Generic design assessment

AP1000® nuclear power plant design by Westinghouse Electric Company LLC

Final assessment report

Radiological impact on members of the public

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AP1000® nuclear power plant design by Westinghouse Electric Company LLC

Final Assessment report – Assessment of radiological impact on members of the public

Protective status

This document contains no sensitive nuclear information or commercially confidential information.

Process and Information Document[1]

The following sections of Table 1 in our Process and Information document are relevant to this assessment:

Section 2.7 Prospective dose assessment for the generic site at the proposed limits for levels of discharge. This should include:

- annual dose to most exposed members of the public for liquid discharges;
- annual dose to most exposed members of the public for gaseous discharges (identifying separately the dose associated with on site incineration where applicable);
- annual dose to the most exposed members of the public for all discharges from the facility;
- annual dose from direct radiation to the most exposed member of the public;
- annual dose to the representative person for the facility;
- potential short-term doses, including via the food chain, based on the maximum anticipated short-term discharges from the facility in normal operation;
- a comparison of the calculated doses with the relevant dose constraints; and
- an assessment of whether the build-up of radionuclides in the local environment of the facility, based on the anticipated lifetime discharges, might have the potential to prejudice legitimate users or uses of the land or sea.

All assumptions made should be set out and reasons for their validity given.

Section 2.8 Collective dose assessments for discharges from the facility truncated at 500 years to the UK, European and World populations. Assumptions made in carrying out these assessments should be set out.

Section 2.9 Sufficient assumed data for others to be able to carry out all dose assessments including as relevant :

- radionuclide composition of each release;
- gaseous release points (including heights, effective heights and volumetric flow rates);
- liquid release points;
- fractions of releases made via each release point (including incinerators);
- release rate;
- information used to estimate incinerator releases (i.e. expected quantities of wastes to be incinerated, expected radionuclide

composition and concentrations, and retention factors for any abatement provided; and

- hydrographic data (mean volumetric flow for any inland water courses, such as rivers, or volumetric exchange rate for estuaries/coasts that receive discharges).

Additionally, detail of assumptions made concerning the following will be helpful to enable others to refine any assessment made:

- dose receptor points;
- weather data;
- chemical form of the activity discharged;
- deposition velocities, washout coefficients and surface roughness factors;
- dose per unit intake factors;
- food consumption rates;
- habits data for the representative person
- nearest food production location; and
- nearest habitation(s).

Radioactive Substances Regulation Environmental Principles[2]

The following principles are relevant to this assessment:

Fundamental Principle E – Protecting Human Health and the Environment

SEDP1 General RSR Principle for siting new facilities - When evaluating sites for a new facility, account shall be taken of the factors that might affect the protection of people and the environment from radiological hazards and the generation of radioactive waste.

SEDP2 Movement of radioactive material in the environment - Data shall be provided to allow the assessment of rates and patterns of movement of radioactive materials in the air and the aquatic and terrestrial environments around sites.

SEDP3 Ambient radioactivity - Levels of ambient radioactivity around the sites of new facilities shall be assessed.

SEDP4 Multi-facility sites - In the case of nuclear and other sites on which there are already one or more facilities, the radiological impact of the whole site on people and the environment shall be assessed when considering the suitability of the site for any new facility.

RPDP1 Optimisation of protection - All exposures to ionising radiation of any member of the public and of the population as a whole shall be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account.

RPDP2 Dose limits and constraints - Radiation doses to individual people shall be below the relevant dose limits and constraints.

RPDP4 Prospective dose assessments for radioactive discharges to the environment - Assessments of potential doses to people and to non-human species shall be made prior to granting any new or revised authorisation for the discharge of radioactive wastes into the environment.

Report author

Tooley, E. J., as amended by Grundy, Dr. C. L.

1. Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Environment Agency, Jan 2007.
http://publications.environment-agency.gov.uk/pdf/GEHO0107BLTN-e-e.pdf

2. Regulatory Guidance Series, No RSR 1: Radioactive Substances Regulation - Environmental Principles (REPs), 2010.
http://publications.environment-agency.gov.uk/pdf/GEHO0709BQSB-e-e.pdf

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1 Summary

1 We have assessed information in the generic design assessment (GDA) submission made by Westinghouse for the AP1000® with respect to prospective doses to members of the public as a result of the disposal of aqueous and gaseous radioactive waste from the AP1000 to the environment.

2 We appointed contactors to undertake the verification and validation of assessments made by Westinghouse for the AP1000 at the generic site and to make an independent assessment of doses to members of the public from the AP1000 at the generic site.

3 We conclude that all the doses assessed by Westinghouse are below the dose constraint for members of the public of 300 μSv y^{-1} and the dose constraint recommended by the Health Protection Agency (HPA) for new nuclear build of 150 μSv y^{-1}.

4 We conclude that sum of doses to the representative person at our proposed limits is below the source dose constraint.

5 All the sites listed in the Nuclear National Policy Statement (DECC, 2011) as potentially suitable for a new nuclear power station are adjacent to existing nuclear power stations. In GDA the specific site at which an AP1000 reactor might be located is not known but we consider, in the light of our assessment that the highest dose from a single AP1000 reactor is unlikely to be greater than 9.8 μSv y^{-1} (ER rev. 4 s5.2.3.3) . Therefore it is very unlikely that doses at any site, including where there are already nuclear power stations will exceed the site dose constraint of 500 μSv y^{-1}. However we consider that it will be necessary to undertake a site specific assessment of the site dose from any AP1000 reactor once the site location is known. This will take into account any local features and discharges and doses from any existing facilities at the site. The outcome will be compared with the source dose constraint, dose constraint for new nuclear power stations and the site dose constraint.

6 Comparison against the dose limit can only be done at site specific permitting when contributions from all sources of radiation can be included.

7 In line with usual procedures we will require a detailed site specific impact assessment to be carried out at site specific permitting based on the actual environmental characteristics of the proposed site to demonstrate that doses to members of the public and non-human species from the AP1000 at the proposed site will be ALARP and below relevant dose constraint and dose limits.

8 Our findings on the wider environmental impacts and waste management arrangements for the AP1000 reactor may be found in our Decision Document (Environment Agency, 2011a).

2 Introduction

9 We originally published this report in June 2010 to support our GDA consultation on the AP1000 design. On 28 June 2010, our consultation began on our preliminary conclusions following our detailed assessment of this submission. The consultation closed on 18 October 2010.

10 This report is an update of our original report covering assessment undertaken between June 2010 and the end of March 2011 when Westinghouse published an update of its submission. Where any paragraph has been added or substantially revised it is in a blue font.

11 This assessment considers the radiological impact of the AP1000 on members of the public arising from discharges into the environment.

12 Regulation of public radiation exposure is shared between the Environment Agency (EA) (in England and Wales) and the Office for Nuclear Regulation[1] (ONR). The Environment Agency regulates doses to the public resulting from discharges of radioactive waste into the environment during normal operation. ONR regulates doses to the public resulting from direct radiation (i.e. direct radiation originating from within the site boundary) during normal operation. ONR require site operators to measure direct radiation at the site perimeter and estimate exposure to a reference person on an annual basis. Direct radiation is radiation received directly from a source such as a nuclear power station, instead of indirectly as a result of radioactive discharges.

13 The assessment considers the information provided by Westinghouse Electric Company LLC (Westinghouse) for its AP1000 design.

14 We appointed contractors (Enviros Consulting Ltd) to make an independent assessment of environmental activity concentrations from the AP1000 at the generic site (Environment Agency, 2009g). We have produced a separate assessment report on the generic site proposed by Westinghouse that was updated in 2011 (Environment Agency 2011b).

15 This assessment does not cover radioactive discharges arising from decommissioning at the end of the reactor lifecycle.

16 The assessment aims to establish whether the design could be operated in the UK in line with UK Statute, policy and guidance on radioactive waste as currently written but it is recognised that the assessment should be kept under review to reflect changes in statute, policy and guidance that may occur between now and plant commissioning.

17 Our assessment of the radiological impact of the AP1000 reactor on members of the public arising from discharges into the environment is documented within this assessment report. This is essentially the same as that provided in the first issue of this assessment report but updated, where appropriate, to reflect:

a) Our assessment of any further information provided by Westinghouse since the consultation date.

b) Any further work that we said, in the consultation document, that we intended to do.

c) Any matters arising from ONR's GDA Step 4 work that are relevant to our assessment.

d) Our consideration of any consultation responses relevant to this topic.

e) Our consideration of any comments from our 6 July GDA stakeholder seminar relevant to this topic.

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[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. In this report we therefore generally use the term "ONR", except where we refer back to documents or actions that originated when it was still HSE's Nuclear Directorate.

18 We have published the consultation responses submitted in regard to our preliminary conclusions for the AP1000 design on our website (see: https://consult.environment-agency.gov.uk/portal/ho/nuclear/gda).

19 The questions raised at our stakeholder seminar have also been published (see: http://www.hse.gov.uk/newreactors/seminar-060710.pdf).

3 Assessment

20 This assessment considers the radiological impact of discharges from an AP1000 on members of the public. We have taken into account Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment (DECC, 2009) which sets out the principle that:

a) regulatory justification of practices should be carried out by the Government;

b) optimisation of protection on the basis that radiological doses and risks to workers and members of the public from a source of exposure should be kept as low as reasonably achievable (the ALARA principle);

c) application of limits and conditions to control discharges from justified activities;

d) sustainable development;

e) the use of Best Available Techniques (BAT);

f) the precautionary principle;

g) the polluter pays principle;

h) 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.

3.1 Assessment methodology

21 The basis of our assessment was to:

a) consider the submission made by Westinghouse in particular the Environment Report and its supporting documents;

b) hold technical meetings with Westinghouse to clarify our understanding of the information presented and explain any concerns we had with that information;

c) raise Regulatory Observations and Technical Queries where we believed information provided by Westinghouse was insufficient;

d) assess the radiological impact of discharges from an AP1000 on members of the public to demonstrate that doses to members of the public from the AP1000 at the proposed site will be as low as reasonably practicable (ALARP) and not exceed dose constraints and limits;

e) consider consultation responses and comments from our stakeholder seminar relevant to this topic;

f) decide on any GDA Issues;

g) identify assessment findings to carry forward from GDA.

22 Westinghouse provided its submission to GDA in August 2007. We carried out our initial assessment and concluded we needed additional information. We raised a Regulatory Issue on Westinghouse in February 2008 setting out the further information that we needed. Westinghouse completely revised its submission during 2008 and provided an Environment Report with supporting documents.

23 We assessed information contained in the Environment Report but found that while much improved from the original submission there were some areas where we required further information.

24 We issued a Regulatory Observation (RO-AP1000-32) on 1 June 2009 relating to statements made by Westinghouse in its submission about the dilution of liquid radioactive waste for discharge.

25 We raised 43 Technical Queries (TQs) on Westinghouse during our assessment. Six were relevant to this report:

a) TQ-AP1000-150 – Dose assessment assumptions – effective release height. 1 June 2009.

b) TQ-AP1000-151 - Dose assessment assumptions – short term releases. 1 June 2009.

c) TQ-AP1000-152 - Generic site – location of nearest properties. 1 June 2009.

d) TQ-AP1000-164 - Liquid radioactive waste – grouping of radionuclides in discharge limits. 17 June 2009.

e) TQ-AP1000-165 - Gaseous radioactive waste – grouping of radionuclides in discharge limits. 17 June 2009.

f) TQ-AP1000-169 – Short term release dose assessment - atmospheric dispersion modelling system (ADMS) input data. 19 June 2009.

26 Westinghouse responded to the TQ's. They reviewed and updated the Environment Report in March 2010 to include all the relevant information provided by the TQs.

27 In March 2011, Westinghouse provided an updated ER (rev. 4). This report refers to the information contained in the updated Environment Report (UKP-GW-GL-790 (Rev. 4)) and its supporting documents. However, as the independent dose assessment was carried out using information from earlier versions of the ER we have referred to earlier versions of the ER where appropriate.

3.2 Assessment objectives

28 Key areas of the submission made under the GDA arrangements by Westinghouse for the AP1000 design that have been considered are:

a) Is the radiological impact assessment carried out by Westinghouse reasonable and justified?

b) Can the radiological impact assessment carried out by Westinghouse be independently validated?

c) Are predicted doses to members of the public below dose constraints for the public and the dose limits for the public?

3.3 Westinghouse documentation

29 We referred to the following documents to produce this report:

Document reference	Title	Version number
UKP-GW-GL-790	UK AP1000 Environment Report	2,3,4
UKP-GW-GL-026	AP1000 Nuclear Power Plant BAT Assessment	2
UKP-GW-GL-025	Generic Site Report	1
EPS-GW-GL-700	AP1000 European Design Control Document	1

3.4 Summary of assessment findings

30 This report summarises the outcomes of our assessment of the information provided and the assessment carried out by Westinghouse with respect to prospective doses to

members of the public as a result of the disposal of aqueous and gaseous radioactive waste from the AP1000 to the environment.

31 In order to assess potential impacts we required Westinghouse to carry out dose assessments set out in section 2.7 of our Process and Information Document. In order to assess doses we also required Westinghouse to describe a generic site on which the dose assessment was based and which represented likely sites where an AP1000 might be located. A separate final assessment report (Environment Agency, 2011b) has been prepared setting out our assessment of the generic site parameters provided by Westinghouse. For consistency the generic site description was also used in the assessment of potential impact on non-human species, see our final assessment report (Environment Agency, 2011c).

32 In order to assess doses to members of the public, in addition to the description of the environmental features of the generic site, we required Westinghouse to provide information about discharges of aqueous and gaseous radioactive waste from the AP1000 and these are set out in our respective final assessment reports (Environment Agency 2011d,e)

33 In order to verify and validate the dose assessment carried out by Westinghouse we appointed a contractor to comment on the assumptions made by Westinghouse with respect to dose assessment parameters, to repeat Westinghouse's dose assessment and provide a methodology by which we could calculate doses to members of the public at our proposed discharge limits (Environment Agency, 2010g).

34 During the dose assessments certain matters were identified and dealt with using the Regulatory Observation and Technical Query system.

35 A Regulatory Observation, RO-AP1000-32, was raised on 1 June 2009 requiring Westinghouse to review the submission made under the GDA process for the AP1000 design to take into account UK policy and practices with respect to the discharge of liquid radioactive waste because we noted that from time to time that both the AP1000 European Design Control Document and the Environment Report made reference to the dilution of liquid radioactive waste. In particular the AP1000 European Design Control Document referred to meeting activity concentration limits and offsite dose limits specified by the US Nuclear Regulatory Commission (US NRC). In response Westinghouse has prepared AP1000 Nuclear Power Plant BAT Assessment (UKP-GW-GL-026, Revision 2) to demonstrate that Best Available Techniques are included in the design of the AP1000 and which takes into account UK policy and practices.

36 Technical Query TQ-AP1000-150 was raised on 1 June 2009 which required Westinghouse to justify the extent to which building downwash had been considered in the calculation of the value for effective release height for the main stack used in its dose assessments. Westinghouse responded on 20 August 2009 and its response included a reassessment of doses using an effective release height of 22.5 m which had been calculated taking into account building downwash. This was also taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in Environment Report UKP-GW-GL-790 Rev 2, 3 (s 5.2.1.2) and Rev. 4 (s 5.2.3.2). along with a revised dose assessment (Chapter 5).

37 Technical Query TQ-AP1000-151 was raised on 1 June 2009 and required Westinghouse to provide information on certain assumed data they had used in its short- term dose assessment. Westinghouse responded on 22 June 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in Environment Report UKP-GW-GL-790 Rev 2 and 3 (s 5.2.1.4) and Rev 4 (s 5.2.5.3).

38 Technical Query TQ-AP1000-152 was raised on 1 June 2009 and required Westinghouse to provide information on data they had used in its generic site description relating to the location of the nearest properties. Westinghouse responded on 30 June 2009 and its response was taken into account by the contractor

undertaking the validation and verification of Westinghouse's dose assessment. The information was included in Environment Report UKP-GW-GL-790 Rev 2, 3 (s 5.2.1.2) and Rev 4 (s 5.2.3.2).

39 Technical Query TQ-AP1000-164 was raised on 17 June 2009 and required Westinghouse to provide information on the approach they had used to identify groups of radionuclides in liquid radioactive waste discharge limits. Westinghouse responded on 20 August 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in Environment Report UKP-GW-GL-790 Rev 2, 3 and 4 (s 6.1.1 and table 6.1-2)

40 Technical Query TQ-AP1000-165 was raised on 17 June 2009 and required Westinghouse to provide information on the approach they had used to identify groups of radionuclides in gaseous radioactive waste discharge limits. Westinghouse responded on 20 August 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The information was included in Environment Report UKP-GW-GL-790 Rev 2, 3 and 4 (s 6.1.1 and table 6.1-1).

41 Technical Query TQ-AP1000-169 was raised on 19 June 2009 and required Westinghouse to provide information on ADMS input data they had used in its short - term dose assessment. Westinghouse responded on 13 August 2009 and its response was taken into account by the contractor undertaking the validation and verification of Westinghouse's dose assessment. The data was included in Environment Report UKP-GW-GL-790 Rev 2 and 3 (s 5.2.1.4 and table 5.2-3) and Rev 4 (s 5.2.3.2 and 5.2.5.2 and 5.2-20).

42 The outcomes of the dose assessment were compared with limits and constraints set out in Basic Safety Standards Directive (96/29/EURATOM), laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation and enacted in England and Wales by the Environmental Permitting Regulations 2010. The limits and constraints are:

a) UK dose limit for members of the public: 1000 μSv (1mSv) per annum individual effective dose.

b) UK dose constraints:

   i) 300 μSv (0.3 mSv) per annum individual effective dose from a single new source, (in their 2009 publication Application of the 2007 Recommendations of the ICRP to the UK (RCE-12) the Health Protection Agency has advised the UK Government to select a constraint value for members of the public for new nuclear power stations that is less than 150 μSv (0.15mSv) per year,

   ii) 500 μSv per annum individual effective dose from a single site not including exposures arising from direct radiation.

43 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 man Sv per year of operation may be exempted from regulatory control. The unit man Sv is also expressed as person Sv – which will be used in this document.

44 In its submission Westinghouse described a generic site and discharge data and using these they undertook a dose assessment to meet the requirements of our Process and Information Document. The dose assessment was provided to us in the Environment Report Chapter 5 (UKP-GW-GL-790 Rev 2, 3 and 4).

45 In early 2009 we invited tenders from contractors using our framework contract to carry out a validation and verification exercise on Westinghouse's dose assessment and undertake an independent dose assessment of the AP1000. The contract was let

to Enviros Consulting Ltd. We consulted with the Health Protection Agency, the Food Standards Agency and the UK National Dose Assessment Working Group (NDAWG) on the contract specification prior to the tendering exercise and incorporated their comments in the final technical specification for the contract.

46 The aim of the independent assessment was to:

a) Validate and verify the assumptions made by Westinghouse in its dose assessments.

b) Validate and verify the outcomes of the dose assessments carried out by Westinghouse.

c) Carry out independent dose assessments to demonstrate that the dose assessments carried out by Westinghouse were realistic.

47 We required the contractor to use PC CREAM to model dispersion and calculate doses to the reference group and collective doses for all exposure pathways including any unusual pathways. PC CREAM is a long recognised system for dose assessment developed for the EC.

48 We considered that:

a) Site specific habits data should be used where available however we recognised that at the generic stage the dose assessment would be carried out using parameters relating to the generic site provided by the Westinghouse.

b) In the absence of site specific habits data generalised habits data from NRPB W41 should be used (NRPB, 2003). NRPB W41 gives generalised food intake rates, generalised inhalation and water intake rates, inadvertent ingestion rates, and consumption rates of aquatic food, coastal, lakeside and river bank occupancy factors and indoor occupancy.

c) For site specific dose assessments at sites where new facilities are close to existing nuclear facilities, consideration needs to be given to doses which may arise as a result of discharges from the existing facilities, bearing in mind the dose constraint of 500 μSv per annum individual effective dose from a single site, not including exposures arising from direct radiation.

d) In order to compare to the dose limit, significant future doses from historic discharges at the site or nearby sites, and future direct radiation from other sites need to be added to future doses due to discharges and direct radiation from the site being assessed.

e) For assessments of individual dose, it is appropriate to take account of accumulation of radionuclides in the environment, usually by undertaking the assessment for the year in which the highest dose to the representative person (critical group) is likely to occur. This ensures that future generations are afforded the same level of protection as the current generation. Assuming no change in discharge limits, the highest dose to the representative person is generally predicted to occur during the last few years of discharges from a plant / site. Once discharges cease or are reduced significantly, the highest environmental activity concentrations near the discharge point generally start to decline. An accumulation time-scale of 50 years is usually selected for new plants and for plants / sites where it is difficult to specify a closure date. Where radionuclides build-up to an equilibrium level more quickly in the environment, then a shorter time-scale may also be adopted. Generally, the highest radionuclide concentrations in the environment, from a given site, tend to decline following a reduction in discharges. A key exception is where there is in-growth of a daughter radionuclide from its parent (e.g. americium-241).

f) We noted that in their 2009 publication '*Application of the 2007 Recommendations of the ICRP to the UK'* (RCE-12) the Health Protection Agency (HPA) advised that the term 'representative person' should be gradually adopted to replace the term

'critical group' in order to ensure consistency with ICRP advice and terminology. In line with their advice we consider the terms 'critical group' and 'representative person' to be equivalent and to refer those individuals in the population of interest who receive or are expected to receive the highest dose. The report from Enviros Consulting Ltd (Environment Agency, 2010g) uses the term 'representative person'.

49 We required the contractor to undertake:

a) Prospective assessment of doses from potential gaseous and aqueous discharges from the AP1000 design for the members of the public, using information on potentially exposed members of the public set out by the Westinghouse for its generic site and taking account of direct radiation for comparison with the source dose constraint. Where applicable assessments should be carried out for 'normal discharges', 'worst case discharges' and at any discharge limits proposed by the requesting party.

b) Prospective assessments of:

   i) annual dose to most exposed members of the public for aqueous discharges;

   ii) annual dose to most exposed members of the public for gaseous discharges;

   iii) annual dose to the most exposed members of the public for all discharges from the facility;

   iv) annual dose from direct shine radiation to the most exposed member of the public;

   v) annual dose to the representative person for the facility;

   vi) potential short-term doses based on the maximum anticipated short-term discharges from the facility in normal operation.

   Information generated on peak concentrations of radionuclides in foods as part of the dose assessment should be identified for ready comparison with the Community Food Intervention Levels (EC, 1989).

c) Assessment of the collective doses from gaseous and aqueous discharges from the AP1000 design for the populations identified by Westinghouse for its generic site. Where applicable assessments should be carried out for 'normal discharges', 'worst case discharges' and at any discharge limits proposed by the Requesting Party (RP).

50 In order to carry out the assessments we assessed the submission made by Westinghouse to ensure it provided the following data for its generic site:

a) For atmospheric dispersion modelling and dose assessment:

   i) Effective release height

   ii) Volumetric flow rate

   iii) Activity of each radionuclide in annual foreseeable discharges

   iv) Location of receptors such as nearby residents, local food production sites, persons most exposed via inhalation of the plume, any free food sources

   v) Meteorological data

   vi) Surface roughness length

   vii) Stability category

   viii) Deposition velocity

   ix) Washout coefficient

   x) Terrestrial food consumption habits

b) For marine dispersion modelling and dose assessment:
   i) Activity of each radionuclide in annual foreseeable discharges
   ii) Volumetric exchange rate for receiving water
   iii) Location of discharge
   iv) Consumption rates of locally caught seafood
   v) Inhalation rates
   vi) Beach occupancy rates
   vii) Location of any receptors

51 The methodology and outcome of the work carried out by the contractor is set out in the report 'Independent Dose assessment' (IMAS/TR/2010/06) (Environment Agency, 2010g) and the outcome is summarised below:

a) In the Westinghouse submission, it is assumed that the AP1000 would be located on the coast. 'Representative discharges' and discharges at Westinghouse's proposed discharge limits for radioactive liquid and atmospheric discharges were used as the basis for assessing doses to the local population and collective doses. 'Representative discharges' are the discharges in the highest 12 months of the 18 month operating cycle (usually month 7 to 18 inclusive as monthly discharges tend to rise throughout the 18 month operating cycle).

3.5 Westinghouse's dose assessment

52 Westinghouse used the Environment Agency's initial radiological assessment approach at Stage 2 for its assessment. Westinghouse also provided estimates of the collective doses to the UK, European and World populations (truncated at 500 years), estimated using PC CREAM 98. They also predicted doses from expected short-term releases using the atmospheric dispersion model ADMS 4.1.

53 As part of the validation and verification activity the approaches applied by Westinghouse were reviewed and repeated.

54 Following our consultation which began in June 2010, Westinghouse revised its dose assessment taking into account a proposed design change involving an increase in the stack release height. An increased stack height results in lower air concentrations at ground level and leads to lower doses to the representative person.

55 **Doses from gaseous discharges** - Using the Stage 2 approach for gaseous discharges, Westinghouse estimated a dose to local residents of 7.6 μSv y^{-1} from the annual representative discharges and 12.0 μSv y^{-1} from discharges at its proposed limits (ER Rev 4 s.5.2.3.2). It was possible to repeat these assessments using the Westinghouse assumptions.

56 **Doses from aqueous discharges** - Using the Stage 2 approach for aqueous discharges, Westinghouse estimated a dose to the fisherman family of 2.3 μSv y^{-1} from the annual representative discharges and 3.8 μSv y^{-1} from discharges at its proposed limits (ER Rev 4 s 5.2.3.1). It was possible to repeat these assessments using the Westinghouse assumptions.

57 **Doses from direct radiation** - Exposure of the public from direct radiation from nuclear sites in the UK is the responsibility of the ONR. ONR require site operators to measure direct radiation at the site perimeter and estimate exposure to a reference group on an annual basis. The Westinghouse assessment of direct radiation was based on measured values for Sizewell B which is the only PWR operating in the UK. The direct radiation dose rate measured at the site perimeter fence during 2007 of 4 μSv y^{-1} was used in the Westinghouse assessment.

58 **Doses from short term releases** – Westinghouse also assessed the impact of short duration releases to atmosphere at higher discharge rates. They assumed that the highest planned monthly discharge was released over 30 minutes. They initially assessed doses due to short term releases to be 12 µSv to an infant (Environment Report (Rev 2)). It was not possible to reproduce this assessment exactly and as a result Westinghouse reviewed its assessment of doses due to short term releases and made the following changes:

a) The initial assessment used the dose per unit intake (DPUI) factor for carbon-14 in vapour form. In their reassessment Westinghouse used the DPUI for carbon-14 in particulate form set out in our initial assessment methodology.

b) In the initial assessment Westinghouse used habit data given in NRPB-W54. In its reassessment Westinghouse used the habit data in NRPB-W41.

As a result of their assessment Westinghouse calculate the dose due to short term releases to be 12 µSv. Following the public consultation Westinghouse reassessed the impact of short duration releases taking into account their expected taller stack. The revised assessment gave a dose of 4.9 µSv (section 5.2.5.3 of the Environment Report Revision 4).

59 **Doses to the representative person** - The dose to the representative person from the reactor from representative discharges was initially assessed by Westinghouse as 14 µSv y^{-1} for representative discharges and 20 µSv y^{-1} for limit discharges. Following the public consultation and, as a result of a proposed design change for GDA, Westinghouse revised their assessment of the expected release height for discharges to atmosphere. This change was re-modelled as an increase in effective height from 22m to 40m. A taller release height leads to greater dispersion and a lower ground level air concentrations. The re-assessment carried out by Westinghouse led to a lower dose of 9.8 µSv y^{-1} for representative discharges, ER Section 5.2.3.3, and 13µSv y^{-1} for limit discharges. This is based on a conservative summation of doses from atmospheric discharges, liquid discharges and direct radiation and excludes doses due to short duration discharges to atmosphere.

60 We conclude that all the doses assessed by Westinghouse will be below the dose constraint for members of the public of 300 µSv y^{-1} and the dose constraint recommended by the HPA for new build of 150 µSv y^{-1}.

61 **Collective dose** Westinghouse estimated the collective doses to the world population (truncated at 500 years) from representative atmospheric discharges to be of the order of 12 to 13 personSv per year of discharge to atmosphere and 0.05 to 0.055 personSv per year from representative aqueous discharges. At the proposed limits, collective doses were 20-21 personSv and 0.08 and 0.09 personSv respectively.

62 The results of Westinghouse's initial dose assessment are summarised below:

Dose to public from AP1000 Representative Discharges μSv y^{-1}					
Candidate for representative person	**Assessment basis**	**Stack 1**	**Marine**	**Direct Radiation**	**Short term releases (μSv)**
CRP1 - local resident (high rate terrestrial food consumer)	Original for consultation	7.6	-	4.0	12.0
	Revised stack height	3.6	-	4.0	4.9
CRP2 - local fisherman (high marine exposure)	Original for consultation	-	2.3	4.0	12.0
	Revised stack height	-	2.3	4.0	4.9

Total dose for members of the public exposed to both gaseous and aqueous disposal at representative discharge levels is 14 μSv y^{-1} (excluding doses from short term releases) (ER Rev 4 s 5.2.4). This is the sum of the numbers highlighted in red in the above table.

Dose to public from AP1000 Discharges at Westinghouse's proposed limits μSv y^{-1}					
Candidate for representative person	**Assessment basis**	**Stack 1**	**Marine**	**Direct Radiation**	**Short term releases (μSv)**
CRP1 - local resident (high rate terrestrial food consumer	Original for consultation	12.0	-	4.0	12.0
	Revised stack height	5.6	-	4.0	4.9
CRP2 - local fisherman (high marine exposure)	Original for consultation	-	3.8	4.0	12.0
	Revised stack height	-	3.8	4.0	4.9

Estimate of total dose made by Westinghouse to representative person from AP1000 representative discharges and discharges at proposed limits μSv y^{-1}						
Representative person	**Discharges**	**Assessment basis**	**Stack 1**	**Marine**	**Direct Radiation**	**Total dose (μSv)**
CRP1 + CRP2 local resident (high rate terrestrial food consumer + local fisherman (high marine exposure)	Representative discharges	Original for consultation	7.6	2.3	4.0	13.9
		Revised stack height	3.6	2.3	4.0	9.9
CRP1 + CRP2 local resident (high rate terrestrial food consumer + local fisherman (high marine exposure)	Proposed limits	Original for consultation	12.0	3.8	4.0	20.0
		Revised stack height	5.6	3.8	4.0	13.4

Total dose for members of the public exposed to both gaseous and aqueous disposal originally assessed by Westinghouse was 20 μSv y^{-1} at Westinghouse's proposed discharge limits. This is based on the addition of doses from the two candidate representative person groups. The revised assessment with increased stack height reduced the assessed dose to 13.4 μSv y^{-1} Releases to atmosphere make a significant contribution to the dose for all assessments, the dominant nuclide being carbon-14. The doses from liquid discharges were generally less important. For liquids the doses are dominated by carbon-14 and cobalt-60.

3.6 Our independent assessment of doses from maximum expected discharges

63 Westinghouse did not undertake a detailed assessment which is sometimes made following on from the initial radiological assessment. A more detailed independent assessment was undertaken on our behalf by Enviros Consulting Ltd. This assessment took into account good practice and published assessment guidance and used PC CREAM 98, a long recognised system for dose assessment developed for the EC. The assessment was based on the assumptions in the original Westinghouse assessment. We did not revise our assessment to reflect the expected increase in effective stack height associated with the proposed design change for GDA. We expect that an increase in stack height would reduce the levels at ground level and hence reduce doses below those we report here.

64 We consulted the Health Protection Agency and the Food Standards agency on the draft independent dose assessment and their comments, which were minor in nature, were incorporated into the final report (Environment Agency, 2010g).

65 **Doses from gaseous discharges** - At the discharges to atmosphere originally assumed by Westinghouse, a dose of around 4 μSv y^{-1} to the most exposed local residents (an infant) consuming locally produced terrestrial foods has been estimated. This assumes an effective stack height of 22.5 m that takes account of the effects of

adjacent buildings on plume behaviour. The ingestion of carbon-14 in milk accounts for the majority of the dose predicted from aerial discharges.

66 **Doses from aqueous discharges** - On the basis of the representative liquid discharges estimated by Westinghouse, effective doses of around 1 μSv y^{-1} to an adult fisherman have been assessed. The dose arises primarily from carbon-14 in fish and shellfish.

67 **Doses from direct radiation** - The assessment of direct radiation was based on measured values for Sizewell B for 2007, for which a value of 4 μSv y^{-1} has been published.

68 **Doses from short term releases -** A dose of around 13 μSv has been predicted to an adult in the local resident family from a single short-term release, compared to 12 μSv predicted by Westinghouse in its revised assessment. The dose is dominated by the inhalation and ingestion pathways.

69 **Doses to the representative person** - The dose to the representative person from the site assessed in the more detailed independent assessment has been predicted to be around 8.4 μSv y^{-1}, including a contribution from direct radiation but without the inclusion of a contribution from short-term releases.

70 Westinghouse's assessment outcomes were higher than the independent assessment because they are based on conservative assumptions in the initial radiological assessment system and more conservative assumptions about combinations of exposures (addition of doses to the two candidate for representative individuals) than those applied in the independent assessment.

71 **Collective doses** -The independent assessment of collective doses calculated collective doses to be 12.2 to 12.6 person Sv per year of discharge for atmospheric discharges and 0.052 to 0.054 person Sv per year of discharge for liquid discharges which are essentially equivalent to those calculated by Westinghouse. The highest dose per person was estimated to be 5 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.

72 The results of our independent assessment at representative discharges are summarised below:

Our independent assessment of dose to public* from AP1000 at representative discharges μSv y^{-1}					
Candidate for representative person	**Age Group**	**AP1000 Discharges**			
		Stack 1	**Marine**	**Direct Radiation**	**Total**
CRP1 - local resident (high rate terrestrial food consumer	Adult	2.6	<0.1	4	6.7
	Child	2.9	<0.1	4	7.0
	Infant	4.4	<0.1	4	8.5
CRP2 - local fisherman (high marine exposure)	Adult	1.6	1.0	0	2.6
	Child	1.9	0.3	0	2.2
	Infant	2.1	0.1	0	2.2

*Based on the original assumptions about atmospheric releases.

3.7 Our independent assessment of doses from discharges at our proposed limits

73 We used the spreadsheet prepared by Enviros Consulting Ltd to estimate doses at our proposed discharge limits. The discharges at the proposed limits are set out below:

Atmospheric discharges at Environment Agency proposed limits		
Radionuclide	**Atmospheric Discharges per Stack (TBq y^{-1})**	
	Stack 1	**Stack 2**
Ar-41	2.00E+00	
Ba-140	0.00E+00	
C-14	1.00E+00	
Co-58	0.00E+00	
Co-60	3.00E-05	
Cr-51	0.00E+00	
Cs-134	0.00E+00	
Cs-137	0.00E+00	
H-3	3.00E+00	
I-131	3.00E-04	0.00E+00
I-133	0.00E+00	0.00E+00
Kr-85	1.30E+01	0.00E+00
Kr-85m	0.00E+00	0.00E+00
Kr-87	0.00E+00	0.00E+00
Kr-88	0.00E+00	0.00E+00
Mn-54	0.00E+00	
Nb-95	0.00E+00	
Sr-89	0.00E+00	
Sr-90	0.00E+00	
Xe-131m	0.00E+00	0.00E+00
Xe-133	0.00E+00	0.00E+00
Xe-133m	0.00E+00	0.00E+00
Xe-135	0.00E+00	0.00E+00
Xe-135m	0.00E+00	0.00E+00
Xe-137	0.00E+00	0.00E+00
Xe-138	0.00E+00	0.00E+00
Zr-95	0.00E+00	

Noble gases taken together were treated as krypton-85

Other radionuclides were treated as cobalt-60

Marine Discharges at Environment Agency proposed limits	
Radionuclide	**Marine Discharges (TBq y^{-1})**
	Discharge point 1
Ag-110m	0.00E+00
Ba-140	0.00E+00
C-14	7.00E-03
Ce-144	0.00E+00
Co-58	0.00E+00
Co-60	5.50E-03
Cr-51	0.00E+00
Cs-134	0.00E+00
Cs-136	0.00E+00
Cs-137	5.00E-05
Fe-55	0.00E+00
Fe-59	0.00E+00
H-3	6.00E+01
I-131	0.00E+00
I-133	0.00E+00
La-140	0.00E+00
Mn-54	0.00E+00
Na-24	0.00E+00
Nb-95	0.00E+00
Ni-63	0.00E+00
Pr-144	0.00E+00
Pu-241	0.00E+00
Ru-103	0.00E+00
Sr-89	0.00E+00
Sr-90	0.00E+00
Tc-99	0.00E+00
Tc-99m	0.00E+00
Y-91	0.00E+00
Zn-65	0.00E+00
Zr-95	0.00E+00

Other radionuclides were treated as cobalt-60

74 **Doses from gaseous discharges** – The highest doses from gaseous discharges at our proposed limits was 7.1 μSv to an infant and the highest contribution was from carbon-14 in milk.

75 **Doses from aqueous discharges –** The highest doses from aqueous discharges at our proposed limits was 2.1 μSv to an adult. The dose arises primarily from carbon-14 in fish and shellfish.

76 **Doses from direct radiation –** The assessment of direct radiation was based on measured values for Sizewell B for 2007, for which a value of 4 μSv y^{-1} has been published in Radioactivity in Food and the Environment, 2007 (Environment Agency, 2008).

77 **Doses to the representative person –** Our Stage 3 assessment resulted in the highest estimated doses of 11 μSv y^{-1} from an AP1000 reactor to a representative person who is an infant, who is most exposed to gaseous discharges. This assessment outcome is for our proposed annual limits on discharges for the AP1000 design.

78 The results of the dose assessment at our proposed limits are summarised below:

Dose to public from AP1000 discharges at Environment Agency limits μSv y^{-1}					
Candidate for representative individual	**Age Group**	**AP1000 Discharges**			
		Stack 1	**Marine**	**Direct Radiation**	**Total**
CRP1 - local resident (high rate terrestrial food consumer	Adult	4.2	0.2	4	8.4
	Child	4.6	0.1	4	8.7
	Infant	7.1	0.1	4	11.2
CRP2 - local fisherman (high marine exposure)	Adult	2.5	2.1	0	4.6
	Child	3.0	0.6	0	3.6
	Infant	3.4	0.2	0	3.6

3.8 Comparison to dose constraints and dose limits

79 Source dose constraint (HMSO, 2010[2]) - The dose constraint for the maximum dose to people that may result from discharges from a new single source (for example, a new nuclear power station) is 300 μSv y^{-1} which applies to the dose from proposed discharges and direct radiation.

80 We conclude that sum of doses to the representative person at our proposed limits is below the source dose constraint, and below the dose constraint recommended by the HPA for new build of 150 μSv y^{-1}.

81 Site dose constraint (HMSO, 2010) - The dose constraint for the maximum dose to people that may result from discharges from a site as a whole is 500 μSv y^{-1} and it applies to the total dose from the discharges (direct radiation is not included) from all sources at a single location, including discharges from immediately adjacent sites.

82 All the sites listed in the Nuclear National Policy Statement (DECC, 2011) as potentially suitable for a new nuclear power station are adjacent to existing nuclear power stations. In GDA the specific site at which an AP1000 might be located is not

[2] The constraint was set under the Basic Safety Standards Direction (Defra, 2000) but the Direction was superseded by the Environmental Permitting Regulations 2010.

known but we consider, in the light of our assessment that the highest total dose is estimated to be 11 μSv y^{-1}, it is very unlikely that doses at the site will exceed the site dose constraint of 500 μSv y^{-1}. We consider that site dose should be assessed at the site specific stage.

83 We conclude that site dose should be assessed at site specific permitting.

84 There is also a dose limit (HMSO, 2010) for the maximum dose to any member of the public from ionising radiation. The dose limit is 1 mSv y^{-1} (1000 μSv y^{-1}) and it applies to the total dose from all artificial sources including past discharges but excluding medical and accidental exposure.

85 **Comparison against the dose limit can only be done at site specific permitting when contributions from all sources of radiation can be included**.

3.9 Comments on our approach

86 We received several comments in response to our consultation that the process and the assessments made by the RP and by us seemed rigorous and thorough and gave confidence that the outcomes are reasonable. One respondent, the Institution of Mechanical Engineers (GDA146[3]) agreed:

a) *'with the consultation document conclusions and that the assessment section was a good section demonstrating the plant will meet all requirements by a good margin and reassuring to see such good agreement between the Westinghouse data and the regulator's independently calculated data. The Institution feels assured that Westinghouse have assessed fully the impact of radioactive discharges and all dose-rates are well below 40 μGy h-1'.*

87 In 2009 the HPA updated its dose assessment methodology and provided a revised implementation of the method in PC CREAM-08. HPA advised in its comments that the newer implementation in PC-CREAM-08 would give similar results to PC-CREAM-98 but recommend adoption of PC-CREAM-08 in future. Therefore, when we make our own site specific assessment PC-CREAM-08 will be used.

[3] We list the names of all the organisations that responded to the consultation in Annex 7 of the Decision Document (Environment Agency, 2011a). We have not given names of individuals or members of the public. The list gives a GDA number to each response (for example, GDA76 is for the Health & Safety Executive), so that the documents can be searched to allow all respondents to see where their responses have been considered. Where we quote consultation responses in this document, we have not corrected spelling or grammar.

4 Public comments

88 We did not receive any public comments during this assessment relating to the assessment of the radiological impact of discharges from the AP1000 on members of the public. Comments made in response to our public consultation in regard to radiological impact of discharges from the AP1000 design were considered in our decision document, and herein where relevant to our assessment

89 Questions were also raised and published from our 6 July GDA stakeholder seminar and are considered in our decision document, and herein where relevant to our assessment. http://www.hse.gov.uk/newreactors/seminar-060710.pdf

90 We received several comments during our consultation about two recent studies and reports on health risks near nuclear sites and from tritium and whether these have been considered.

91 Our dose assessments take into account health risks arising from exposure to radiation using UK dose to risk factors that have been recommended by the Health Protection Agency (HPA). The UK factors are based on those recommended by the International Commission on Radiation Protection (ICRP) and form part of a wider radiation protection framework (ICRP-60 and ICRP-103) and enacted into legislation through the 1996 EC Basic Safety Standards and in the UK through the Ionising Radiation Regulations 1999, and the Environmental Permitting Regulations 2010. The risks from doses are reflected in the dose limits and dose constraints set in these legislative devices.

92 In 2007 a study had been published of leukaemia near nuclear sites in Germany - the so called KiKK study (Spix et al 2008, Kaatsch et al 2008) and also into risk factors specifically related to tritium (AGIR 2007).

93 The HPA (Mobbs et al 2010) have stated that the KiKK 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. 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.

94 We formally sought advice from the HPA to confirm if our dose factors or methodology should as a result of the Advisory Group on Ionising Radiation (AGIR 2007) report on tritium. HPA have advised us that the current radiation protection system remains appropriate, the current risk factors are valid and that we should continue to use the dose coefficients published by ICRP in our regulatory decision.

95 The HPA has recently recommended a revised dose constraint for use at the planning stage of new nuclear facilities (HPA 2009).

96 For our regulation we continue to apply dose factors published by ICRP (ICRP 1996) and compare the calculated doses with the legal dose limits and dose constraints (EPR 2010) and have taken into account the revised dose constraint recommended by the HPA.

5 Conclusion

97 We conclude that all the doses assessed by Westinghouse are well below the dose constraint for members of the public of 300 μSv y^{-1} and the dose constraint recommended by the HPA for new nuclear build of 150 μSv y^{-1}.

98 We conclude that sum of doses to the representative person at our proposed limits is below the source dose constraint.

99 A number of the sites listed in the Nuclear National Policy Statement as potentially suitable for a new nuclear power station are adjacent to existing nuclear power stations. In GDA the specific site at which a AP1000 reactor might be located is not known but we consider, in the light of our assessment that the highest total dose is estimated to be 11 μSv y^{-1} ,it is very unlikely that doses at the site will exceed the site dose constraint of 500 μSv y^{-1}. We consider that site dose should be assessed at the site specific stage.

100 Comparison against the dose limit can only be done at site specific permitting when contributions from all sources of radiation can be included.

101 In line with our usual procedures we will require a detailed site specific impact assessment to be carried out at site specific permitting based on the actual environmental characteristics of the proposed site to demonstrate that doses to members of the public and non-human species from the AP1000 at the proposed site will be ALARP and below relevant dose constraint and dose limits. In responding to our consultation, the Health Protection Agency (GDA89) agreed that detailed site-specific assessments of the potential impacts of discharges to the environment will be required at the permit application stage.

6 Compliance with Environment Agency requirements

P&I table 1 section or REP	Compliance comments
Section 2.7 Prospective dose assessment for the generic site at the proposed limits for levels of discharge.	An assessment was carried out by Westinghouse which included an assessment of • annual dose to most exposed members of the public for liquid discharges; • annual dose to most exposed members of the public for gaseous discharges (identifying separately the dose associated with on site incineration where applicable); • annual dose to the most exposed members of the public for all discharges from the facility; • annual dose from direct radiation to the most exposed member of the public; • annual dose to the representative person for the facility; • potential short-term doses, including via the food chain, based on the maximum anticipated short-term discharges from the facility in normal operation; • a comparison of the calculated doses with the relevant dose constraints; and • an assessment of whether the build-up of radionuclides in the local environment of the facility, based on the anticipated lifetime discharges, might have the potential to prejudice legitimate users or uses of the land or sea.
Section 2.8 Collective dose assessments for discharges from the facility truncated at 500 years to the UK, European and World populations.	An assessment of collective dose was made by Westinghouse.
Section 2.9 Sufficient assumed data for others to be able to carry out all dose assessments	Sufficient data was provided by Westinghouse and this allowed the independent validation and verification of its dose assessments.
SEDP1 General RSR Principle for siting new facilities - When evaluating sites for a new facility, account shall be taken of the factors that might affect the protection of people and the environment from radiological hazards and the generation of radioactive waste	The generic site proposed by Westinghouse considered factors that might affect the protection of people and the environment. The information about the generic site used in the dose assessments seemed reasonable.

P&I table 1 section or REP	Compliance comments
SEDP2 Movement of radioactive material in the environment - Data shall be provided to allow the assessment of rates and patterns of movement of radioactive materials in the air and the aquatic and terrestrial environments around sites.	Information on the potential movement of radioactive material in the environment was provided by Westinghouse
SEDP3 Ambient radioactivity - Levels of ambient radioactivity around the sites of new facilities shall be assessed.	An assessment of potential doses from direct radiation from the AP1000 was made.
SEDP4 Multi-facility sites - In the case of nuclear and other sites on which there are already one or more facilities, the radiological impact of the whole site on people and the environment shall be assessed when considering the suitability of the site for any new facility.	This will be dealt with at the site specific stage if the AP1000 is located on a multi-facility site.
RPDP1 Optimisation of protection - All exposures to ionising radiation of any member of the public and of the population as a whole shall be kept as low as reasonably achievable (ALARA), economic and social factors being taken into account	ALARP has been demonstrated at this stage however we require Westinghouse to keep ALARP matters under review.
RPDP2 Dose limits and constraints - Radiation doses to individual people shall be below the relevant dose limits and constraints.	Predicted doses to members of the public from the AP1000 at the generic site are less than the relevant dose limits and constraints.
RPDP4 Prospective dose assessments for radioactive discharges to the environment - Assessments of potential doses to people and to non-human species shall be made prior to granting any new or revised authorisation for the discharge of radioactive wastes into the environment.	A prior assessment has been made based on the generic site. We will require that prospective dose assessments are carried out at the site specific stage as part of the permitting process and using information specific to the site in question.

P&I table 1 section or REP	Compliance comments
UK dose limit for members of the public - 1 mSv per annum individual effective dose	Individual doses predicted from the Westinghouse assessment and from the independent assessment were below the UK dose limit for members of the public. We will require that prospective dose assessments are carried out at the site specific stage as part of the permitting process and using information specific to the site in question.
UK dose constraints -300 µSv per annum individual effective dose from a single new source, (in their 2009 publication Application of the 2007 Recommendations of the ICRP to the UK (HPA, 2009) the Health Protection Agency has advised the UK Government to select a constraint value for members of the public for new nuclear power station that is less than 0.15 mSv per year (150 µSv y^{-1})).	Individual doses predicted from the Westinghouse assessment and from the independent assessment were below the dose constraint of 300 µSv y^{-1} and the proposed constraint for new nuclear power stations of 150 µSv y^{-1}. We will require that prospective dose assessments are carried out at the site specific stage as part of the permitting process and using information specific to the site in question.
UK dose constraints - 500 µSv per annum individual effective dose from a single site not including exposures arising from direct radiation.	Individual doses predicted from the Westinghouse assessment and from the independent assessment were below the dose constraint of 500 µSv y^{-1} from a single site assuming the AP1000 is not on a multi-facility site. We will require that prospective dose assessments are carried out at the site specific stage as part of the permitting process and using information specific to the site in question.
IAEA suggest that practices which give rise to collective doses less than 1 person Sv per year of operation may be exempted from regulatory control.	Collective doses predicted from the independent assessment are greater than 1 person Sv per year of operation. The practice will not be exempted from regulatory control.

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

Abbreviations

ADMS	Atmospheric Dispersion Modelling System
ALARA	As low as reasonably achievable
ALARP	As Low As Reasonably Practicable
BAT	Best available techniques
DCD	Design Control Document
DPUI	Dose Per Unit Intake
ER	Environment Report
FSA	Food Standards Agency
GDA	Generic design assessment
HPA-RPD	Health Protection Agency – Radiation Protection Division
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
JPO	Joint Programme Office
NDAWG	UK National Dose Assessment Working Group
NRPB	National Radiological Protection Board (now part of Health Protection Agency)
ONR	Office for Nuclear Regulation, an Agency of the HSE (formerly HSE's Nuclear Directorate)
P&ID	Process and information document
PC CREAM	Radioactive discharge modelling software
PCSR	Pre-Construction Safety Report
PWR	Pressurised water reactor
QA	Quality Assurance
REPs	Radioactive substances environmental principles
RGN	Regulatory Guidance Note
RGS	Regulatory Guidance Series
RO	Regulatory Observation
RP	Requesting Party
SODA	Statement of Design Acceptability
TQ	Technical Query
US NRC	United States Nuclear Regulatory Commission
WEC	Westinghouse Electric Company LLC
WGS	Gaseous radioactive waste system
WLS	Liquid radioactive waste system

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