3s4.1	PCER sub-chapter 3.3 section 4.1 (example reference)
PCSR	Pre-construction safety report – unless stated otherwise this refers to the PCSR as referenced in the DAC

PWR	Pressurised water reactor
RO	Regulatory Observation
RP	Requesting party (organisation that submitted a design for GDA)
RWMC	Radioactive waste management case
RWMD	Radioactive Waste Management Directorate (of NDA)
SDM	System design manual
SF	Safety function
SoDA	Statement of Design Acceptability
SML	Submission master list
SSER	Safety, security and environmental report
SSCs	Structures, systems and components

In addition EDF and AREVA's UK EPR™ system descriptions can be found in the glossary in Section 0 of the SSER.

Annex 1 – Statement of Design Acceptability

Generic assessment of candidate nuclear power plant designs Statement of Design Acceptability for the UK EPR™ design submitted by Electricité de France SA and AREVA NP SAS (EDF and AREVA)

The Environment Agency has undertaken a generic design assessment of the EDF and AREVA UK EPR™ design, during the period July 2007 to December 2012, using the process set out in the document Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs (Ref. 1).

The findings of our assessment are summarised in the decision document for the generic design assessment of EDF and AREVA's UK EPR™ (Ref. 2) and the supplement to the decision document (Ref. 3).

The Environment Agency is satisfied that EDF and AREVA have demonstrated the acceptability for environmental permitting of the UK EPR™ on the generic site, as defined in Schedule 1.

This statement is provided as advice to EDF and AREVA, under section 37 of the Environment Act 1995. It does not guarantee that any site-specific applications for environmental permits for the UK EPR™ will be successful. Any site-specific applications will be considered on a case by case basis and will be informed by generic design assessments.

The statement will remain valid for ten years from the date of issue. This would be subject to no significant new information arising during that period which might call into question our original assessment of the UK EPR™ design.

Name	Date
[name of authorised person] Ian Parker Manager, Nuclear Regulation Group (North)	13 December 2012

Authorised on behalf of the Environment Agency

References

1. Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Environment Agency, January 2007.
2. Decision document for the Generic Design Assessment of EDF and AREVA's UK EPR™, Environment Agency, December 2011. https://publications.environment-agency.gov.uk/pdf/GEHO1211BTNO-E-E.pdf
3. Supplement to the decision document for the Generic Design Assessment of EDF and AREVA's UK EPR™, Environment Agency, December 2012. https://brand.environment-agency.gov.uk/mb/Cb9Qpt

Schedule 1 – Scope of the generic design assessment

This Statement of Design Acceptability refers to the UK EPR™ as described in the design reference documentation:

a) *Reference Design Configuration* UKEPR-I-002 Revision 15. EDF and AREVA, 6 December 2012.

b) *Final Consolidated UK EPR GDA Pre-Construction Environmental Report*. EDF and AREVA, 2012, as detailed in EDF and AREVA letter REG EPR01471N, 30 November 2012.

c) The documents identified in the Submission Master List: *UK EPR GDA Submission Master List*. UKEPR-0018-001 Issue 03, EDF and AREVA, 6 December 2012.

Certain aspects have been agreed as being out of scope for generic design assessment and these are identified by EDF and AREVA in the reference design configuration document at a) above.

Annex 2 – Changes to PCER terminology

EDF and AREVA changed and harmonised some of the terminology they used in the PCER and supporting documents. Our documents published in 2011 use the terminology of the PCER 2011, if considered against the PCER 2012 then our documents need to be read with the following changes:

PCER: Changes to terminology	
PCER 2011	**PCER 2012**
bleed and vent system	vent and drain system
BTE	ETB
chimney	Stack
CILWDS	SiteLWDS[7]
decay tank	final storage tank
delay tank	final storage tank
DWQ[ETBVS]	8DWQ[ETBVS]
effluent treatment systems	effluent and waste treatment systems
Ex[CILWDS]	Ex(0SEK[SiteLWDS])[7]
ExLWPS	ExLWDS
experience feedback	operating experience feedback
fleet policy	fleet management policy
fresh cartridges	new resins
hold-up bed	delay bed
HSE	ONR
ion exchange media	ion exchange resins
ion exchanger	ion exchange resins
KER	0KER
KER[LRMDS]	0KER[LRMDS]
KRT[PRMS]	8KRT[PRMS] OR 0KRT[PRMS]
load cask	handling machine
NII	ONR
nuclear units	nuclear facilities
operating experience	operating experience feedback
operating feedback experience	operating experience feedback
operational feedback	operating experience feedback
Operational Production Centre	Operational Service Centre
pond	Pool
PTR[FPCS]	PTR[FPC(P)S]

PCER: Changes to terminology	
PCER 2011	**PCER 2012**
QEM Systems	Management Systems
radioelements	Radionuclides
relay tank	relay sump
residual drain	process drain
residual drainage	process drainage
retarding bed	delay bed
retention tank	storage tank
RPE	RPE[NVDS]
SEK	0SEK
SEK[CILWDS]	0SEK[SiteLWDS][7]
T tanks	T (or S) tanks
T(0KER[LRMDS]) (or S(0TER[ExLWDS])) tanks	T(0KER[LRMDS]) (or S(0KER[LWDS])) tanks
TEG	TEG[GWPS]
TEN	8TEN
TEP	TEP[CSTS]
TER	0TER
TER[ExLWDS]	0TER[ExLWDS]
TES	8TES
TES[SWTS]	8TES[SWTS]
TEU	8TEU
TEU[LWPS]	8TEU[LWPS]
TEU[LWPS]FD	8TEU[LWPS]FD
waste treatment building	effluent treatment building
8TES	SWTS

[7] Terminology only changed where the text refers to the turbine hall, rather than the site discharge tanks

Annex 3 – Other minor changes to EDF and AREVA's submission

118 This annex summarises other changes from the 2011 submission to the 2012 submission.

119 **We have reviewed all of these changes below and do not consider they lead us to change any of our conclusions or assessment findings given in our decision document.**

A3.1 PCER changes

120 The PCER is part of the EDF and AREVA safety, security and environmental report (SSER) (document UKEPR-0001-001, Issue 06). The following modifications have been made to the introduction to the SSER:

a) A general update has been added for the end of GDA.

b) The acronyms for the systems have been updated / corrected / added to ensure that this document is consistent with the PCER.

c) Addition of acronyms used in the PCER that were not listed in the previous version.

A3.1.1 Sub-chapter 1.1 – Introduction

121 The following modifications have been made to PCERsc1.1:

a) Some additional text has been added to Section 2 to state that the PCER has been updated from the submission made in March 2011 to include:

   i) additional information following detailed assessment from the Environment Agency and the GDA consultation;

   ii) the conclusions of the resolution of the relevant GDA Issues (for example, reactor chemistry and Fukushima);

   iii) minor revisions to ensure consistency between the PCER and PCSR;

   iv) revisions to provide further clarity; and

   v) corrections (such as revisions to the collective dose results detailed in Chapter 11 of the PCER).

b) The following sentence has been added to Section 2: '*Following the Fukushima event in March 2011, analyses have been carried out and are presented in PCSR Sub-chapter 16.6.*'

A3.1.2 Sub-chapter 1.2 – General description of the unit

122 The following modification has been made to PCERsc1.2:

a) A footnote has been added to Section 4.1 to clearly state that no use of MOX is claimed for GDA. [MOX is mixed oxide fuel.]

A3.1.3 Sub-chapter 1.3 – Comparison with reactors of similar design

123 The following modification has been made to PCERsc1.3:

a) In the table, in the '*Accounting for Break Preclusion*' line which is in the '*Main Primary System*' section, '*Yes*' has been replaced with '*HIC* [high integrity component] *claim*' in the '*UK EPR*' column.

A3.1.4 Sub-chapter 1.4 – Compliance with regulations

124 The following modifications have been made to PCERsc1.4:

a) The following sentence has been added to Section 3: '*The regulations identified in the SSER are those that applied, and were taken into account, during the GDA phase. In the site-specific phase, future operators should take into account any new or revised regulations that the Licensee and holder of environmental permits determine to be relevant*'.

b) The following footnote has been added to Section 3.4: '*The basis of planning for a Nuclear Power Station has changed since the start of the Generic Design Assessment. The Town and Country Planning Act (1990) has been replaced by the Planning Act 2008, and the Town and Country Planning EIA [Environmental Impact Assessment] (England and Wales) Regulations have been replaced by the Infrastructure Planning (Environmental Impact Assessment) Regulations 2009 for nationally significant infrastructure projects, including nuclear power plants*'.

A3.1.5 Sub-chapter 1.5 – Safety assessment and international practice

125 The following modification has been made to PCERsc1.5:

a) The text has been updated in Sections 3.2, 3.4 and 3.7 to reflect the current status of the US EPR design certification review by the US regulator (the Nuclear Regulatory Commission (NRC)).

A3.1.6 Chapter 2 – Quality and project management

126 The following modifications have been made to Chapter 2 of the PCER:

a) The following sentence has been added to the control of non-conformances section to incorporate information from the response to Regulatory Observation RO-EPR-31: '*In order to facilitate learning across the organisation and projects, AREVA and EDF determine, during the application of the non-conformance process, whether the non-conformance is limited to a specific case or whether it could have affected other processes, products or projects, through dedicated cause and impact analyses*'.

b) The following sentence has been added to the internal audits section to incorporate information from the response to RO-EPR-31: '*The findings raised during audits are managed in the same way as non-conformances*'.

c) Additional information has been included in Section 2.2.1.1 on the organisation of the EDF management system and in Section 2.2.2.1 on the organisation of the AREVA management system.

A3.1.7 Chapter 4 – Aspects having a bearing on the environment during construction phase

127 The following modifications have been made to Chapter 4 of the PCER:

a) In Section 2.4 of PCERsc4.3, additional chemicals involved in commissioning are mentioned. These include trisodium phosphate, boric acid, ammonia and ethanolamine. We will fully evaluate any future operator's assessment of the impacts of these chemicals as part of any future site-specific application for a water discharge activity.

b) In Table 5 in PCERsc4.3, the basis of the quantities of chemicals has been amended to early estimates of chemicals required in commissioning before treatment and disposal. These are based on an evaluation for Flamanville 3 (an EPR plant currently under construction in France). Ammonia and ethanolamine have been added to the table. The quantities are higher than the previous figures and in some cases exceed normal operating maximum annual discharges. However these values provided are before treatment. Future operators will need to provide a site-specific assessment to us for circuit cleaning and effluent treatment before disposal (this aspect will be under the EPR 10 water discharges activity permit). The assessment will need to address minimisation of chemical discharge quantities and their impact on the environment. These revised figures do not impact on our GDA conclusions.

A3.1.8 Chapter 5 – Design principles related to decommissioning

128 The only modifications made to Chapter 5 of the PCER are those as described in Section 4.1.

A3.1.9 Sub-chapter 6.0 – Safety requirements

129 The only modifications made to PCERsc6.0 are those as described in Section 4.1.

A3.1.10 Sub-chapter 6.2 – Details of the effluent management process

130 The following modification has been made to PCERsc6.2:

a) Clarification in Section 3.4.1.2 that solvents are expected to be incinerated.

131 The amendments that should be taken into consideration when reading our decision document and FARs with respect to solvents are detailed in the PCER Sub-chapter 6.5 Section of this document (see Section 4.2.3).

A3.1.11 Sub-chapter 6.3 – Outputs for the operating installation

132 The following modifications have been made to PCERsc6.3:

a) The following sentence has been added to Section 2: '*It should be noted that no use of MOX* [mixed oxide fuel] *is claimed for GDA; technical capability is described in the safety case for information only.*'

b) The following sentence has been added to Section 6.3.1: '*The production of carbon-14 due to the zinc injection as zinc acetate ($Zn(O_2CCH_3)_2(H_2O)$) is negligible [Ref-1[8]] [Ref-2[9]].*'

c) The following sentence has been added to Section 6.3.1.3: '*In all cases, the C-14 activity susceptible of being produced by zinc acetate injection only represents about 1 x 10^{-4} to 3 x 10^{-4}% of the C-14 coming from the other sources. Therefore, the potential C-14 produced by zinc acetate may be considered as negligible [Ref-1[7]].*'

d) The following sentence has been added to Section 6.4.2.1: '*The injection of zinc as depleted zinc ensures that low activities of Zn-65 are maintained [Ref-1[7]].*'

e) The following text in Section 6.4.2.1 of the 2011 PCER: '*Both 134 and 137 isotopes are highly soluble and can provide a good indication of potential fuel leaks if detected in the reactor cooling water. They both behave in a similar way*', has been replaced in the 2012 PCER with: '*As explained in Sub-chapter 5.5 of the PCSR, the caesium isotopes are not used for fuel failure detection but for estimation of burn-up [Ref-1[10]]. They have similar chemical behaviour.*'

f) An additional section (Section 8.1.3) has been added on zinc injection.

g) The following sentence has been added to Section 8.1.6 (which was Section 8.1.5 in the 2011 PCER): '*The impact of zinc acetate injection on liquid chemical discharges is considered negligible [Ref-4[11]] (see PCSR Sub-chapter 5.5).*'

A3.1.12 Sub-chapter 6.4 – Effluent and waste treatment systems design architecture

133 The following modifications have been made to PCERsc6.4:

a) The following two sentences have been added to Section 1: '*Smart devices may be required for class 1, 2 or 3 systems. For the effluent and waste treatment systems, this will be identified when suppliers are chosen and appropriate substantiation will be provided as part of the detailed design. In addition, the detailed implementation of the electrical design in the effluent and waste treatment systems will be performed as part of the detailed design.*' We would expect any future operators to apply the methodology developed in response to ONR GDA Issue GI-UKEPR-CI-04 to SMART devices that provide an environmental protection function, and hence we have added a new assessment finding, detailed in the ONR assessments Section of this report (see Section 5).

b) The following bullet point has been added to the list of other conditioning facilities in Section 1.3.2 (which was Section 1.3.1.1 in the 2011 PCER): '*the facility for conditioning of sludge and concentrates'.* This makes it consistent with Sub-chapter 11.3 of the PCSR.

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8 Zinc Injection Implementation at UK-EPR. ECEF110138 Revision A. EDF. March 2011

9 Zinc Injection claims, arguments and evidences: overall balance for UK-EPR. ECEF110139 Revision A. EDF. March 2011

10 Analysis of environmental performance in the EPR France project. ECEP050315 Revision A1. EDF. March 2012

11 Zinc Injection claims, arguments and evidences: overall balance for UK-EPR. ECEF110139 Revision A. EDF. March 2011

c) The following sentence has been added to Section 2.1.3.1.2: '*Following analysis of the content of the relay sump, effluents are transferred to the 0SEK [SiteLWDS] or to the 8TEU [LWPS] FD for filtering.*'

d) The following bullet point has been added to the list of effluent collection systems in Section 2.3.3.1: '*pipes collecting effluent from the hot laundry'.* This makes it consistent with Section 2.3.2.

e) The following bullet point has been added to the list of systems in Section 2.4.3: '*Storage tanks which are designed to store the effluent produced by the number of units needed for the site chosen for the UK EPR (2 or 4)*'. This makes it consistent with Section 2.3.3.1.

f) Section 3 has been updated to include the safety role of the motorised valves located on the gaseous waste processing system lines connected to the containment sweep ventilation system in minimising radiological releases in the event of an accident. The flow diagrams have also been modified. These changes have been made as a result of a modification to the heating, ventilation and air-conditioning (HVAC) systems.

g) Section 3 has been updated on reactor chemistry topics.

h) '*Sludge*' has been added to the list of materials that are encapsulated in concrete in Section 4.2.

i) System design manual references have been added, and some references have been updated to English translated versions.

j) In several locations, a statement has been added regarding proportional sampling, to clarify that the effluent discharge line is equipped with a flow proportional sampling device.

A3.1.13 Chapter 7 – Measures for monitoring discharges

134 The following modification has been made to Chapter 7 of the PCER:

a) The role of the S, T and Ex tanks in Sections 2.1.2, 2.2.2 and 2.2.4.1 in PCERsc7.3 has been aligned with PCERsc6.4.

A3.1.14 Chapter 8 – Best Available Techniques

135 The following modifications have been made to PCERsc8.2:

a) In Section 3.2.2.1 further information has been added on evaporator bottoms concentrates. Additionally, with respect to water filters, the text now states that these are removed from the circuits '*via a handling machine*' – the 2011 PCER said that they were removed '*via a lead cask*'.

b) In Section 3.3.1.1.4 additional words have been added to clarify that the optimisation of the primary coolant chemistry conditioning for hot functional tests will be decided by operators using an as low as reasonably practicable (ALARP) approach and operating experience feedback.

c) In Section 3.3.1.1.5 EDF and AREVA now state that electro-polishing of steam generator channel heads will be an operator-specific choice and the assessment of the optimal arrangements for undertaking this during manufacture (type and length of treatment) will be chosen taking into account the cost and schedule.

d) In Section 3.3.1.2.1.1 a summary of best available techniques (BAT) arguments regarding primary coolant pH management has been added.

e) In Section 3.3.1.2.1.2 additional information and assessment on the use of zinc injection has been provided to support its use in the UK EPR™. EDF and AREVA say '*the UK EPR can benefit from the positive effects of zinc injection from the first cycle of operation*'.

f) In Section 3.3.1.2.1.3 a summary of BAT arguments regarding primary coolant dissolved hydrogen control has been added.

g) In Section 3.3.1.2.2 a summary of BAT arguments regarding hydrazine and hydrogen peroxide injections has been added.

h) In Section 3.3.3 additional words have been added to state that the management of liquid radioactive effluents achieve a balance between gaseous and liquid discharges, generation of solid wastes, practical feasibility of concentrating and containing all streams, worker doses and the public doses and other environmental impacts incurred by discharge, in line with BAT / ALARP principles. We have added an additional sentence on this to our decision document and integrated waste strategy FAR (see the GDA UK EPR – Integrated waste strategy document Section of this document (Section 4.3)).

i) Another example of a technique used for the treatment of the EPR liquid effluents has been added to the list in Section 3.3.3; this is the evaporation systems for removal of active materials and soluble and particulate chemical components.

j) French references have been replaced by English ones in Sections 3.3.3.4.1, 3.3.3.4.2 and 3.3.3.4.3.

136 As noted in Section 4.2.2, EDF and AREVA produced a number of additional reference documents regarding reactor chemistry mainly to address the ONR GDA Issue GI-UKEPR-RC-02 '*Control and minimisation of ex-core radiation*' but also to provide more detail to us to confirm their claims that corrosion control measures minimise discharges. We assessed these reference documents and reviewed the content of them with EDF and AREVA at technical meetings. The additional information confirms our conclusions in the decision document that corrosion control measures, including zinc injection, contribute to BAT for the UK EPR™.

137 We included as an assessment finding in the decision document, UK EPR-AF05 '*Future operators shall, before the commissioning phase, provide their proposals for how they intend to implement zinc injection. The proposals shall be supported by an assessment on the impact of zinc injection on waste and crud composition*'. While the additional information discussed above gives confidence that zinc injection will give no adverse impact, we have decided to retain the finding as different operators may make differing proposals and operational experience from the first EPRs which may affect implementation procedures.

138 We note that ONR has assessment findings on specifying the normal operating chemistry regimes (AF-UKEPR-RC-01), and specifying chemistry limits and conditions (AF-UKEPR-RC-02). We support these assessment findings and expect BAT to be considered for site-specific chemistry regimes.

A3.1.15 Chapter 9 – Principles and methods used for environmental approach at the design stage

139 The following modification has been made to Chapter 9 of the PCER:

a) Updated information on the Water Framework Directive has been added to Section 1.3 of PCERsc9.2. This includes an update on River Basin Management Plans (RBMP) which now need to be considered at site-specific level. This does not affect our GDA work.

A3.1.16 Chapter 10 – Site environmental characteristics

140 The only modifications made to Chapter 10 of the PCER are those as described in Section 4.1 above.

A3.2 GDA UK EPR™ – BAT demonstration

141 The following modifications have been made to the supporting document GDA UK EPR™ - BAT demonstration, reference UKEPR-0011-001 Issue 06:

a) The following sentence has been added to Table 2 in the Cr-51 row: '*In addition, the zinc injection has a supplementary effect on cobalt inhibition and replacement.*'

b) Two additional bullet points have been added to the BAT form for carbon-14:

i) '*recombining hydrogen (H_2) and oxygen (O_2) in the purge gas to water using a catalytic recombiner. This reduces the concentrations of these in the gas that is recirculated in the system to less than 0.3% and 0.1% respectively. This minimises oxygen in liquids in the various tanks to allow these to be reused in the primary circuit and maintains hydrogen in the tanks below an explosive limit of 4% (eliminating a potential internal hazard). The effect of the catalytic recombiner on Carbon-14 speciation has not yet been fully determined; however, the total released activity of C-14 stays unchanged*'

ii) 'providing radioactive decay of noble gases (xenon is kept for at least 40 days and krypton for at least 40 hours) using three charcoal adsorption delay beds (with no impact on reducing overall C-14 discharges).'

c) An additional paragraph has been added to the BAT form for tritium: '*The strategy for management of tritium will also have an impact on the tritium concentration in the storage and discharge tanks. For instance, Chooz site OPEX from 1999 to 2011 show high variations in the tritium concentrations contained in the T (0KER [LRMDS]) tanks: the average tritium concentrations are approx. 1.79 MBq/l and the maximum values reported were approx. 7.9 MBq/l. These variations are mainly due to the way tritium has been managed from 1999 to 2011.*'

d) In the BAT form for cobalt-58 and cobalt-60, EDF and AREVA now state that electro-polishing of steam generator channel heads will be an operator-specific choice and the assessment of the optimal arrangements for undertaking this during manufacture (type and length of treatment) will be chosen taking into account the cost and schedule. Additionally, in this BAT form, two reference documents have been added – see PCER Chapter 8 Section of this document above.

e) The following sentence has been deleted from the BAT form for radioiodine isotopes: '*A decision on the use of an evaporator to treat the chemical drains in the TEU [LWPS] has yet to be made for the UK EPR (proposed for Flamanville 3; see reference above)*.' [An evaporator is included in the UK EPR™ design – see Paragraph 594 of our decision document.]

f) Throughout the document the collective dose values have been corrected, see our notes on PCER Chapter 11 for the rationale for correction.

g) Information has been added or amended to match additional information provided in PCERsc8.2 and on reactor chemistry topics.

142 We note that further information on reactor chemistry is given in the PCSR.

A3.3 Monitoring of liquid and gaseous discharges

143 The following modifications have been made to the monitoring of liquid and gaseous discharges document, Prospective arrangements for the UK EPR™, reference UKEPR-0007-001 Issue 03:

a) Minor error corrections and minor text amendments have been made to ensure that this document is consistent with the PCER.

Annex 4 – Changes to our documents

We described changes to the PCER and its supporting documents in Chapters 2, 3, 4 and 5, and Annex 3 of this supplement. These changes have led us to make some minor revisions to the text in our decision document and the supporting FARs. We decided that the revisions were not so significant as to need us to re-issue the documents but those documents should now be read with the revised paragraphs tabulated below.

Document to be changed	Location of change	Change (in blue or red text)	
Decision document	Paragraph 16, addition of new rows	AF-UKEPR-CC-08	A future licensee shall use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15.
		AF-UKEPR-CC-09	A future licensee shall use relevant arrangements under the licence and environmental permits to demonstrate that the impact of design changes raised after 31 May 2012 and included in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15 are As Low As Reasonably Practicable (ALARP) / Best Available Techniques (BAT), and confirm their categorisation in terms of significance to nuclear safety and environment prior to their implementation into the site-specific detailed UK EPR™ design.
		AF-UKEPR-CC-10	A future licensee shall ensure that the development of the site-specific detail of the UK EPR™ design from the GDA UK EPR™ design, including work that is undertaken by vendors / contractors, is carried out under relevant arrangements as required by the licence and environmental permits.
		AF-UKEPR-CC-11	A future licensee shall use relevant arrangements under the licence and environmental permits for implementing the design changes listed in the GDA Reference Design Configuration UK EPR-I-002 Rev. 15 and described in the design change handover package documentation (see UKEPR-0020-001 Issue 01).
		UK EPR-	Future operators shall provide evidence

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<tr><th>Document to be changed</th><th>Location of change</th><th>Change (in blue or red text)</th></tr>
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<tr><td>AF19</td><td>during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CI-04) used to qualify SMART devices for nuclear safety functions, has been applied to relevant SMART devices that provide an environmental protection function.</td></tr>
<tr><td>UK EPR-AF20</td><td>When undertaking detailed design of structures, systems and components (SSCs) that deliver an environmental protection function, future operators shall provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised.</td></tr>
<tr><td>UK EPR-AF21</td><td>Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.</td></tr>
</table>
</td></tr>
<tr><td>Decision document</td><td>Paragraph 252</td><td>EDF and AREVA state in their IWS that when considering the options for treatment of individual waste streams, the preferred approach used for the UK EPR design involved considering the balance between gaseous and aqueous discharges, and the generation of solid waste, while favouring a strategy of ‘concentrate and contain’. (The ‘concentrate and contain’ option involves trapping the radioactivity in a solid, concentrated form for storage and eventual disposal rather than the ‘dilute and disperse’ option that involves the direct discharge of gaseous or aqueous radioactivity into the environment (DECC, 2009a)). EDF and AREVA also state that final treatment choice results from consideration of the following: worker dose, practical feasibility of concentrating and containing all streams, BAT / ALARP principles and costs. The Institution of Mechanical Engineers (GDA145) responded to our consultation saying that it supports the principle of ‘concentrate and contain' as the preferred process for the radioactive waste strategy. Stop Hinkley (GDA157) provided the following response: ‘We applaud the preference for the principle of ‘concentrate and contain’ not ‘dilute and disperse’ referred to in paragraph 166. Unfortunately the text does not seem to receive</td></tr>
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Document to be changed	Location of change	Change (in blue or red text)
		ownership by the Environment Agency, who we believe should approach all radioactive waste issues with this as the primary principle rather than BAT or ALARP'.
Decision document	Paragraph 376	Corrosion control – The reduction of corrosion is important to reduce the level of corrosion products. EDF and AREVA state that the UK EPR will: b) use a programme to produce an oxide layer on reactor circuit components before beginning power operation. This layer reduces the potential for corrosion products to form (PCERsc8.2s3.3.1.1.4); c) apply a reactor chemistry regime to minimise formation of corrosion products (PCERsc8.2s3.3.1.2); d) use preventative zinc injection (PCERsc8.2s3.3.1.2.1.2). EDF and AREVA have not reduced their estimates of discharges to gain benefit from the reduction in use of silver and antimony and use of pre-treatment corrosion control measures as the reductions are difficult to quantify without operational experience (PCERsc6.1s2.6).
Decision document	Paragraph 651	Disposability of operational LLW is discussed in PCERsc6.5 of the PCER. EDF and AREVA will dispose of LLW promptly after it has been generated to the low level waste repository (LLWR). EDF and AREVA have completed LLWR form D1s (Request for agreement in principle to dispose of radioactive waste at the low level waste repository) for each of the UK EPR LLW streams (except waste oils and solvents).
Decision document	Paragraph 652	Although D1 forms have been completed for all UK EPR operational LLW (except waste oils and solvents), EDF and AREVA have identified waste streams that are likely to be suitable for incineration and smelting to minimise the waste sent to the LLWR. We note that we would need a BAT assessment to consider other options. We have an assessment finding on this (UK EPR-AF12).
Decision document	Paragraph 718	The assumption cited by RWMD that evaporator concentrates can be incinerated leaving no radioactive residue will need clarification in LoC submissions and in the RWMC if a future operator proposes such incineration. However, EDF and AREVA note that the evaporator concentrates in France that are incinerated are LLW, and not ILW. We require evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of ILW before disposal are BAT (UK ERP-AF12). We have also identified the following assessment finding: If incineration of any intermediate level waste (ILW) is

<table>
<tr><th>Document to be changed</th><th>Location of change</th><th>Change (in blue or red text)</th></tr>
<tr><td></td><td></td><td>pursued, the future operator shall, demonstrate that the conditions of acceptance of any available incineration facilities can be met (UK EPR-AF15).
We note that EDF and AREVA state in their PCER issued in 2012 in Section 5.2 of PCERsc6.5 that should evaporator concentrates be ILW they would not be incinerated but packaged for disposal as ILW.</td></tr>
<tr><td>Decision document</td><td>Paragraph 954</td><td>EDF and AREVA have estimated collective doses to UK, Europe and world populations truncated at 500 years using PC CREAM 98. Table 13.4a shows the results of EDF and AREVA's original collective dose assessment that was undertaken and reported for the consultation. After the consultation, it was identified that the PC CREAM 98 model had not been set up correctly for the collective dose calculations for the UK and Europe. Once the model had been set up correctly, the estimates of collective doses for the UK and Europe increased. The revised values are shown in Table 13.4b below.
Table 13.4a EDF and AREVA estimate of collective doses and per person dose from one year's discharges at maximum expected annual discharges (original consultation version)
<table>
<tr><th>Population</th><th>Collective dose manSv (for one year of discharge)</th><th>Per person dose nSv (for one year of discharge)</th></tr>
<tr><td>UK</td><td>0.11</td><td>2.0</td></tr>
<tr><td>Europe</td><td>1.26</td><td>1.8</td></tr>
<tr><td>World</td><td>16.9</td><td>1.7</td></tr>
</table>
Table 13.4b EDF and AREVA's revised estimate of collective doses and per person dose from one year's discharges at maximum expected annual discharges (revised after the consultation)
<table>
<tr><th>Population</th><th>Collective dose manSv (for one year of discharge)</th><th>Per person dose nSv (for one year of discharge)</th></tr>
<tr><td>UK</td><td>0.31</td><td>5.6</td></tr>
<tr><td>Europe</td><td>2.46</td><td>3.5</td></tr>
<tr><td>World</td><td>16.9</td><td>1.7</td></tr>
</table></td></tr>
<tr><td>Decision document</td><td>Paragraph 956</td><td>We have also carried out our own calculations of collective dose. We did this for the UK, European and world populations over the next 500 years, assuming</td></tr>
</table>

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<tr><th>Document to be changed</th><th>Location of change</th><th>Change (in blue or red text)</th></tr>
<tr><td></td><td></td><td>discharges are made at the maximum expected discharges of aqueous and gaseous radioactive waste. We used the PC CREAM 98 software to estimate collective dose. Our original results are set out in the table 13.5a below. After the consultation we reviewed the collective dose calculation and identified that PC CREAM 98 had not been set up correctly for our calculation of collective doses and per person doses for the UK and Europe. The revised doses are shown in Table 13.5b.
Table 13.5a Our original estimate of collective doses and per person doses from one year's discharges at maximum expected annual discharges
<table>
<tr><th>Population</th><th>Collective dose manSv (for one year of discharge)</th><th>Per person dose nSv (for one year of discharge)</th></tr>
<tr><td>UK</td><td>0.11</td><td>2.0</td></tr>
<tr><td>Europe</td><td>1.22</td><td>1.7</td></tr>
<tr><td>World</td><td>16.9</td><td>1.7</td></tr>
</table>
Table 13.5b Our revised estimate of collective doses and per person doses from one year's discharges at maximum expected annual discharges (revised after the consultation)
<table>
<tr><th>Population</th><th>Collective dose manSv (for one year of discharge)</th><th>Per person dose nSv (for one year of discharge)</th></tr>
<tr><td>UK</td><td>0.28</td><td>5.1</td></tr>
<tr><td>Europe</td><td>2.72</td><td>3.9</td></tr>
<tr><td>World</td><td>16.9</td><td>1.7</td></tr>
</table></td></tr>
<tr><td>Decision document</td><td>Annex 2, addition of new rows</td><td>
<table>
<tr><td>AF-UKEPR-CC-08</td><td>A future licensee shall use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15.</td></tr>
<tr><td>AF-UKEPR-CC-09</td><td>A future licensee shall use relevant arrangements under the licence and environmental permits to demonstrate that the impact of design changes raised after</td></tr>
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Document to be changed	Location of change	Change (in blue or red text)	
			31 May 2012 and included in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15 are As Low As Reasonably Practicable (ALARP) / Best Available Techniques (BAT), and confirm their categorisation in terms of significance to nuclear safety and environment prior to their implementation into the site-specific detailed UK EPR™ design.
		AF-UKEPR-CC-10	A future licensee shall ensure that the development of the site-specific detail of the UK EPR™ design from the GDA UK EPR™ design, including work that is undertaken by vendors / contractors, is carried out under relevant arrangements as required by the licence and environmental permits.
		AF-UKEPR-CC-11	A future licensee shall use relevant arrangements under the licence and environmental permits for implementing the design changes listed in the GDA Reference Design Configuration UK EPR-I-002 Rev. 15 and described in the design change handover package documentation (see UKEPR-0020-001 Issue 01).
		UK EPR-AF19	Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CI-04) used to qualify SMART devices for nuclear safety functions, has been applied to relevant SMART devices that provide an environmental protection function.
		UK EPR-AF20	When undertaking detailed design of structures, systems and components (SSCs) that deliver an environmental protection function, future operators shall provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised.
		UK EPR-AF21	Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and

Document to be changed	Location of change	Change (in blue or red text)
		components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.
Solid radioactive waste FAR	Paragraph 54	Disposability of operational LLW is discussed in PCERsc6.5 of the PCER. EDF and AREVA will dispose of LLW promptly after it has been generated to the low level waste repository (LLWR). EDF and AREVA have completed LLWR form D1s (Request for agreement in principle to dispose of radioactive waste at the low level waste repository) for each of the UK EPR LLW streams (except waste oils and solvents). These forms describe the nature of the process producing the waste, the type of radioactive waste generated and the physical and chemical form of the waste and its radiological characteristics.
Solid radioactive waste FAR	Paragraph 55	Although D1 forms have been completed for all UK EPR operational LLW (except waste oils and solvents), EDF and AREVA have identified waste streams that are likely to be suitable for incineration and smelting to minimise the waste sent to the LLWR. We note that we would need a BAT assessment to consider other options. We have an assessment finding on this (UK EPR-AF12).
Solid radioactive waste FAR	Paragraph 123	Studsvik UK Ltd (GDA131) provided the following response: 'Incineration or grouting of ion-exchange resin cannot be considered BAT. Technologies such as steam reforming will minimise the waste from the ion exchange resin with a factor 7 to 30 depending on resin type, loading and boron content.' Additionally, Nuclear Waste Advisory Associates (GDA133) and the UK and Ireland Nuclear Free Local Authorities (GDA82), both provided the following point in their responses: '*EDF assume that certain ILW can be incinerated leaving no radioactive residue. The EA state that this assumption: "needs further explanation" – and that the incineration of ILW would be "novel". The EA should rule out incineration of these wastes at this stage, as it would clearly fail to meet the requirement 'Best Available Techniques*'. Stop Hinkley (GDA157) said that they are appalled that an operator may incinerate ILW just to reduce the volume of waste. RWMD said in its disposability assessment that : *'The EDF and AREVA submission assumed that, in the Reference Case, evaporator concentrates would be incinerated leaving no radioactive residue, which is the current practice in France*.' The assumption cited by RWMD that evaporator concentrates can be incinerated leaving no radioactive residue will need clarification in LoC submissions and in the RWMC if a future operator proposes such incineration. We require evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of ILW before

Document to be changed	Location of change	Change (in blue or red text)
		disposal are BAT (UK ERP-AF12). We have also identified the following assessment finding: If incineration of any intermediate level waste (ILW) is pursued, the future operator shall, demonstrate that the conditions of acceptance of the selected incineration facility can be met (UK EPR-AF15). We note that EDF and AREVA wrote to us in July 2011 (Letter: EPR00918N) stating that there is no intention to perform such incineration in the UK, and that the waste incinerated in France is LLW, not ILW. We also note that EDF and AREVA state in their PCER issued in 2012 in Section 5.2 of PCERsc6.5 that should evaporator concentrates be ILW they would not be incinerated but packaged for disposal as ILW.
Disposability of ILW and spent fuel FAR	Paragraph 47	The assumption cited by RWMD that ILW evaporator concentrates can be incinerated leaving no radioactive residue will need clarification in LoC submissions and in the RWMC if a future operator proposes such incineration. Furthermore, it will need to be demonstrated that any wastes assumed to be incinerated meet expected conditions of acceptance for an incinerator (as well as that incineration is BAT for those wastes). We note that EDF and AREVA wrote to us in July 2011 (Letter: EPR00918N) stating that there is no intention to perform such incineration in the UK, and that the waste incinerated in France is LLW, not ILW. We also note that EDF and AREVA state in their PCER issued in 2012 in Section 5.2 of PCERsc6.5 that should evaporator concentrates be ILW they would not be incinerated but packaged for disposal as ILW.
Integrated waste strategy FAR	Paragraph 36	EDF and AREVA state in their IWS that when considering the options for treatment of individual waste streams, the preferred approach used for the UK EPR design involved considering the balance between gaseous and aqueous discharges, and the generation of solid waste, while favouring a strategy of '*concentrate and contain*'. (The '*concentrate and contain*' option involves trapping the radioactivity in a solid, concentrated form for storage and eventual disposal rather than the '*dilute and disperse*' option that involves the direct discharge of gaseous or aqueous radioactivity into the environment (DECC, 2009a)). EDF and AREVA also state that final treatment choice results from consideration of the following: worker dose, practical feasibility of concentrating and containing all streams, BAT / ALARP principles and costs**.** The Institution of Mechanical Engineers (GDA145) responded to our consultation saying that it supports the principle of '*concentrate and contain*' as the preferred process for the radioactive waste strategy. Stop Hinkley (GDA157) provided the following response: '*We applaud the*

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		preference for the principle of 'concentrate and contain' not 'dilute and disperse' referred to in paragraph 166. Unfortunately the text does not seem to receive ownership by the Environment Agency, who we believe should approach all radioactive waste issues with this as the primary principle rather than BAT or ALARP'. We base our regulatory decisions on applying all the environmental principles set out in the 2009 Statutory Guidance (DECC, 2009a), one of which is: '*the preferred use of "concentrate and contain" in the management of radioactive waste over "dilute and disperse" in cases where there would be a definite benefit in reducing environmental pollution, provided that BAT is being applied and worker dose is taken into account*'. We note that it is not practical to capture all gaseous and aqueous waste streams, but we require BAT to minimise the radioactivity content of such discharges.
Radiological impact on members of the public FAR	Paragraph 35	The outcomes of the dose assessment were compared with limits and constraints referred to and set out in SI 2010 No. 675 - Environmental Permitting Regulations 2010 (as amended) - Schedule 23, Part 4 Section 1. This requires that - in respect of a radioactive substances activity that relates to radioactive waste, the regulator (The Environment Agency) must exercise its relevant functions to ensure that: a) All exposures to ionising radiation of any member of the public and of the population as a whole resulting from the disposal of radioactive waste are kept as low as reasonably achievable, taking into account economic and social factors; and (b) the sum of the doses resulting from the exposure of any member of the public to ionising radiation does not exceed the dose limits set out in Article 13 of the Basic Safety Standards Directive subject to the exclusions set out in Article 6(4) of that Directive. The limit on effective dose for members of the public is: 1 mSv (1000 µSv) per year. The Environmental Permitting Regulations 2010 also require that when exercising those relevant functions in relation to the planning stage of radiation protection, the regulator (The Environment Agency) must have regard to the following maximum doses to individuals which may result from a defined source: i) 0.3 millisieverts per year (300 µSv per year) from any source from which radioactive discharges are first made on or after 13th May 2000; ii) 0.5 millisieverts per year (500 µSv per year) from the discharges from any single site. In addition, the Health Protection Agency (HPA) has

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		advised the UK Government to select a constraint value for members of the public for new nuclear power stations that is less than 0.15 mSv (150 µSv) per year (HPA 2009).
Radiological impact on members of the public FAR	Paragraph 36	There are no regulatory limits and constraints for collective dose. Collective dose information is normally used for comparisons across sites or facilities. The International Atomic Energy Agency (IAEA) suggest that practices which give rise to collective doses less than 1 personSv (personSv is intended to be equivalent to manSv) in a year of operation may be exempted from regulatory control provided other criteria are also met (see below from the IAEA document No. WS-G-2.3). ['*2.10. Exemption from the regulatory requirements is also possible for particular practices or sources within a practice. It is recognized internationally that regulatory systems may need to include provisions for granting exemptions if it is clear that the practice is justified but regulatory provisions are unnecessary or unwarranted. Briefly, the general principles for exemption are that the radiation risks to individuals and populations caused by the exempted practice or source are sufficiently low as to be of no regulatory concern and that the exempted practices and sources are inherently safe. In particular, "a (justified) practice or a source within a (justified) practice may be exempted without further consideration provided that the following criteria are met in all feasible situations:* *(a) The effective dose expected to be incurred by any member of the public due to the exempted practice or source is of the order of 10 µSv or less in a year, and* *(b) Either the collective effective dose committed by one year of performance of the practice is no more than about 1 man Sv, or an assessment for the optimization of protection shows that exemption is the optimum option." (Ref. [3], Schedule 1, para. I–3).* *The exempted practices and sources should also be inherently safe, with no appreciable likelihood of scenarios that could lead to a failure to meet the criteria in (a) and (b).* *Exemption of a practice or source covers all discharges of radionuclides from that practice or source.*']
Radiological impact on members of the public FAR	Paragraph 54	Collective dose – EDF and AREVA estimated the collective doses to the world population (truncated at 500 years) to be 16.9 person Sv per year of discharge from atmospheric and liquid discharges in together. The highest dose per person was estimated to be 2 nSv y^{-1} to the UK population. Subsequently the estimates of collective doses were revised upwards to 0.31 person Sv

Document to be changed	Location of change	Change (in blue or red text)
		per year of discharge for the UK and 2.46 person Sv per year of discharge for the European population. However the collective dose to the world remained unchanged at 16.9 person Sv per year of discharge. The highest dose per person was revised upwards to 5.6 nSv y^{-1} to the UK population. Calculated average annual individual doses for a population group in the nanosievert (nSv/y) range or below can be ignored in the decision making process as the associated risks are minuscule and the contribution to total doses to individuals will be insignificant. Higher annual doses, up to say a few microsievert (μSv/y) can be considered trivial but may require some consideration particularly if at the higher end of the range.
Radiological impact on members of the public FAR	Paragraph 63	**Collective dose -** The outcome of the independent assessment of collective doses was essentially equivalent to that presented in the EDF and AREVA submission. With the subsequent revision in collective dose to the UK and European population the independent assessment was reviewed and the UK and European population collective doses were revised to 0.28 person Sv per year of discharge for the UK and 2.7 person Sv per year of discharge for the European population. Our estimate of collective dose to the world was 16.9 person Sv per year of discharge. The highest dose per person was 5.1 nSv y^{-1} to the UK population.
Radiological impact on members of the public FAR	Paragraph 85	The HPA (Mobbs et al 2010) have stated that the KiKK[12] study was reviewed by the German Commission on radiation protection who concluded that the design of the KiKK study was unsuitable for establishing relationships between leukaemia and exposure to radiation from nuclear power plants. This is because the natural radiation exposure within the study area and its fluctuations are greater by several orders of magnitude than the radiation exposure from the nuclear power plants themselves. Similar UK and French data have subsequently been analysed for any trend with distance and do not show higher levels of leukaemia close to power stations. In its 14th report '*Further consideration of the incidence of childhood leukaemia around nuclear power plants in Great Britain*' (published in 2011); the Committee on Medical Aspects of Radiation in the Environment (COMARE) reviewed in depth the available evidence from several countries operating nuclear power programmes, including Great Britain and Germany.

[12] Kinderkrebs in der Umgebung von Kernkraftwerken (Childhood cancer in the vicinity of nuclear power plants)

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<tr><td></td><td></td><td>These have been the subject of major recent studies with apparently conflicting findings. COMARE also considered a current analysis for Great Britain, specific for risk of childhood leukaemia in children under 5 years of age living within 5 km of a nuclear power plant (NPP).
From this review COMARE made several recommendations, the first being particularly relevant in the context of the KiKK study outcomes:
‘Recommendation 1: COMARE has found no reason to change its previous advice that there is no evidence to support the view that there is an increased risk of childhood leukaemia and other cancers in the vicinity of Nuclear Power Plants (NPPs) due to radiation effects. The Committee acknowledges, however, that it is almost impossible to come to a final conclusion on questions determined by epidemiological evidence alone, and also that circumstances relevant to risk change. In particular, operating practices need to be continually monitored and new possibilities for analysing the data may become available as recording and monitoring systems become more sophisticated. COMARE recommended that the Government keeps a watching brief in this area’.
The Health Protection Agency (HPA) provides advice in the UK on the protection of the public from ionising radiation. The HPA have not indicated that any change is required in the radiation protection arrangements for the public as a result of the COMARE’s 14th report.</td></tr>
<tr><td>Radiological impact on members of the public FAR</td><td>Section 6, last row of table</td><td><table><tr><td>IAEA suggest that practices which give rise to collective doses less than 1 man Sv per year of operation may be exempted from regulatory control.</td><td>Collective doses predicted from the independent assessment are greater than 1 man Sv per year of operation. This is a clear indication that the practice should not be exempted from regulatory control.</td></tr></table></td></tr>
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Annex 5 – List of assessment findings for the UK EPR™

We listed 18 assessment findings in our 2011 decision document. We have added seven additional assessment findings following our assessment of the GDA Issues outstanding when the 2011 decision document was published. The full list of assessment findings is shown in the table below.

Reference	Assessment finding
UK EPR-AF01	The future operator shall, at the detailed design stage, identify any changes to the 'reference case' for solid radioactive waste and spent fuel strategy, and provide evidence that the site-specific integrated waste strategy (IWS) achieves the same objectives.
UK EPR-AF02	The future operator shall, at the detailed design stage, provide an updated decommissioning strategy and decommissioning plan.
UK EPR-AF03	Future operators shall keep the removal of secondary neutron sources (to further minimise creation of tritium) under review. EDF and AREVA should provide future operators with relevant EPR operational information when available to facilitate their reviews of Best Available Techniques (BAT)
UK EPR-AF04	Future operators shall, during the detailed design phase for each new build project, review BAT on minimising the production of activated corrosion products for the following matters, where possible improvements were identified in the PCER: i) corrosion resistance of steam generator tubes; ii) electro-polishing of steam generator channel heads; iii) specification of lower cobalt content reactor system construction materials; iv) further reducing use of stellites in reactor components, in particular the coolant pump. Where appropriate, any improvements considered BAT should be incorporated into the new build.
UK EPR-AF05	Future operators shall, before the commissioning phase, provide their proposals for how they intend to implement zinc injection. The proposals shall be supported by an assessment of the impact of zinc injection on waste and crud composition.
UK EPR-AF06	Prior to construction of the conventional and nuclear island liquid effluent discharge tank systems, future operators shall demonstrate that site-specific aspects such as size and leak-tight construction techniques are BAT.
UK EPR-AF07	Future operators shall, before the commissioning phase, provide an assessment to demonstrate that proposed operational controls on the fuel pool are BAT to minimise the discharge of tritium to air.

Reference	Assessment finding
UK EPR-AF08	Future operators shall, during the detailed design phase, provide their proposals for the operational management of the Liquid Waste Processing System to minimise the discharge of radioactivity from the site so that exposures of any member of the public and the population as a whole are kept as low as reasonably achievable (ALARA) and to protect the environment. The proposals should be supported by a BAT assessment to show that the use of the evaporator, the choice of filter porosity and the demineralisation media have been optimised to minimise the dose to members of the public. The future operator shall also provide evidence that the Water Treatment Systems have sufficient capacity and resilience to cope with all the aqueous radioactive waste arisings consigned to the evaporator by the proposals. The proposals should consider all plant states, including for example outages and unavailability due to maintenance or breakdown.
UK EPR-AF09	Future operators shall, during the detailed design stage, provide a predicted mass balance showing how their proposed aqueous radioactive waste management regime will affect the disposal of carbon-14 to the gaseous, solid or aqueous routes. For each route the form of carbon-14 expected shall be provided. For solid wastes the quantities of each type of waste shall be provided with expected carbon-14 content.
UK EPR-AF10	The future operator shall provide confidence that adequate radioactive waste management cases (RWMCs), supported by appropriate stage Letters of Compliance (LoCs), can be developed for all intermediate level waste (ILW) on the timescales identified in EDF and AREVA's plan for disposability of ILW
UK EPR-AF11	The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for preventing and, where that is not possible, minimising the creation of low level waste (LLW) and ILW are BAT.
UK EPR-AF12	The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT.
UK EPR-AF13	If smelting of any LLW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected smelting facility can be met.
UK EPR-AF14	If incineration of any LLW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected incineration facility can be met.
UK EPR-AF15	If incineration of any ILW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected incineration facility can be met.
UK EPR-AF16	The future operator shall, before the commissioning phase, propose techniques for the interim storage of spent fuel following a period of initial cooling in the pool. The future operator shall provide an assessment to show that the techniques proposed are BAT.

Reference	Assessment finding
UK EPR-AF17	The future operator shall, before the commissioning phase, provide confidence that adequate RWMCs, supported by appropriate stage LoCs and taking due account of necessary storage periods, can be developed for spent fuel on the timescales identified in EDF and AREVA's plan for disposability of spent fuel.
UK EPR-AF18	Future operators shall provide: a) during the detailed design phase, the location and arrangement of sampling and continuous monitoring facilities for gaseous and aqueous wastes supported by an assessment that these will provide representative sampling and monitoring; b) during the detailed design phase and before final equipment selection, the details of equipment and techniques to be used for analysis of gaseous, aqueous and solid wastes supported by an assessment that these represent BAT for monitoring.
UK EPR-AF19	Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CI-04) used to qualify SMART devices for nuclear safety functions, has been applied to relevant SMART devices that provide an environmental protection function.
UK EPR-AF20	When undertaking detailed design of structures, systems and components (SSCs) that deliver an environmental protection function, future operators shall provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised.
UK EPR-AF21	Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.
The following are joint assessment findings with ONR and we have used ONR's numbering system for consistency.	
AF-UKEPR-CC-08	A future licensee shall use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15.
AF-UKEPR-CC-09	A future licensee shall use relevant arrangements under the licence and environmental permits to demonstrate that the impact of design changes raised after 31 May 2012 and included in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15 are As Low As Reasonably Practicable (ALARP) / Best Available Techniques (BAT), and confirm their categorisation in terms of significance to nuclear safety and environment prior to their implementation into the site-specific detailed UK EPR™ design.

Reference	Assessment finding
AF-UKEPR-CC-10	A future licensee shall ensure that the development of the site-specific detail of the UK EPR™ design from the GDA UK EPR™ design, including work that is undertaken by vendors / contractors, is carried out under relevant arrangements as required by the licence and environmental permits.
AF-UKEPR-CC-11	A future licensee shall use relevant arrangements under the licence and environmental permits for implementing the design changes listed in the GDA Reference Design Configuration UK EPR-I-002 Rev. 15 and described in the design change handover package documentation (see UKEPR-0020-001 Issue 01).

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