Generic design assessment

AP1000® nuclear power plant design by Westinghouse Electric Company LLC

Final assessment report

Solid radioactive waste (LLW and ILW)

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AP1000™ nuclear power plant design by Westinghouse Electric Company LLC

Final assessment report - solid radioactive waste (LLW and ILW)

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: 2.1 – a description of how radioactive wastes will arise, be managed and disposed of throughout the facility's lifecycle 2.4 – design basis estimates and substantiation of annual arisings of solid radioactive waste during operation and decommissioning 1.5 – an analysis should be provided that includes an evaluation of options considered and shows that the best available techniques will be used to minimise the production and discharge or disposal of waste
Radioactive substances regulation environmental principles[2]	The following principles are relevant to this assessment: RSMDP3 - Use of BAT to minimise waste RSMDP8 - Segregation of wastes RSMDP9 – Characterisation RSMDP10 – Storage RSMPD15 - Requirements and conditions for disposal of wastes
Report author	Price-Walter, S. J.

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 This report presents the findings of our assessment of the AP1000™'s solid radioactive waste (low level waste (LLW) and intermediate level waste (ILW)) based on information submitted by Westinghouse in its environment report (ER) and supporting documents.

2 Our conclusions are unchanged since our consultation, however, we have reworded our assessment findings and added an additional one on arisings of low level waste (LLW) and intermediate level waste (ILW).

3 **We conclude that:**

a) **Westinghouse has identified all LLW and ILW waste streams that an AP1000 will typically produce.**

b) **The AP1000 uses BAT to minimise the arisings of LLW and ILW, subject to assessment finding AP1000-AF08.** Prior to consultation we only proposed an assessment finding relating to the disposal of LLW and ILW (UK AP1000-AF09, below).

c) **The AP1000 uses BAT to treat and condition LLW and ILW prior to disposal, subject to assessment finding AP1000-AF09.**

d) **The AP1000 is not expected to produce LLW or ILW for which there is no foreseeable disposal route.**

e) **Westinghouse has provided valid estimates for the annual arisings (during operations and decommissioning) of LLW and ILW. These arisings (during operations) are consistent with those of comparable reactors around the world (Isukul, 2009).**

4 As part of our assessment, we identified the following assessment findings:

a) 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 Westinghouse's plan for disposability of ILW (AP1000-AF07).

b) 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 intermediate level waste (ILW) are the best available techniques (BAT) (AP1000-AF08).

c) The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of low level waste (LLW) and intermediate level waste (ILW) before disposal are the best available techniques (BAT) (AP1000-AF09).

5 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

6 We originally published this report in June 2010 to support our GDA consultation on the AP1000 design. The consultation was on our preliminary conclusions. It began on 28 June 2010 and closed on 18 October 2010.

7 We received additional information from Westinghouse after June 2010 and also undertook additional assessment in response to consultation responses. 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 their submission. Where any paragraph has been added or substantially revised it is in a blue font. It is noted that sections 3.4, 3.5 and 3.6 have been completely rewritten.

8 Guidance on our generic design assessment (GDA) process was published in January 2007 (process and information document (P&ID) (Environment Agency, 2007)). Table 1, section 2.1 of the P&ID requires the requesting parties (RPs) to provide a description on how radioactive waste will arise, be managed and disposed of throughout the facility's lifetime. Table 1, section 2.1 of the P&ID states that:

'*A description of how radioactive wastes will arise, be managed and disposed of throughout the facility's lifecycle. This should include:*

a) *sources of radioactivity and matters which affect wastes arising;*

b) *gaseous, liquid and solid wastes;*

c) *discharge points for gaseous wastes and discharge routes for liquid wastes;*

d) *disposal routes for solid wastes (including any proposals for incineration of combustible waste).*'

9 Table 1, section 2.4 of the P&ID requires the RPs to propose design basis estimates and substantiation of annual arisings of solid radioactive waste. Table 1, section 2.4 of the P&ID states that:

> '*Design basis estimates and substantiation of annual arisings of solid radioactive waste during operation and decommissioning. Wastes should be identified in terms of category (high level waste (HLW), ILW, LLW), physico-chemical characteristics and proposed disposal route (if any). Quantification should be in terms of activity of key individual radionuclides and overall groupings of radionuclides (e.g. total alpha), mass and volumes.*
>
> *The requesting party should obtain, and provide, a view from the Nuclear Decommissioning Authority (NDA) (as the UK authoritative source in providing such advice) on the disposability of any proposed arisings of ILW or HLW*.'

This P&ID requirement includes all radioactive wastes arisings, including those from operations and decommissioning, and includes waste arising from all activities, both routine and reasonably foreseeable non-routine activities (e.g. breakdown maintenance). This information is required:

a) in support of the waste and spent fuel strategy and BAT analysis which is the subject of P&ID requirements 1.4, 1.5 and 2.1;

b) in support of the assessment of the impact of any proposed direct disposal of waste (for example by on-site incineration);

c) to provide a basis for indicative limit setting where appropriate;

d) to provide confidence that wastes will not be generated for which there is no foreseeable disposal route.

10 Table 1, section 1.5 of the P&ID requires the RPs to provide an analysis that includes an evaluation of options considered and show that BAT will be used to minimise the

production and discharge or disposal of waste. Table 1, section 1.5 of the P&ID states that:

> '*An analysis should be provided that includes an evaluation of options considered and shows that the best available techniques will be used to minimise the production and discharge or disposal of waste. This should include:*
>
> – *a description of the means used by each significant waste generating and management process to minimise waste arising and discharged or disposed of and a demonstration that these are the best practicable;*
>
> – *a review of design features, including those of fuel usage, such as burn-up and rating, that facilitate minimisation of arisings and disposal of waste during operation of the reactor;*
>
> – *a review of design features that facilitate decommissioning and minimise the arisings of decommissioning waste.*
>
> *Reference should be made to:*
>
> – *all periods of "operation", for example at power, shutdown, maintenance and refuelling (including related tasks such as fuel and flask handling);*
>
> – *transitory periods (e.g. returning to power following shutdown);*
>
> – *issues relating to minimising radioactivity source terms (for example materials of construction and coolant chemistry);*
>
> – *abatement issues (for example optimising resin types and usage in treatment systems);*
>
> – *process control and monitoring arrangements including fault detection;*
>
> – *the selection of materials and physical features to minimise activation and contamination, facilitate decontamination, removal of components etc;*
>
> – *practices at other existing and proposed facilities.*'

11 We are carrying out our assessment in two stages:

a) preliminary assessment – we examine the outline details of the requesting party's submission to find out if further information is needed, if there are any issues that are obviously unacceptable, or if there needs to be any significant design modifications;

b) detailed assessment – we examine the submission in detail to decide initially if we might issue a statement of design acceptability. We will only make our final decision after we have consulted the public and considered the responses we receive.

12 Westinghouse submitted its AP1000 design for GDA in August 2007. We published the findings of our preliminary assessment in March 2008 (Environment Agency, 2008).

13 We found that the submission did not contain the level of information we needed to carry out a detailed assessment but Westinghouse committed to providing further information. In fact it provided a completely revised submission, its environment report (ER) with supporting documents. They have published the ER and other documents on its website (https://www.ukap1000application.com/ap1000_documentation.aspx).

14 Our detailed assessment of the information contained in the revised submission on solid radioactive waste (low level waste (LLW) and intermediate level waste (ILW)) 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 the Office for Nuclear Regulation's[1] (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.

15 We also liaised with ONR on other matters of joint interest and used their Step 3 and Step 4 reports to inform our assessment.

16 The assessment of disposability of ILW is the subject of a separate assessment report (Environment Agency, 2011d). The assessment of spent fuel and non-radioactive wastes are also documented within other assessment reports (Environment Agency, 2011b and Environment Agency, 2011c).

17 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).

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).

[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.

3 Assessment

3.1 Assessment methodology and process

20 The basis of our assessment was to:

a) review appropriate sections of the ER 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 (ROs) and Technical Queries (TQs) where we believed information provided by Westinghouse was insufficient;

d) assess the techniques proposed by Westinghouse to prevent and minimise production of solid radioactive waste using our internal guidance and regulatory experience;

e) carry out supporting site visits to gain knowledge to inform our decision;

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

g) decide on any assessment findings to carry forward from GDA.

21 In undertaking our assessment, we have worked closely with ONR. We have also had discussions with other Regulators; the Radiation and Nuclear Safety Authority of Finland (STUK) and the United States Nuclear Regulatory Commission (NRC).

22 As detailed in our preliminary assessment report (Environment Agency, 2008), Westinghouse's submission received in August 2007 did not contain the level of information that was needed to carry out a detailed assessment on integrated waste strategy. Therefore, as a result a Regulatory Issue (RI) was raised in February 2008.

23 In January 2009, Westinghouse provided additional information; revision 1 of its ER with supporting documents. We assessed information contained in the ER but found that while much improved from the original submission it still lacked detail on some aspects of LLW and ILW arisings. Subsequently, two Regulatory Observations (ROs) were raised jointly by the Environment Agency and ONR; one requesting a standalone strategy for waste management and the other a disposability case for spent fuel and ILW.

24 Additionally, several TQs were also raised.

25 In March 2010, Westinghouse provided an updated ER and supporting documents which included all the relevant information provided by its TQ and RO responses up until this date.

26 In December 2010, in response to a RO action we raised jointly with HSE, Westinghouse provided updated radioactive waste management case (RWMC) evidence reports for Intermediate Level Waste (ILW) and High Level Waste (HLW) that identify how their existing documentation forms the basis of a RWMC for the AP1000.

27 In December 2010, in response to a RO action we raised jointly with HSE, Westinghouse provided further information on their plan for disposability of ILW which includes the plan for long-term storage and the work being undertaken by the Radioactive Waste Management Directorate (RWMD). In March 2011, this was incorporated into a supporting document.

28 In March 2011, Westinghouse provided an updated ER and supporting documents (including an updated IWS and RWMC evidence reports for ILW and HLW) which included all the relevant information provided by its TQ and RO responses up until this date.

29 The following table provides information on the RI, ROs and TQs that were raised which are relevant to LLW and ILW:

RI/RO/TQ number and title	Reason for raising	Comments on response
RI-AP1000-0001 Information required by the Environment Agency for the detailed assessment stage	Limited information received in August 2007 submission.	Westinghouse provided a commitment (to which we assigned the unique number CM-AP1000-1) to provide information to comply with the P&ID requirements identified in the schedule to RI-AP1000-001 within several future submissions.
RO-AP1000-034 RO-AP100034.A01 RO-AP1000-034.A02 RO-AP1000-034.A03 RO-AP1000-34.A04: Integrated Waste Strategy	Limited information received in August 2007 submission and January 2009 information. Hence RO asked for a comprehensive integrated waste strategy and documentary evidence that BAT has been used.	Documentation provided.
RO-AP1000-034.A05 Integrated Waste Strategy	RO action asked for an update to the RWMC which incorporates comments from the Regulators and a review of all relevant documents that had been submitted as part of GDA since the original document was submitted, and is in line with the updates to guidance on RWMCs (HSE et al, 2010).	In December 2010, Westinghouse provided updated 'evidence reports' for ILW and HLW that identify how its existing documentation forms the basis of a RWMC for the AP1000. In March 2011, Westinghouse provided us with another update of these documents.
RO-AP1000-60 RO-AP1000-060.A01: Disposability of Spent Fuel and ILW	The Regulators consider that Westinghouse should show how and when the matters identified in the radioactive waste management directorate disposability assessments will be addressed.	The response to this RO was considered in our assessment report on disposability of ILW and spent fuel (Environment Agency, 2010b).
RO-AP1000-074 RO-AP1000-074.A01 RO-AP1000-074.A02 RO-AP1000-074.A03: Long Term Waste (Including Spent Fuel) Storage	The Regulators consider that Westinghouse should provide a plan showing when waste management facilities will be developed and constructed over the lifetime of an AP1000.	The response to this RO was considered in our assessment report on disposability of ILW and spent fuel (Environment Agency, 2010b). In March 2011, this response was incorporated into a supporting document (UKP-GW-GL-085, Long Term Storage of AP1000 NPP ILW and Spent Fuel in the UK, Revision 0).

RI/RO/TQ number and title	Reason for raising	Comments on response
RO-AP1000-074.A04 Consolidation of the plan for disposability of waste and spent fuel	RO action asked for the consolidation of the plan produced in response to RO-AP1000-60 for disposability of waste and spent fuel to include the plan for long-term storage and the work being undertaken by RWMD.	In December 2010, Westinghouse provided further information on its plan for disposability of ILW which includes the plan for long-term storage and the work being undertaken by RWMD (UN REG WEC 000452, Full Response to Regulatory Observation Action RO-AP1000-074.A4 – Consolidation of the plan for disposability of waste and spent fuel, 17/12/10). In March 2011, this was incorporated into a supporting document (UKP-GW-GL-085, Long Term Storage of AP1000 NPP ILW and Spent Fuel in the UK, Revision 0).
RO-AP1000-86 RO-AP1000-86: Health Physics and Radioactive Waste Facilities	This RO was raised by HSE because of concerns about the size of the radioactive waste facilities.	Westinghouse provided further information on the radioactive waste facilities in November 2010 (UN REG WEC 000422, Regulatory Observation RO-AP-1000-086 Health Physics and Radioactive Waste Facilities Supplement Information, 09/11/10). This has been included in UKP-GW-GL-027, Radioactive Waste Arisings, Management and Disposal, Revision 2).
TQ-AP1000-92: Disposability of AP1000 Wastes	This TQ asks for the documentation from Westinghouse's review of waste from AP1000 systems and rooms.	Documentation provided.
TQ-AP1000-91: AP1000 BAT Documentation	Limited information on BAT received in August 2007 submission and January 2009 information. Hence TQ asked for documentation from the 'optioneering workshop and BAT study'.	Documentation provided.
TQ-AP1000-139: AP1000 Spent Ion Exchange Resins	Secondary spent ion exchange resins at Sizewell B are currently disposed of as LLW. Hence TQ asks for justification that all the Westinghouse spent ion-exchange resins are ILW.	Justification that spent ion exchange resins are ILW provided, although the polishing (secondary) resin will be LLW.

RI/RO/TQ number and title	Reason for raising	Comments on response
TQ-AP1000-140: Disposability of AP1000 Low Level Waste	No information on how LLW meets the conditions for acceptance (CFA) for the disposal facility in August 2007 submission and January 2009 information. This TQ asks for evidence that the AP1000 LLW is acceptable at current disposal facilities.	No evidence provided that LLW meets CFA for the low level waste repository (LLWR). Hence, TQ-AP1000-256 raised.
TQ-AP1000-256: Disposability of AP1000 LLW at the LLWR	Since the response to TQ-AP1000-140 was unacceptable, this TQ asks for evidence that LLW meets the CFA of the LLWR.	Evidence provided that LLW meets the CFA of the LLWR.
TQ-AP1000-93: AP1000 LLW Proposed for Incineration	No information on how LLW proposed for incineration meets the CFA for available incinerators in August 2007 submission and January 2009 information. This TQ asks for evidence that the AP1000 LLW proposed for incineration is acceptable at current incinerators.	No evidence on how the fingerprint / chemical make-up of the waste proposed to be incinerated meets the CFA of currently available incinerators. Additionally, TQ response only mentions incineration of waste oils but it is stated in the response to TQ-AP1000-140 that condensate polishing resins will be incinerated. Hence TQ-AP1000-257 raised.
TQ-AP1000-257: Disposability of AP1000 LLW Oils and Condensate Polishing Resins	Since the response to TQ-AP1000-93 was unacceptable, this TQ asks for a copy of the relevant incinerator(s)'s CFA, and a commentary that demonstrates how the physical, chemical and radiological characteristics of both the waste oils and condensate polishing (CPS) resins are compatible with the incinerator(s)'s CFAs.	Evidence provided that the waste oils and CPS resins meets the CFA of an available incinerator.
TQ-AP1000-141: Solid Radioactive Waste Estimates	No evidence provided in August 2007 submission and January 2009 information on whether the solid radioactive waste estimates are realistic for the AP1000. This TQ asks for justification that the estimates are realistic.	Limited information provided. Hence, TQ-AP1000-383 raised. Additionally, the Environment Agency and HSE attended a presentation by Westinghouse in February 2010 on its processes for deriving data on radioactive wastes where further confidence was gained.

RI/RO/TQ number and title	Reason for raising	Comments on response
TQ-AP1000-167: Storage of AP1000 LLW	This TQ asks for further details (than that in the August 2007 submission and January 2009 information) on the short term buffer storage of LLW in the waste treatment building, for example, the capacity of the store.	Information provided.
TQ-AP1000-142: AP1000 ILW Decay to LLW	No information in August 2007 submission and January 2009 information. Hence, this TQ asks for information on the management of ILW that may decay to LLW during storage.	Information provided.
TQ-AP1000-255: Category and Management Arrangements for AP1000 Waste	No information on some waste streams in the August 2007 submission and January 2009 information. Hence, this TQ asks for details on the management arrangements of the following waste streams; • high-dose-rate contaminated metals, plastics, cloth, etc., that arise from outage operations; • 'sludges' arising from the cleaning of the bottoms of liquid waste treatment tanks and various sumps; • 'evaporator concentrates' (expected to be rich in boron) that might arise from operations to minimise activity release in liquid effluent.	Basic information provided.
TQ-AP1000-381: Large, Solid Radioactive Waste Items	No information received in August 2007 submission and January 2009 information. Hence this TQ asks for demonstration that large one-off items, such as reactor pressure vessel heads and steam generators that could need replacing during operation can be stored, conditioned for disposal and are disposable.	Information only provided on steam generators as Westinghouse assumes that a reactor head is not expected to require replacement during the operational period. We had expected them to consider that a reactor head may fail and hence, TQ-AP1000-406 raised.

RI/RO/TQ number and title	Reason for raising	Comments on response
TQ-AP1000-406: Reactor Pressure Vessel Head	Since the response to TQ-AP1000-381 was unacceptable, this TQ asks for demonstration that if a reactor pressure vessel head were to fail during operation, it can be stored, conditioned for disposal and is disposable.	Basic information provided.
TQ-AP1000-383: Solid Radioactive Waste Data	Since the response to TQ-AP1000-141 was unacceptable, and to provide confidence that the estimates in the August 2007 submission and January 2009 information are realistic for the AP1000 plant, further information was requested by this TQ.	Information provided. Additionally, the Environment Agency and HSE attended a presentation by Westinghouse in February 2010 on its processes for deriving data on radioactive wastes where further confidence was gained.
TQ-AP1000-1019: Multi Reactor Sites	This TQ was raised in response to a GDA consultation response on the impacts and arrangements of multi reactor sites, given that potential developers are likely to propose some at their sites.	Information provided, for example, systems related to solid radioactive waste management (for example for treatment, storage, and transportation), could be shared. This is now discussed in chapter 7 of the ER (revision 4).

3.2 Assessment objectives

30 We started our assessment with some key questions to answer:

a) Have all the sources of LLW and ILW been identified?

b) How will LLW and ILW be treated and conditioned?

c) Have all the disposal routes for LLW and ILW been identified?

d) Have the arisings of LLW and ILW been quantified?

e) Has BAT been applied to minimise the arisings of LLW and ILW?

3.3 Westinghouse documentation

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

Document reference	Title	Version number
UKP-GW-GL-790	UK AP1000 Environment Report	4
UKP-GW-GL-054	UK AP1000 Integrated Waste Strategy	1
UKP-GW-GL-026	AP1000 Nuclear Power Plant BAT Assessment	2
UKP-GW-GL-027	Radioactive Waste Arisings, Management and Disposal	2
UKP-GW-GL-012	GDA: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the Westinghouse Advanced Passive PWR (AP1000)	0
NXA/10897959	GDA: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the Westinghouse Advanced Passive PWR (AP1000) Part 1: Main Report	16/01/10
LL/10900069	GDA: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the Westinghouse Advanced Passive PWR (AP1000) Part 2: Data Sheets and Inventory Tables	15/01/10
UKP-GW-GL-057	UKAP1000 NDA Data Sheet Submission	0
UKP-GW-GL-061	Acceptability of AP1000 Waste Oil for Incineration	0
UKP-GW-GL-055	UK AP1000 Radioactive Waste Management Case Evidence Report for Intermediate Level Waste	2
UKP-GW-GL-056	UK AP1000 Radioactive Waste Management Case Evidence Report for High Level Waste	2
UKP-GW-GL-004	Process Mass Balance for AP1000 Solid Waste	1
UKP-GW-GL-058	UK AP1000 D1 Submission	0
UKP-GW-GL-039	Radwaste Treatment Options Study Report	0
UKP-GW-GL-003	Solid Waste Activity Calculation from AP1000	0
UN REG WEC 00098	GDA – Disposability Assessment for the Westinghouse Passive Pressurized Water Reactor (AP1000) – Westinghouse Electric Company Opinion	19/10/09
UKP-GW-GL-085	Long Term Storage of AP1000 NPP ILW and Spent Fuel in the UK	0

32 We use short references in this report, for example:

a) ER = Environment report;

b) IWS = AP1000 integrated waste strategy document.

3.4 Creation of solid waste

33 The sources of solid radioactive waste generated in the AP1000 are summarised in Table 3.5-1 in the ER and a detailed breakdown of the wastes can be found in Appendix A of the ER.

34 Westinghouse provides information in section 3.5.3.1 of the ER about LLW, which includes dry active wastes, general trash and mixed waste as a result of normal plant operation. Section 3.5.3.1 of the ER states that waste will generally contain: plastics, paper, metallic items, clothing, rubber, filters, redundant equipment, glass and wood.

35 In section 3.5.3.2 of the ER, Westinghouse states that ILW comprises mainly of spent ion exchange resins, activated carbon and used filters. It states that the production of these wastes is intermittent and associated with replacement and maintenance procedures.

36 The quantities of solid radioactive waste generated by the AP1000 are summarised in ER Table 3.5-1.

37 Westinghouse states in ER section 3.5.3 that the solid radioactive waste estimates in the ER are best, realistic estimates. A major source of information for its calculations was consultations with experienced personnel who have worked in the design of the AP1000 and worked on existing plants.

38 The estimated gross annual volumes of solid LLW produced during the operation and maintenance of the AP1000 is 175.6 m^3 and the estimated volume of treated LLW to be disposed of or stored per year is 72.73 m^3. Therefore, for the conditioned waste, assuming the AP1000 design is for a single, pressurised water reactor (PWR) capable of generating in total 1117 MW of electricity, the estimated volume is 65.1 m^3 per 1000 MWe plant-year of operation. We note that this figure is higher than the 54.7 m^3 quoted in our consultation document because of the design changes to the radiologically controlled area ventilation system (VAS) (see the 'Ventilation systems' section in our decision document (Environment Agency, 2011a)).

39 The estimated gross annual volumes of solid ILW produced during the operation of the AP1000 is 10.25 m^3 and the estimated volume of final solid ILW packages to be disposed of or stored per year is 40.86 m^3. Therefore, for the conditioned waste, assuming the AP1000 design is for a single, pressurised water reactor (PWR) capable of generating in total 1117 MW of electricity, the estimated volume is 36.6 m3 per 1000 MWe plant-year of operation.

40 The IWS states that solid ILW decommissioning waste will be handled in a similar way to that used for operational and maintenance waste, but with a size reduction stage incorporated to allow larger waste items (for example, structural steel) to be processed into a form that allows immobilisation.

41 The quantities and classification of decommissioning waste associated with the AP1000 are shown in Appendix A3, Appendix A4 and Appendix A6, and summarised in Table 3.5-10 of the ER. An estimated volume of LLW from decommissioning is around 5500 - 6000 m^3. An estimated volume of ILW from decommissioning is 800 m^3. A typical schematic for treatment of decommissioning waste is shown in Figure 3.5-21 of the ER.

42 The estimates in Westinghouse's submission for the volumes of operational LLW and ILW appear to be reasonable for the AP1000. These estimates were derived by Westinghouse using information from consultations with experienced personnel who have worked in the design of the AP1000 and worked on existing plants. Additionally, Westinghouse has provided a comparison of its estimated solid radioactive waste arisings against available operating plant experience in its response to TQ AP1000-383. This supplementary information provides confidence that the estimates are

realistic for the UK AP1000.

43 The Health Protection Agency (HPA) (GDA88[2]) made the following comment about the UK EPR design that is also applicable to the AP1000; the reference on the review of waste arisings at comparable reactors (Isukul, 2009) is not available in the public domain, and therefore it is difficult to compare the estimates with independently collated data. We can confirm that this reference is available via the Imperial College London library service.

44 The Committee on Medical Aspects of Radiation in the Environment (GDA130) commented that more emphasis should be placed on re-use, recycling and decontamination of waste on reaching authorisation limits, particularly for solid waste. We have not set any limits on solid radioactive waste in GDA, and we no longer set specific limits in permitting, relying on the principle that waste should be minimised at source. We agree that Westinghouse has only provided basic evidence of how it will minimise the quantities of LLW and ILW needing disposal. Hence, we require evidence during the detailed design phase that the proposed specific techniques for preventing and, where that is not possible, minimising the creation of LLW and ILW are BAT (AP1000-AF07). We also require evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT (AP1000-AF08).

45 An individual respondent (GDA14) commented that the amounts of solid wastes are small in comparison to previous UK reactors, and the conclusions seem sound.

46 The Institution of Mechanical Engineers (GDA146) notes that the annual levels for LLW and ILW exceed the European Utility Requirement but they would expect this to be resolved in the site-specific review. This is a matter that we will assess at the site-specific permitting stage.

3.5 Management and disposal of low level waste

47 In this section we cover our assessment of the management and disposal of LLW. LLW is defined in the UK as 'solid radioactive waste having a radioactive content not exceeding 4 GBq per tonne (GBq te^{-1}) of alpha or 12 GBq $te^{-1}$of beta/gamma activity', but we also consider here some liquid waste such as contaminated oils. These types of low level waste are usually suitable for disposal at the low level waste repository (LLWR) near Drigg, disposal by on or off-site incineration, or transfer off-site for recovery (for example, of metals).

48 Having minimised the overall production of radioactive waste, the application of BAT to minimise the activity in gaseous and aqueous discharges tends to transfer activity to low (and intermediate – see below) level solid waste. This is in line with the principle of preferred use of 'concentrate and contain' over 'dilute and disperse' (DECC 2009a). There is little opportunity to reduce the activity of this waste, except by decay storage when the waste contains radionuclides with short half-lives. However, the volume of LLW requiring final disposal can be reduced by using techniques such as waste sorting and segregation, compaction, incineration, removal of surface contamination, re-use and recycling.

49 We summarise below the information presented in Westinghouse's submission on the management and disposal of LLW. We assessed all this information and used the GDA process of ROs and TQs to query and expand information where necessary. The conclusions of our assessment are provided at the end of this sub-section.

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[2] 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.

50 A schematic of solid AP1000 waste management is given in Figure 3.5-2 of the ER.

51 Waste treatment of LLW is described in section 3.5.7.1 of the ER. LLW will be brought into the radwaste building and sorted to segregate the waste. Whenever possible, Westinghouse claims that waste items will be decontaminated to the extent that allows handling as conventional waste. It also states that compactable LLW items will be sorted and compacted in metal 200 litre drums and non-compactable items will be cut into pieces to allow packing into metal 200 litre drums. Additional information is provided in the following document: UKP-GW-GL-027, Radioactive Waste Arisings, Management and Disposal, Revision 2.

52 Westinghouse states in ER Section 3.5.7.1 that contaminated material that may arise from equipment replacement parts, tools and other metallic, plastics or cloth parts from outage operations would normally be classified as LLW. However, in the event that they were initially classified as ILW, the AP1000 plant includes provisions for the decontamination of these types of materials so that they can be decontaminated to a LLW category if feasible.

53 A schematic of the LLW processing in the radwaste building is given in Figure 3.5-9 of the ER.

54 In section 3.5.7.1 of the ER, Westinghouse states that full drums containing LLW will be assayed with a low resolution gamma spectroscope (LRGS) and placed into half height ISO (HHISO) containers. HHISO containers will be stored on site in the LLW buffer store before being shipped to the LLWR. Westinghouse states in its IWS that the combined capacity for HHISO containers within the buffer store and the radwaste building will provide up to two years of waste arisings. Off-site incineration is considered for certain LLW, for example, waste oil. Solid LLW disposal routes are shown in Figure 3.5-10 in the ER and a schematic of LLW oil disposal is in Figure 3.5-12 of the ER.

55 In section 3.5.1.3 of the ER, Westinghouse states that a range of appropriate options for waste treatment, such as evaporation, drying, incineration and cement encapsulation, were considered at an optioneering workshop. It documented the results of this workshop and the chosen options were substantiated. Further details of this BAT workshop that formed a part of its BAT assessment and a summary of the BAT workshop report are given in section 3.5.5 of the ER. There is a schematic of LLW options in Figure 3.5-3 of the ER. The study recommended that compaction is adopted as the design option for the treatment of LLW. There is also a schematic of the summary of the selected BAT treatment systems for ILW and LLW waste in Figure 3.5-8 of the ER.

56 Disposal of LLW is briefly discussed in section 3.5.9.1 of the ER. Westinghouse will dispose of LLW to the LLWR. Westinghouse's IWS assumes that the national LLWR is available within two years of site operations commencing.

57 Westinghouse has completed LLWR form D1s (Request for Agreement in Principle to dispose of radioactive waste at the LLWR) for each of the AP1000 LLW streams. These forms describe the nature of the process producing the waste, the type of radioactive waste generated, the physical and chemical form of the waste, and its radiological characteristics.

58 Westinghouse has provided us with signed form D1s from the LLWR, giving agreement in principle for the treatment / disposal of the following LLW:

a) Condensate polishing (CPS) resin;

b) general LLW;

c) waste oil;

d) steam generator sludge.

59 The LLWR recognises that Westinghouse's form D1 applications represent assumed

waste disposals at some point in the future and, as such, it cannot guarantee future capacity today. However, the LLWR has assessed Westinghouse's application against its current arrangements and can give agreement in principle on the basis that this waste would be suitable for treatment / disposal against its current arrangements.

60 Although form D1s have been completed for all AP1000 operational LLW (CPS resin, general LLW, waste oil and steam generator sludge), Westinghouse has identified waste streams that are likely to be suitable for incineration to minimise the waste sent to the LLWR. The CPS resin form D1 was included as a contingency, as generally they are not expected to be contaminated, and are proposed to be treated in the high temperature incinerator at Fawley. The form D1 considers the case if the resin contamination prevents it from being accepted at this incinerator.

61 Off-site incineration is also considered for waste oil as described in ER section 3.5.7.1. Waste oil will normally be non-radioactive, however, in the event of the oil becoming contaminated with radioactivity it will be shipped to an appropriate incineration facility (for example, the Tradebe Incinerator at Fawley). Westinghouse has carried out a review of this contaminated oil against the conditions of acceptance of this incinerator and shown that they can be met. However, Westinghouse states in section 3.5.7.1 that if any waste oil exceeds the radioactivity acceptance thresholds of the incinerator, it will be solidified by mobile plant before being disposed of to the LLWR. We note that we would need a BAT assessment to consider other options. We have an assessment finding on this (AP1000-AF09).

62 Westinghouse has considered the treatment and disposal of large, one-off solid radioactive waste items that could need replacing during the operation of the AP1000. It considers steam generators and reactor pressure vessel heads. Westinghouse states in section 3.5.7.1 that steam generators will be LLW and that they will be reduced in size in a temporary facility, placed in HHISO containers and sent for disposal at the LLWR. Westinghouse states in ER section 3.5.7.1 that the reactor pressure vessel head is not likely to have to be replaced during the operating lifetime but, if it is necessary, it will be treated in a similar way to steam generators.

63 In section 3.5.1.1 in the ER, Westinghouse summarises its waste minimisation strategy. It states that waste minimisation is an inherent part of waste management and that waste is minimised by:

a) the design: The AP1000 was designed with fewer valves, pipes, and other components so less waste will be generated during maintenance activities (repair and replacement) and decommissioning.

b) material selection: For example, the level of cobalt in structures is limited to limit the activation of metal components, and surfaces (including steel wall and floor surfaces) will be sealed to prevent penetration and to facilitate decontamination.

64 In section 3.5.4.1 of the ER, Westinghouse states how the basic AP1000 design principles minimise the creation of LLW during operations and decommissioning, which are:

a) good housekeeping;

b) operating procedures;

c) segregation;

d) volume reduction;

e) sealed surfaces (including steel wall and floor surfaces) to prevent penetration and to facilitate decontamination;

f) limiting the amount of material brought into containment;

g) training all staff allowed to enter radiation controlled areas;

h) providing waste facilities immediately outside of the radiation controlled areas, for

the disposal of unnecessary packaging materials;

i) providing tool stores within the reactor containment area (RCA), to prevent contamination of clean tools brought in from outside;

j) testing filter performance to ensure filters are only replaced when necessary;

k) providing radioactive waste advice on radiation work permits.

65 In section 3.5.5 of the ER, Westinghouse provides details of the BAT assessment that has been carried out on the radwaste treatment system. This addressed the waste activities from the transportation point of the 'nuclear island' through to dispatch to the ILW storage before disposal or to the LLW disposal.

66 Westinghouse states in its IWS that within the design of the AP1000, there are many features that facilitate the eventual decommissioning of the plant. For example:

a) reduced equipment numbers reduce the amount of waste that needs managing;

b) carefully selecting materials reduces activation of equipment and structure;

c) reduction in activated corrosion products by improved control of primary circuit water chemistry (pH range; 6.9-7.4) and suitable dosing regimes; for example, zinc acetate.

67 Westinghouse has provided evidence in its BAT assessment that BAT has been used to prevent and minimise at source generation of radioactive wastes for the AP1000. This includes information such as how the control of the choices of materials in contact with the primary coolant leads to a reduction in the production of corrosion products. Having reviewed this information, we accept that the AP1000 uses BAT to minimise the arisings of LLW subject to assessment finding AP1000-AF07.

68 Ingleby Barwick Town Council (GDA39) provided the following response to our consultation: '*The reduction of and handling technique of solid radioactive waste will largely depend on good housekeeping. Strict controls are required to prevent human error.*' We agree with these statements. We require evidence during the detailed design phase that the proposed specific techniques for preventing and, where that is not possible, minimising the creation of LLW and ILW are BAT. We also require evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT. These are assessment findings in our conclusions on solid radioactive waste (AP1000-AF08 and AP1000-AF09). Subject to these assessment findings, we are satisfied that the AP1000 uses BAT to minimise the arisings of LLW and ILW and uses BAT to treat and condition LLW and ILW prior to disposal.

69 Maldon Town Council (GDA51) provided the following response: '*AP1000 we note that Westinghouse has provided basic evidence only. Just implied that other plants around the world are worse. Only basic evidence provided*'. We do not expect the information on solid radioactive waste treatment to have the same level of detail as that of an existing plant or one that is undergoing decommissioning. We agree that Westinghouse has only provided basic evidence of how it will minimise the quantities of LLW and ILW needing disposal. Hence, we require evidence during the detailed design phase that the proposed specific techniques for preventing and, where that is not possible, minimising the creation of LLW and ILW are BAT (AP1000-AF08). We also require evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT (AP1000-AF09).

70 Several respondents, including the Nuclear Legacy Advisory Forum (NuLeaf) (GDA81), Somerset County Council (GDA162), Cumbria County Council (GDA167), West Somerset Council and Sedgemoor District Council (GDA155), and Suffolk County Council (GDA72) thought that we were being overly optimistic in our conclusions on LLW because of the amount of space available for disposal at the LLWR, the time it would take to site any replacement LLW disposal facilities and the

extent that landfills will become available for the disposal of VLLW. Additionally, at our stakeholder seminar, the following four questions / comments were raised: '*The adequacy and responsibility for the existing low level waste storage (off site)? What is the NDA's responsibility? What is the capacity and suitability of storage space for the new build? Concerns due to lack of planned waste storage facility.*' This is outside the scope of GDA because under the Energy Act 2004, the NDA has the responsibility for developing a UK-wide strategy for managing the UK nuclear industry's LLW.

71 Suffolk Coastal District Council (GDA165) responded to our consultation stating that it supports the response from NuLeaf (GDA81), dated 4 October 2010, given that the Council is a member of NuLeaf and has in the past expressed concerns about the arrangements for nuclear waste storage / disposal. We have addressed the response from NuLeaf in several chapters within our decision document.

72 Horizon Nuclear Power (GDA128) provided the following response with respect to the issues raised in our consultation document on LLW: '*Evidence during site-specific permitting that specific arrangements for minimising the disposals of LLW and ILW are BAT. Horizon is aware that during site-specific permitting it will need to present information to demonstrate BAT. Minimising the disposals of LLW and ILW is intimately linked with how the reactor is operated, what discharge abatement technology is deployed and what conditioning and packaging technologies are used. Minimising the quantities of waste for disposal is not something that can be targeted in isolation but will instead be a balance between a number of competing issues such as operator doses and environmental discharges.*' We agree that operators should use BAT to achieve a high degree of protection of the environment, taken as a whole and to meet the principle of optimisation.

73 West Somerset Council and Sedgemoor District Council (GDA155) made the following point in response to our consultation: '*The techniques and processes described generally appear satisfactory; however several of these, for example metal smelting and incineration, rely on the establishment and development of suitable supply chains to ensure that they can play an effective role in waste minimisation. Where these do not exist, the burden of waste management will fall entirely on disposal to GDF and LLWR*.' We note this comment but this is outside the scope of GDA. We also note that incineration and metal recycling facilities are now available.

74 Studsvik UK Ltd (GDA132) provided the following response: '*It is not clear how BAT or the Waste Management Hierarchy has been considered for all solid radioactive wastes. Treatment of metallic waste has been considered, but no facilities have been investigated or if the potential waste will fit their waste acceptance criteria*'. We agree that Westinghouse has only provided basic evidence of how it will minimise the quantities of LLW and ILW needing disposal. Our assessment findings AP1000-AF08 and AP1000-AF09 address this.

75 Several respondents, including; individual respondents (GDA26, GDA85), Nuclear Technology Subject Group of the Institution of Chemical Engineers (GDA71), Springfields Site Stakeholder Group (GDA97), and the Institution of Mechanical Engineers (GDA146) said that they were satisfied with our conclusions on solid radioactive waste.

76 ONR has raised concerns about the size of the radioactive waste facilities. Westinghouse provided further information on the radioactive waste facilities in November 2010, which has been included in UKP-GW-GL-027, Radioactive Waste Arisings, Management and Disposal, revision 2. This included revising the layout of the LLW assay systems and providing a description of the path for each type of waste entering the radwaste building to reduce cross-contamination. However, ONR considered that the amount of space allocated to radioactive waste facilities was not sufficient. Westinghouse provided an outline of a potential strategy for multi-unit sites which argues that systems related to solid radioactive waste management (for example for treatment, storage, and transportation), could be shared between the individual units. Westinghouse claimed that this would mean that better utilisation of

space could be implemented by dedicating each of the multiple radioactive waste buildings to treating specific types of waste generated across the site. For example, one radioactive waste building could include equipment to treat site compactable waste, another to package site metallic waste, and a separate building could be constructed for treating site solid radioactive waste. Alternatively, Westinghouse claimed that a separate, dedicated building could be constructed for treating solid radwaste (ERs7). ONR view these approaches as adequate for GDA; although detailed development work will be required during the detailed design phase, and have captured this as an assessment finding. We agree with ONR's finding.

77 Westinghouse UK (GDA110) said that it agrees with our preliminary conclusions and that it is committed to resolving any outstanding issues within the GDA process.

78 **We conclude that:**

a) **Westinghouse has identified all LLW waste streams that an AP1000 will typically produce.**

b) **The AP1000 uses BAT to minimise the arisings of LLW, subject to assessment finding AP1000-AF08.**

c) **The AP1000 uses BAT to treat and condition LLW prior to disposal, subject to assessment finding AP1000-AF09.**

d) **The AP1000 is not expected to produce LLW for which there is no foreseeable disposal route. Westinghouse has demonstrated that the waste streams would meet the criteria for disposal in a LLW facility or an incineration facility.**

e) **Westinghouse has provided valid estimates for the annual arisings (during operations and decommissioning) of LLW. The arisings of LLW exceed the European Utility Requirement (European Utility Requirements for LWR Nuclear Power Plants Rev C Apr 2001 (Volume 2 chapter 2, section 5.2)) objective of ≤ 50m^3 per 1000 MWe plant-year of operation, although the operational arisings are consistent with those of comparable reactors around the world (Isukul, 2009).**

3.6 Management and disposal of intermediate level waste

79 In this section we cover our assessment of the management of ILW. ILW is waste with activity levels exceeding the upper boundaries for LLW, but which does not require heat generation to be accounted for in the design of disposal or storage facilities. There are currently no final disposal facilities for ILW in the UK. However, the Government has stated (BERR 2008a) that it is satisfied that:

a) a geological disposal facility would provide a possible and desirable mechanism for disposing of higher level waste (both from a new nuclear programme and existing legacy waste);

b) there are feasible and long-term mechanisms through the Managing Radioactive Waste Safely (MRWS) (Defra et al 2008) programme for identifying a suitable site and for constructing a geological disposal facility.

80 Although a permit for final disposal may not be required for a considerable time, we expect Westinghouse to show now whether the waste:

a) is likely to be suitable for disposal in a geological repository;

b) will be appropriately managed in the interim, so as not to prejudice its ultimate disposal.

81 We summarise below the information presented in Westinghouse's submission on the management and disposal of ILW. We assessed all this information and used the GDA process of ROs and TQs to query and expand information where necessary.

The conclusions of our assessment are provided at the end of this sub-section.

82 A schematic of solid AP1000 waste management is given in Figure 3.5-2 of the ER. Waste treatment of ILW is described in section 3.5.7.2 of the ER and shown in the schematic in Figure 3.5-13.

83 ILW will be segregated on an AP1000 nuclear site in the following ways:

a) ion exchange and spent activated carbon will be monitored and sent to spent resin tanks;

b) replacement filter cartridges and any ILW filters will be placed in a Radioactive Waste Management Directorate (RWMD) approved box.

84 In section 3.5.1.3 of the ER, Westinghouse states that a range of appropriate options for waste treatment, such as evaporation, drying, incineration and cement encapsulation, was considered at an optioneering workshop. It documented the results of this workshop and the chosen options were substantiated. Further details of this BAT workshop that formed a part of its BAT assessment and a summary of the BAT workshop report are given in section 3.5.5 of the ER. There is a schematic of ILW organic resin treatment options in Figure 3.5-4 of the ER and a schematic of ILW filter treatment options in Figure 3.5-7 of the ER. There is also a schematic of the summary of selected BAT for ILW and LLW waste in Figure 3.5-8 of the ER. The solid ILW will be immobilised in a cementitious grout within a RWMD approved container (drums or boxes). Westinghouse's BAT assessment concluded that solid ILW should be encapsulated in cement, stored and ultimately disposed of to a national ILW repository.

85 Hence, the spent ion exchange resin and / or activated carbon will be immobilised in a cementitious grout formulation within a RWMD approved drum. The spent filters, etc., will be immobilised in a cementitious grout formulation within a RWMD approved box. The waste encapsulation will be carried out using a mobile encapsulation facility on a campaign basis. Westinghouse states that the ILW waste packages will be subject to monitoring checks. They also state that once the cement in the containers has set and passed quality assurance checks, they will be transported to the on-site ILW storage building. The boxes and drums will be stored here until a national ILW repository becomes available. A schematic of ILW treatment and disposal is given in Figure 3.5-13 of the ER.

86 Westinghouse states that the ILW store will be designed for a total inventory of 60 years of operational waste arisings from one AP1000 unit and it will have a 100-year design life.

87 ILW will be stored on the sites in dedicated building(s) until a final disposal site for ILW is opened in the UK.

88 Westinghouse states in ER section 3.5.8.2 that when a national ILW repository becomes available, it will monitor the waste packages before transportation. If the results of a package indicates that the radionuclides in the package have decayed such that the package could be LLW, the package will be temporarily placed in a LLW storage area. If suitable, these will be disposed of to the LLWR, which will reduce the final quantities of ILW to be disposed of. However, Westinghouse expects that all waste packages sent to the ILW store will remain ILW.

89 Disposability of operational ILW is briefly discussed in section 3.5.9.2 of the ER. In order to assess the disposability of ILW, Westinghouse provided the Nuclear Decommissioning Authority (NDA) with a datasheet for each of the AP1000 waste streams. Each datasheet included information on the nature of the waste stream, rate of arising, proposed matrix, package type, physical and chemical composition and radionuclide inventory, package heat output and external dose rate. Westinghouse has provided us with datasheets for the following operational waste types:

a) filter cartridges (ILW);

b) primary resins (ILW);

c) mixed resins (ILW).

90 Westinghouse has provided us with a datasheet for decommissioning waste.

91 Westinghouse has obtained and provided to us a view from the RWMD of the Nuclear Decommissioning Authority (NDA) (as the UK authoritative source) on the disposability of its proposed arisings of ILW. RWMD concluded that compared with legacy waste, no new issues arise that challenge the fundamental disposability of the waste expected to arise from operation of the AP1000 (See 'Westinghouse documentation' section). Westinghouse also provided the Regulators with its critique of the RWMD disposability assessment, and this is available on its website.

92 The Regulators requested Westinghouse to make a case for the disposability of spent fuel and ILW, which demonstrates the following:

a) How the issues identified in its critique of RWMD's Disposability Assessment will be addressed.

b) How the issues in Appendix B of RWMD's Disposability Assessment will be addressed.

c) How they will manage any risks associated with these issues

93 We received Westinghouse's response on 1 March 2010. We note in particular that Westinghouse has consulted with potential operators of the AP1000 on when they would expect to address issues and we recognise that, in most cases, these issues will need to be addressed by future operators of AP1000s, rather than by Westinghouse. We note that Westinghouse has consulted with potential operators of the AP1000 on when they would expect to address issues and RWMD on the stages in the LoC process at which it would expect issues to be addressed.

94 Since our consultation was published, Westinghouse has provided further information in December 2010 on its plan for disposability of ILW which includes the plan for long-term storage and the work being undertaken by RWMD (see 'Westinghouse documentation' section). The plan outlines the activities necessary to provide further confidence that ILW is disposable.

95 In general, we consider the plans proposed by Westinghouse outlining how and when it and future licensees will address the outstanding disposability issues to be adequate at this stage. We will expect these plans to be periodically refined and updated in future to reflect developments. We will expect prospective licensees to make progress on demonstrating disposability at the earliest reasonable opportunities rather than waiting for dates specified in the plan.

96 We note that Westinghouse has produced a 'RWMC Evidence Report', intended to indicate where the information that will be needed for future radioactive waste management cases (RWMCs) will come from, and when. This document gives us some assurance at this stage that RWMCs can be compiled at relevant stages in the development of an AP1000 fleet, which is sufficient at this stage of the GDA process.

97 In December 2010, Westinghouse provided an updated 'RWMC Evidence Report' for ILW, which incorporates comments from the Regulators and a review of all relevant documents that have been submitted as part of GDA since the original evidence report was submitted. The updated document gives us sufficient assurance for this stage of the GDA process that RWMCs can be compiled at relevant stages in the development of an AP1000 fleet.

98 Since our consultation, NDA has published a generic Disposal Systems Safety Case (gDSSC) for a future Geological Disposal Facility (GDF), based on its understanding of the scientific and engineering principles supporting geological disposal (RWMD, 2010). NDA has also provided a report regarding the impact of the gDSSC on its previous new build disposability assessments undertaken for RPs to support GDA submissions

(RWMD, 2011). The report concludes:

a) '*The original 2009 GDA Disposability Assessments concluded that ILW and spent fuel from operation and decommissioning of an AP1000 or EPR raised no new disposability issues when compared against legacy wastes and existing spent fuel. These assessments have been reviewed in the light of recent developments to disposal concepts and generic safety assessment methodologies as applied in the generic DSSC.*

Overall, the changes in concept, assessment methodology and assumptions regarding parameter values have only minor impacts on the findings of the original GDA Disposability Assessments. The review therefore confirms that there are no new issues arising from the generic DSSC that would challenge the fundamental disposability of the wastes and spent fuel expected to arise from operation of the AP1000 and EPR. This conclusion is supported by the similarity of the wastes to those expected to arise from the existing PWR at Sizewell B, which are included in the generic DSSC Baseline Inventory and have been found to be acceptable.'

99 We have assessed this further information on disposability from Westinghouse and its RWMC evidence report and have identified the following assessment finding: The future operator shall provide confidence that adequate RWMCs, supported by appropriate stage LoCs, can be developed for all ILW on the timescales identified in Westinghouse's plan for disposability of ILW (AP1000-AF07).

100 ONR has reviewed information on long-term storage of ILW in its Step 4 assessment. We have worked jointly with ONR throughout the GDA process in the area of solid radioactive waste and our conclusions are consistent.

101 Westinghouse states in section 3.5.4.2 of the ER that ILW will be minimised by the following activities:

a) optimum operation of the reactor in terms of power generation per tonne of fuel;

b) select fuel with minimal potential for fuel defects, thereby minimising the radioactive isotope contamination of the primary cooling water circuit. This will reduce load being treated by the ion exchange resin beds and hence the volume of ILW;

c) fuel is received and carefully inspected for any imperfections;

d) minimisation of plant shutdowns;

e) use of grey rods for mechanical shim control;

f) use of canned coolant pumps eliminates seal leaks and creation of radioactive wastewater;

g) selecting materials with a composition low in cobalt;

h) using zinc addition for corrosion control;

i) selecting ion exchange media to give optimum decontamination factor (DF), which will:

  i) minimise the number of ion exchange media changes required and reduce the waste volume;

  ii) give flexibility in routing effluent through the different ion exchange beds to optimise resin uptake.

j) testing filter performance to make sure filters are only replaced when necessary;

k) segregation procedures to prevent dilution of ILW streams by mixing them with LLW streams;

l) formulation trials to determine optimum blend ratio producing the optimum number of waste packages;

m) operating procedures.

102 Westinghouse states in its RWMC document that minimisation is an important initial step in waste management, and AP1000 operational procedures will seek to design, construct, operate, and decommission the plant in such a way that both the waste volume and radioactivity are minimised. It states that this will be achieved on the AP1000 nuclear site by activities such as:

a) optimum operation of the reactor in terms of power generation per tonne of fuel, minimise fuel defects, and hence, minimise the activity of primary cooling water circuit, which in turn, minimises volumes of spent ion exchange resin;

b) good housekeeping: for example, minimising the amount of material brought into containment;

c) selecting ion exchange media to give optimum decontamination factor, which will minimise the number of ion exchange media changes required and reduce the waste volume;

d) formulation trails to determine blend ratio producing the optimum number of waste packages;

e) operating procedures.

103 Westinghouse has provided evidence in its BAT assessment that BAT has been used to prevent and minimise at source generation of radioactive wastes for the AP1000. This includes information such as how the control of the choices of materials in contact with the primary coolant leads to a reduction in the production of corrosion products. Having reviewed this information, we accept that the AP1000 uses BAT to minimise the arisings of ILW subject to assessment finding AP1000-AF08.

104 One of the questions raised at the stakeholder seminar was: '*Disposability of waste and spent fuel – not covered adequately in consultation / public domain. What are the options and timescales?*'. Disposability of solid radioactive waste was discussed in chapter 11 of the consultation document and spent fuel in chapter 12, and subsequently in the equivalent chapters of our decision document. This included information on options and timescales but we note that additional information is available in our assessment reports. The assessment reports are published on our website. Additionally, since our consultation was published, as mentioned above, we received further information from Westinghouse on disposability in December 2010 (see 'Westinghouse documentation' section).

105 Another question raised at the stakeholder seminar, was what are the options for the storage of intermediate and high level waste, both on-site and off-site, and what are the most likely options and why. As stated above, for GDA, ILW will be stored on the sites in dedicated building(s) until a final disposal site for ILW is opened in the UK.

106 At the stakeholder seminar, the following comment was made: '*CoRWM recommended that new build waste be subjected to a separate process. This waste is of a different order, and should have its own safety case*'. It is the responsibility of the NDA to develop a safety case for any proposed geological disposal facility.

107 Blackwater Against New Nuclear Group (BANNG) (GDA113) provided the following response to our consultation: '*It is proposed to manage long-lived solid radioactive wastes (ILW) and spent fuel on site. There are two problems here. The first is that the methods of management are not specified in detail and may be subject to variation. It is assumed that wastes will eventually be disposed of in a geological repository and, in the meanwhile, will be appropriately managed. ILW will be immobilised and encapsulated and stored on site or possibly moved to another (regional or central) store until a repository becomes available. Beyond this the design details are vague and the regulators are clearly unsatisfied with the level of information provided. In the case of ILW they require 'more information on the potential for degradation of ILW over the longer term that might affect disposability and safe storage' (p.85).More information will be required on proposed storage facilities. In particular the risks to workers, the environment and to the population arising from encapsulation, waste*

transfer and transport needs to be assessed and there is precious little information on these matters. The regulators regard the management of these wastes as a key issue and will be looking in more detail at the plans in its Step 4 assessment. Indeed, it may be said that the information supplied in the consultation document is vague and far too flexible. Therefore in answer to Question 6, BANNG considers the response by the regulators to be complacent and inadequate. In our view the regulators should call for a much more detailed and robust explanation of proposed ILW storage together with details of the methods and facilities required and indicate that this should be supplied as part of the current assessment and not delayed until Step 4'. Kent Against a Radioactive Environment (KARE) (GDA148) and Bradwell for Renewable Energy (GDA122) said that they fully endorse BANNG's response to the Generic Design Assessment consultation. The Regulators received additional information from Westinghouse in December 2010 (see 'Westinghouse documentation' section) that we have assessed and this is discussed above. We note that ONR regulates nuclear safety, including the safe management, conditioning and storage of wastes on nuclear licensed sites, and DfT regulates the safe transport of radioactive material.

108 An individual respondent (GDA120) said that it is highly likely that a waste repository will never be built and the stores should be designed to fulfil all requirements on the assumption that high level waste and spent fuel will be on-site permanently. Another individual respondent (GDA136) stated that the conclusions drawn rest on the assumption that geological disposal of ILW is technically achievable and that this is at best speculative and not supported by the available evidence. Communities Against Nuclear Expansion (GDA49) said that there is no proven safe way of disposing of nuclear waste and as a result have to store it for timescales beyond the human imagination, at least ten thousand and maybe up to two hundred thousand years. West Somerset Council and Sedgemoor District Council (GDA155) said that they are concerned with potential risks associated with the delay and delivery of the GDF programme, which runs the risk of continued need for on-site ILW and spent fuel stores until an ultimate disposal route is established. Additionally, at our stakeholder seminar, concerns about the GDF and the fall back for the storage for the lifetime of waste if the GDF falls through were raised. Another individual respondent (GDA14) raised similar concerns: '*Westinghouse's radioactive waste and spent fuel strategy does all it can do within the boundaries and uncertainties of UK policy and waste facilities. This would, in the event that multiple new build reactors are commissioned and the GDF programme is unchanged or delayed, run the risk of several / many isolated waste and spent fuel stores on otherwise decommissioned reactor sites. Some form of centralised UK waste storage would probably be more optimal for many points of view - but there is time for such optimisation to be considered.*' Nuclear Waste Advisory Associates (NWAA) (GDA134) and the UK and Ireland Nuclear Free Local Authorities (NFLA) (GDA83), both provided the following point in the conclusions of their responses and the Nuclear Consultation Group (GDA150) quoted this from NFLA: '*At present it is quite apparent the nuclear industry would not be able to dispose of new build reactor wastes safely. It would be wholly irresponsible to wait until such wastes are created to confirm this. Unless and until the nuclear industry are able to demonstrate that new reactor wastes could be disposed of safely there should be no further steps taken towards the development of new reactors.*' They also quoted this from Blackwater Against New Nuclear Group: '*Regulators must suspend the GDA process until such time as there is adequate information provided on how the wastes arising from new build will be managed and there is in place a long-term management solution that is scientifically robust and socially acceptable*.' A similar comment from our stakeholder seminar was: '*Concern with the whole waste management issue – GDA fails to consider adequately waste management – has no answers – relies on disposal / repository being available – not certain? The concept of a central store is new – what does this mean?*'

109 Government considered the issue as to whether ILW and spent fuel should be created by new reactors prior to the availability of a GDF when it consulted on energy policy. We note that DECC has published its response to the consultation on the Draft

National Policy Statements (NPS) for Energy Infrastructure. With respect to radioactive waste management, DECC had asked the following question in its consultation: Do you agree with the Government's preliminary conclusion that effective arrangements will exist to manage and dispose of the waste that will be produced by new nuclear power stations in the UK? Having considered carefully the responses to this question, the Government has concluded that it is satisfied with the preliminary conclusion set out in the draft NPS. The Nuclear NPS confirms that the Government is satisfied that effective arrangements will exist to manage and dispose of the waste that will be produced by new nuclear power stations in the UK. We note that CoRWM have said that the Government must judge whether all the arrangements will exist by the time they are needed (CoRWM, 2010). We also note that the Government base case for new build is that a facility for long-term storage of high level waste and spent fuel will be available in time to receive the wastes from new reactor build. With respect to the comment on a central store, this is outside the scope of GDA.

110 Studsvik UK Ltd (GDA132) provided the following response: '*Incineration or grouting of ion-exchange resin can not 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.*' We require evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of ILW before disposal are BAT. This is an assessment finding in our conclusions on solid radioactive waste. Additionally, Westinghouse has considered controlled oxidation (for example steam reforming) in its Radwaste Treatment Options Study Report (see 'Westinghouse documentation' section).

111 Nuclear Waste Advisory Associates (GDA134) and the UK and Ireland Nuclear Free Local Authorities (GDA83), both provided the following comment on radioactive carbon in ILW in their responses: '*Work by Nirex has indicated that carbon from a nuclear disposal facility could escape as radioactive methane gas and carbon dioxide. This would be able to quickly reach people at the surface. Nirex have calculated the resultant risk could be as high as 100 times the allowable limit as soon as the dump has been closed. There would be a relatively large inventory of radioactive carbon in decommissioning waste. The NDA's Radioactive Waste Management Division (RWMD) says this need not be a significant concern. The EA says these arguments are rather speculative at this stage and will need to be underpinned more convincingly. Yet EA recognise the NDA is unlikely to have more confidence in their risk estimates associated with radioactive carbon in repository-generated gases before a site for the GDF has been selected. So there will be a continuance along the road of new reactor construction before there is knowledge of whether or not waste containing radioactive carbon can be 'disposed' of safely*'. We agree that this matter needs to be resolved, but on the balance of the evidence to date we see no compelling reason to conclude that it cannot be resolved. The details of gas migration from the GDF – which will determine the impact – are expected to be very site-dependent and so can only really be addressed when a site has been identified.

112 The UK and Ireland Nuclear Free Local Authorities (GDA83) provided the following comment on waste in their response and the Nuclear Waste Advisory Associates (GDA134) and Greenpeace (GDA152) provided very similar ones: '*Information from the nuclear industry on the 'disposal' of waste from new reactors is available in several reports. However, at Section 3.3 of the EA assessment reports on the disposability of ILW and spent fuel, a number of unspecified issues are referred to that the EA has raised with the nuclear industry. Neither the issues – nor the industry response is made available to the Public. The Agency states that it recognises these issues will have to be addressed at some unspecified point in the future, but that in general they consider plans for dealing with them are adequate. In the NFLA view, this kind of 'pretend' consultation is unacceptable. It makes it difficult to fully respond to the consultation without knowing this important information – what are the unspecified issues?* ' Section 3.3 of the disposability assessment report does not refer to any issues '*that the EA has raised with the nuclear industry*' – this section refers to the

issues RWMD have raised in Appendix B of their disposability assessment and to a few additional issues raised by Westinghouse in its critique of the disposability assessment. Westinghouse now has the full disposability assessment, including Appendix B and its critique (opinion) on its web site.

113 Nuclear Waste Advisory Associates (GDA134) and the UK and Ireland Nuclear Free Local Authorities (GDA83), both provided the following comment on waste in their responses: '*To predict the contamination of water or gas that could leak from a nuclear disposal facility, the chemical characteristics and surroundings of the radioactive atoms must be known. However, inventory information set out in the NDA 'Disposability Assessment' reports is limited to information on the 'atom type' (the 'isotopes') alone – not the characteristics and chemical surrounding of these atoms. The critical importance of this type of information may be appreciated by comparing the solubility of carbon in a diamond and carbon in sugar. In one chemical form the carbon will not dissolve at all – whilst in the other form the carbon is completely soluble. Although there is some mention in the Disposability Assessments of the presence of materials such concrete and cellulose that would affect the chemical environment, to all intents and purposes, the information required is simply absent. Therefore, there is no way in which the NDA would be able to realistically predict how contaminated the leaks for a nuclear dump would be. This means their risk calculations do not reflect the reality.*' RWMD's assessments of post-closure impact from disposed wastes are based on assumptions about the physical and chemical forms of waste, which are in turn based on knowledge of the materials making up the wastes and their proposed conditioning and packaging. Potential release rates of radionuclides from the wastes, either in groundwater or as gases, are estimated from either detailed modelling of the evolution of the chemical environment of the GDF (based on the expected materials and conditions) or on simplified – generally pessimistic – models informed by more complex analysis of the chemistry. The behaviour of radionuclides in solution in groundwater or as a gas also takes account of the chemistry, and where there is real doubt about the chemical form, the form leading to the highest impact is typically assumed.

114 The UK and Ireland Nuclear Free Local Authorities (GDA83) provided the following comments on waste disposal in their response and the Nuclear Waste Advisory Associates (GDA134) provided very similar ones:

a) '*The EA has set a limit on the risk that may be caused by the burial of radioactive wastes of 10-6 yr^{-1} (i.e. one person in a million per year contracting a fatal cancer, a non-fatal cancer or inherited genetic defect as a result of radiation exposure). In comparison the NDA calculates the dose from the spent fuel arising from 6 new EPR reactors (almost 10GW) would be more than half this total risk. As the Agency points out: "...this does not leave a large margin to the regulatory risk guidance level". The (November 2009) Draft "Nuclear National Policy Statement" (27) proposed ten reactors sites, each with up to two reactors. Thus, in addition to current wastes, the wastes from up to 20 new reactors would need to be considered. The assumption that the nuclear industry may meet the regulatory target of a 'one in a million' risk simply by beginning the construction of an additional disposal facility cannot be legitimate. A second dump would result in double the original dose – even if this was spread geographically. It should also be noted that a large number of problems have been identified with the NDA's disposal project indicating that the NDA dose figures represent an extreme underestimate. For example, in March 2010 Nuclear Waste Advisory Associates (NWAA) compiled a register of current technical issues which remain to be resolved if a technical case for radioactive waste disposal is to be made. Over one hundred issues were identified. The EA simply states that: "At the time of disposal it will need to be confirmed by the GDF [disposal facility] licensee that the performance of the GDF with its whole inventory will be consistent with our risk guidance level". At present it is quite apparent the nuclear industry would not be able to 'dispose' of new build reactor wastes safely. It would be wholly*

irresponsible to wait until such wastes are created to confirm this. Unless and until the nuclear industry are able to demonstrate that new reactor wastes could be disposed of safely there should be no further steps taken towards the development of new reactors.'

b) *'The Environment Agency's 'generic' evaluation of new reactor wastes prior to construction is meant to avoid a similar situation re-occurring. The Government says that potential new reactor developers have made clear they want national issues to be dealt with in advance of a public inquiry otherwise they will not consider investing in new nuclear power stations. Similarly, the Environment Agency says a key objective of utility companies is that uncertainties associated with regulatory matters are reduced so they can make well informed commercial decisions. The Environment Agency oversees waste issues associated with the nuclear industry, including nuclear waste 'disposal'. The NFLA would have been expected, therefore, that the Agency would look in some detail at the disposability of spent fuel from new reactors. The NDA's Radioactive Waste Management Division (RWMD) has produced reports on behalf of the nuclear industry on the disposability of nuclear waste and spent fuel arising from both EPR and AP1000 reactors. The nuclear vendors, or Requesting Parties (RPs) as they are known, responded to RWMD's Disposability Assessments. Yet the EA's consideration of this issue in the Consultation Document covers just seven out of over 170 pages. The report highlights several technical issues that are not fully resolved. Crucially, the EA has already stated that it is not known whether or not it will be possible to safely 'dispose' of waste fuel. But, in effect, the Agency postpones these outstanding disposability issues to some unspecified time in the future. The EA has produced additional 'assessment' reports on waste fuel and also the disposability of Intermediate Level Wastes (ILW) and waste fuel. These reports also indicate the EA plans to postpone the question of whether or not safe disposal is achievable. The EA states that it expects EDF: "...to identify at least one complete credible route by which the higher activity wastes from a fleet of UK EPRs could be safely disposed of and to provide grounds for reasonable confidence that the route(s) could be followed successfully." It is difficult to see how such a 'credible route' can be identified at this stage when the NDA's RWMD has yet to publish its draft safety case for the GDF, and when there are so many unresolved uncertainties regarding the deep geological disposal of nuclear waste. The fact that the outcome of future research may be that wastes cannot be 'disposed' of safely has been referred to extensively by the EA. It is imperative this issue is resolved prior to the expenditure of billions of pounds on reactor construction. If the nuclear industry is not required to prove they have a safe disposal route for wastes until after the planned reactors are built, then a powerful financial momentum would be created towards allowing the reactors to operate – and so produce waste fuel for which there was no long term safe management route. This should be a 'deal-breaker' for new reactors yet the EA simply chooses to postpone the problem until some unspecified time in the future. This is wholly irresponsible.'*

c) *'For both types of reactor, the EA propose to issue an interim certificate to state the designs are 'acceptable' – pending the resolution, at some stage, of the 'disposability' issue. What the NDA's has called "disposability assessments" were relied upon by the Government to reach the conclusion that it was "satisfied that effective arrangements will exist to manage and dispose of the waste that will be produced from new nuclear power stations." The NDA argues that – because it would not be able to use a site for disposal unless it was approved by the regulators, then - necessarily - the chosen site would meet regulatory standards. Of course, this argument does not follow. It is possible the NDA could select a site, but be unable to meet the necessary standards. There has been a precedent for this in the rejection of the site proposed in the 1990s, partly for generic technical reasons, but partly for site-specific reasons. In March 2010, the House of Commons Energy and Climate Change Select Committee stated: "…the*

Government has no choice but to find a solution [for nuclear wastes], regardless of a decision on nuclear new build [and] waste arising from new nuclear power stations will not pose a significant additional challenge in terms of finding a permanent storage solution." This 'King Canute' argument that because the waste problem exists, the Government must be able to solve it, similarly makes no sense. Clearly, just because radioactive waste exists, it does not necessarily follow that it will be possible to safely dispose of it. The EA must make it clear that it rejects both of these arguments. There is no safe disposal route available for new reactor wastes, therefore the Agency must refuse to authorise its creation.'

d) *'The EA Assessment Reports fail to fully analyse the NDA's 'Disposability Assessment' reports and the Requesting Parties responses. Instead they postpone dealing with outstanding disposability issues to some unspecified time in the future. This is unacceptable.'*

e) *'The consultation documents fail to acknowledge other work by the EA which states that it is possible that an acceptable safety case for a GDF cannot be made.'* The Nuclear Consultation Group (GDA150) also quoted this from NFLA.

115 We are familiar with the NWAA's list of issues, and aware that RWMD are discussing with NWAA their responses to them, and we have ourselves raised many issues with Nirex and RWMD over the years. As stated above, the Nuclear NPS confirms that the Government is satisfied that effective arrangements will exist to manage and dispose of the waste that will be produced by new nuclear power stations in the UK. We also note that the Government base case for new build is that a facility for long term storage of high level waste and spent fuel will be available in time to receive the wastes from new reactor build. As also mentioned above, we have received additional information from Westinghouse in December 2010 (see 'Westinghouse documentation' section). We have assessed this further information and have identified the following assessment finding: The future operator shall provide confidence that adequate RWMCs, supported by appropriate stage LoCs, can be developed for all ILW on the timescales identified in Westinghouse's plan for disposability of ILW (AP1000-AF07).

116 The Institution of Mechanical Engineers (GDA146) provided the following response to our consultation: '*Notwithstanding that the Generic Design Assessment is not intended to cover Site Specific Issues the potential for adjacent nuclear facilities to provide storage of radioactive waste and monitoring of radioactive waste discharges should be recognised.*' Adjacent facilities are outside the scope of GDA. However, we would encourage operators to work with adjacent operators where they exist to reuse existing facilities.

117 Horizon Nuclear Power (GDA128) provided the following response with respect to the issues raised in our consultation document on ILW:

a) *'The disposability of ILW following longer term interim storage. We are confident that it will be possible to conclude that ILW can be safely stored over the longer term and that it will then be possible to dispose of it. Many thousands of packages of legacy ILW at Nuclear Decommissioning Authority (NDA) owned sites have already been prepared with the expectation that these will be disposable and the NDA / Radioactive Waste Management Division (RWMD) has issued Letters of Compliance to provide confidence that this will be the case. Horizon recognises that it will need to continue to engage with the RWMD to obtain appropriate Letters of Compliance for our site specific proposals'.*

b) *'Evidence during site-specific permitting that specific arrangements for minimising the disposals of LLW and ILW are BAT: Horizon is aware that during site-specific permitting it will need to present information to demonstrate BAT. Minimising the disposals of LLW and ILW is intimately linked with how the reactor is operated, what discharge abatement technology is deployed and what conditioning and packaging technologies are used. Minimising the quantities of waste for disposal*

is not something that can be targeted in isolation but will instead be a balance between a number of competing issues such as operator doses and environmental discharges.'

118 The Regulators received additional information from Westinghouse in December 2010 (see 'Westinghouse documentation' section) that we have assessed and this is discussed above. We agree that operators should use BAT to achieve a high degree of protection of the environment, taken as a whole and to meet the principle of optimisation.

119 Several respondents, including; individual respondents (GDA26, GDA85), Nuclear Technology Subject Group of the Institution of Chemical Engineers (GDA71), Springfields Site Stakeholder Group (GDA97), Horizon Nuclear Power (GDA128) and the Institution of Mechanical Engineers (GDA146) said that they were satisfied with our conclusions on solid radioactive waste.

120 The Nuclear Technology Subject Group of the Institution of Chemical Engineers (GDA71) noted that the uncertainty regarding disposability of long-term stored ILW is a generic UK issue rather than a design specific or site-specific issue.

121 The Institution of Mechanical Engineers (GDA146) said that they fully support the requirement for a disposability assessment of ILW following longer term interim storage pending disposal as the uncertainty surrounding the ILWR means we must have assurance of the efficacy of long term interim storage. Again, as stated above, the Regulators received additional information from Westinghouse in December 2010 (see 'Westinghouse documentation' section) that we have assessed and this is discussed above.

122 We note that ONR has an assessment finding on the operator to undertake a site-specific optimisation process for the conditioning of ILW; any associated short-term storage of the ILW; and the potential revisions to the radwaste building. It also has an assessment finding on the operator to produce a pre-construction safety report for the new waste management facilities. We support these assessment findings.

123 As mentioned above, in our sections on LLW, ONR has raised concerns about the size of the radioactive waste facilities. We agree with ONR's finding on this matter.

124 Westinghouse UK (GDA110) said that it agrees with our preliminary conclusions and that it is committed to resolving any outstanding issues within the GDA process.

125 Westinghouse has provided valid estimates for the annual arisings (during operations and decommissioning) of ILW. The arisings of ILW exceed the European Utility Requirement (European Utility Requirements for LWR Nuclear Power Plants Rev C Apr 2001 (Volume 2 chapter 2, section 5.2)) objective of ≤ 50m^3 per 1000 MWe plant-year of operation, although the operational arisings are consistent with those of comparable reactors around the world (Isukul, 2009).

126 **We conclude that:**

a) **Westinghouse has identified all ILW waste streams that an AP1000 will typically produce.**

b) **The AP1000 uses BAT to minimise the arisings of ILW, subject to assessment finding AP1000-AF08.**

c) **The AP1000 uses BAT to treat and condition ILW prior to disposal, subject to assessment finding AP1000-AF09.**

d) **On the basis of the information provided for GDA, we see no reason at this stage to believe that any of the ILW from a UK EPRs will not be disposable in a suitably designed and located GDF. The AP1000 is not expected to produce ILW for which there is no foreseeable disposal route.**

e) **In due course, we will need to see more definitive assessments to confirm how all of the ILW will be conditioned for disposal, that the selected**

conditioning methods represent the application of BAT, and that in their conditioned forms the ILW will continue to be disposable. Our conclusion is, therefore, subject to an Assessment Finding

i) The future operator shall provide confidence that adequate RWMCs, supported by appropriate stage LoCs, can be developed for all ILW on the timescales identified in Westinghouse's plan for disposability of ILW (AP1000-AF07).

3.7 Supporting visits

127 The ER and supporting documents identify a number of options for operating the AP1000 that are relevant to our assessment on LLW and ILW. However, the prospective operator will choose the actual method of operation. Therefore, to help substantiate the claims made about the different methodologies, we made a number of site visits.

128 During GDA, sites were visited in France, Germany, Sweden, UK and USA. On these sites, the operation of the waste management facilities, training and maintenance facilities, decommissioning activities, spent fuel pool operations and mobile plant was observed. We have used the knowledge gained to inform our assessment for the AP1000.

129 The visits were successful in establishing that different operational approaches can be successfully implemented.

3.8 Compliance with our REPs

130 The following REPs were considered in our assessment of Westinghouse's LLW and ILW:

a) Principle RSMDP3 – Use of BAT to minimise waste: The best available techniques should be used to ensure that production of radioactive waste is prevented and where that is not practicable minimised with regard to activity and quantity.

b) Principle RSMDP8 – Segregation of wastes: The best available techniques should be used to prevent the mixing of radioactive substances with other materials, including other radioactive substances, which might where such mixing compromise subsequent effective management or increase environmental impacts or risks.

c) Principle RSMDP9 – Characterisation: Radioactive substances should be characterised using the best available techniques so as to facilitate their subsequent management, including waste disposal.

d) Principle RSMDP10 – Storage: Radioactive substances should be stored using the best available techniques so that their environmental risk and environmental impact are minimised and that subsequent management, including disposal is facilitated.

e) Principle RSMPD15 – Requirements and conditions for disposal of wastes: Requirements and conditions that properly protect people and the environment should be set out and imposed for disposal of radioactive waste. Disposal of radioactive waste should comply with imposed requirements and conditions.

131 The table below summarises whether these REPs have been addressed in Westinghouse's submission:

REP number	REP title & Information in submission
RSMDP3	**Use of BAT to minimise waste** See descriptions in 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. Westinghouse has provided basic evidence of how it will minimise the quantities of LLW and ILW needing disposal. This includes appropriate characterisation and segregation. The AP1000 uses BAT to minimise the arisings of LLW and ILW, and to treat and condition LLW and ILW prior to disposal. However, during the detailed design phase, the future operator shall provide evidence that the proposed specific techniques for preventing and, where that is not possible minimising the creation of LLW and ILW are BAT (AP1000-AF08) and that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT (AP1000-AF09). We accept that LLW and ILW will be treated and conditioned using proven and recognised techniques.
RSMDP8	**Segregation of wastes** Westinghouse state in section 3.5.7.1 of the ER that LLW will be brought into the radwaste building and sorted to segregate the waste. Whenever possible, Westinghouse claims that waste items will be decontaminated to the extent that allows free release and handling as conventional waste. They also state that compactable LLW items will be sorted and compacted in metal 200 litre drums and non-compactable items will be cut into pieces to allow packing into metal 200 litre drums. With respect to large one-off items, Westinghouse states in section 3.5.7.1 that steam generators will be LLW and that they will be reduced in size in a temporary facility, placed in HHISO containers and sent for disposal at the LLWR. Westinghouse states in ER section 3.5.7.1 that the reactor pressure vessel head is not likely to have to be replaced during the operating lifetime but, if it is necessary, it will be treated in a similar way to steam generators. Westinghouse state in section 3.5.7.2 of the ER and shows in the schematic in Figure 3.5-13 that ILW will be segregated on an AP1000 nuclear site in the following ways: • Ion exchange and spent activated carbon will be monitored and sent to spent resin tanks. • Replacement filter cartridges and any ILW filters will be placed in a RWMD approved box.
RSMDP9	**Characterisation** See 'RSMDP3' and 'RSMDP8' above.
RSMDP10	**Storage** See descriptions in 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. Westinghouse has described its buffer storage arrangements for LLW and its storage arrangements for ILW prior to disposal.

REP number	REP title & Information in submission
RSMPD15	**Requirements and conditions for disposal of wastes** See descriptions in 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. The design is not expected to produce LLW for which there is no foreseeable disposal route. Westinghouse has demonstrated that the waste streams would meet the criteria for disposal in a LLW facility or an incineration facility. The design is not expected to produce ILW for which there is no foreseeable disposal route. ONR has reviewed information on long-term storage of ILW in its Step 4 assessment. Westinghouse has obtained and provided a view from the NDA (as the UK authoritative source in providing such advice) on the disposability of its proposed arisings of ILW. RWMD concluded that compared with legacy wastes, no new issues arise that challenge the fundamental disposability of the wastes expected to arise from operation of the AP1000. The future operator shall provide confidence that adequate RWMCs, supported by appropriate stage LoCs, can be developed for all ILW on the timescales identified in Westinghouse's plan for disposability of ILW (AP1000-AF06). Further information on the disposability of ILW can be found in our assessment report on disposability of ILW and spent fuel (Environment Agency, 2011d).

3.9 Compliance with Table 1 in our Process and Information Document

132 Sections 2.1, 2.4 and 1.5 in Table 1 of the P&ID were considered in our assessment of Westinghouse's LLW and ILW. The table below summarises whether these requirements have been addressed in Westinghouse's submission:

Section number	Description of requirement & Information in submission
2.1	**A description of how radioactive wastes will arise, be managed and disposed of throughout the facility's lifecycle.** See 'Creation of solid waste' section above. This shows that Westinghouse has provided a description of how radioactive solid wastes will arise. All LLW and ILW waste streams that an AP1000 will typically produce have been identified by Westinghouse. See 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. This shows that Westinghouse has provided a description of how radioactive solid wastes will be managed and disposed of. The design is not expected to produce LLW for which there is no foreseeable disposal route. Westinghouse has demonstrated that the waste streams would meet the criteria for disposal in a LLW facility or an incineration facility. The design is not expected to produce ILW for which there is no foreseeable disposal route. ONR has reviewed information on long-term storage of ILW in its Step 4 assessment. Westinghouse has obtained and provided a view from the NDA (as the UK authoritative source in providing such advice) on the disposability of their proposed arisings of ILW. RWMD concluded that compared with legacy wastes, no new issues arise that challenge the fundamental disposability of the wastes expected to arise from operation of the AP1000. The future operator shall provide confidence that adequate RWMCs, supported by appropriate stage LoCs, can be developed for all ILW on the timescales identified in Westinghouse's plan for disposability of ILW (AP1000-AF06). Further information on the disposability of ILW can be found in our assessment report on disposability of ILW and spent fuel (Environment Agency, 2011d). Westinghouse has considered decommissioning radioactive solid waste.

Section number	Description of requirement & Information in submission
2.4	**Design basis estimates and substantiation of annual arisings of solid radioactive waste during operation and decommissioning. Wastes should be identified in terms of category (HLW, ILW, LLW), physico-chemical characteristics and proposed disposal route (if any). Quantification should be in terms of activity of key individual radionuclides and overall groupings of radionuclides (e.g. total alpha), mass and volumes.** See 'Creation of solid waste', 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. This shows that Westinghouse has provided estimates of annual arisings of solid radioactive waste during operation and decommissioning. Wastes have been identified in terms of category, physico-chemical characteristics and proposed disposal route. Quantification is in terms of activity of key individual radionuclides and overall groupings of radionuclides (e.g. total alpha), mass and volumes. The estimates in Westinghouse's submission for the volumes of LLW and ILW are reasonable for the AP1000. These estimates were derived by Westinghouse using information from consultations with experienced personnel who have worked in the design of the AP1000 and worked on existing plants. Additionally, Westinghouse has provided a comparison of its estimated solid radioactive waste arisings against available operating plant experience in its response to TQ-AP1000-383. This supplementary information provides confidence that the estimates are realistic for the UK AP1000. Additionally, the Environment Agency and HSE attended a presentation by Westinghouse in February 2010 on its processes for deriving data on radioactive wastes where further confidence was gained. These arisings of LLW and ILW are consistent with those of comparable reactors around the world (Isukul, 2009). However, the arisings of LLW and ILW exceed the European Utility Requirement objective of less than ≤ 50 m^3 per 1000 MWe plant-year of operation (EUR, 2001).
2.4	**The requesting party should obtain, and provide, a view from the Nuclear Decommissioning Authority (NDA) (as the UK authoritative source in providing such advice) on the disposability of any proposed arisings of ILW.** See descriptions in 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. Westinghouse has obtained and provided a view from the NDA (as the UK authoritative source in providing such advice) on the disposability of its proposed arisings of ILW. RWMD concluded that compared with legacy wastes, no new issues arise that challenge the fundamental disposability of the wastes expected to arise from operation of the AP1000. Further information on the disposability of ILW can be found in our assessment report on disposability of ILW and spent fuel (Environment Agency, 2011d).

Section number	Description of requirement & Information in submission
1.5	**An analysis should be provided that includes an evaluation of options considered and shows that the best available techniques will be used to minimise the production and discharge or disposal of waste.** See descriptions in 'Management and disposal of low level waste' and 'Management and disposal of intermediate level waste' sections above. Westinghouse has provided basic evidence of how it will minimise the quantities of LLW and ILW needing disposal. This includes appropriate characterisation and segregation. The AP1000 uses BAT to minimise the arisings of LLW and ILW, and to treat and condition LLW and ILW prior to disposal. However, during the detailed design phase, the future operator shall provide evidence that the proposed specific techniques for preventing and, where that is not possible minimising the creation of LLW and ILW are BAT (AP1000-AF08) and that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT (AP1000-AF09). We accept that LLW and ILW will be treated and conditioned using proven and recognised techniques.

4 Public comments

133 The public involvement process remained open during our detailed assessment stage (see http://www.hse.gov.uk/newreactors/publicinvolvement.htm). We did not receive any public comments on LLW and ILW by this route.

134 Responses made to our public consultation for the AP1000 design in regard to our preliminary conclusions on LLW and ILW are considered herein and in our decision document, where relevant.

5 Conclusion

135 Our conclusions are unchanged since our consultation, however, we have reworded our assessment findings and added an additional one on arisings of LLW and ILW.

136 **We conclude that:**

a) **Westinghouse has identified all LLW and ILW waste streams that an AP1000 will typically produce.**

b) **The AP1000 uses BAT to minimise the arisings of LLW and ILW, subject to assessment finding AP1000-AF08.** Prior to consultation we only proposed an assessment finding relating to the disposal of LLW and ILW (UK AP1000-AF09, below).

c) **The AP1000 uses BAT to treat and condition LLW and ILW prior to disposal, subject to assessment finding AP1000-AF09.**

d) **The AP1000 is not expected to produce LLW or ILW for which there is no foreseeable disposal route.**

e) **Westinghouse has provided valid estimates for the annual arisings (during operations and decommissioning) of LLW and ILW. These arisings (during operations) are consistent with those of comparable reactors around the world (Isukul, 2009).**

137 As part of our assessment, we identified the following assessment findings:

a) 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 Westinghouse's plan for disposability of ILW (AP1000-AF07).

b) 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 intermediate level waste (ILW) are the best available techniques (BAT) (AP1000-AF08).

c) The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of low level waste (LLW) and intermediate level waste (ILW) before disposal are the best available techniques (BAT) (AP1000-AF09).

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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

AP1000™	AP1000 is trademark of Westinghouse Electric Company LLC
BAT	Best available techniques
CFA	Conditions for acceptance
CPS	Condensate polishing
DF	Decontamination factor
ER	UK AP1000 environment report
ERs*.*	Environment report section reference e.g. 3.2.2.2
GDA	Generic design assessment
GDF	Geological disposal facility
HHISO	Half height ISO
HLW	High level waste
HSE	The Health and Safety Executive
ILW	Intermediate level waste
IWS	AP1000 integrated waste strategy document
LLW	Low level waste
LLWR	The national Low level waste repository, near Drigg, Cumbria
LRGS	Low resolution gamma spectroscope
MRWS	Managing Radioactive Waste Safely
NDA	Nuclear Decommissioning Authority
NRC	The United States Nuclear Regulatory Commission
ONR	Office for Nuclear Regulation, an Agency of the HSE (formerly HSE's Nuclear Directorate)
P&ID	Process and information document
PWR	Pressurised water reactor
RCA	Reactor containment area
REPs	Radioactive substances environmental principles
RI	Regulatory issue
RO	Regulatory observation
RP	Requesting party
RWMC	Radioactive waste management case
RWMD	Radioactive Waste Management Directorate (of NDA)
STUK	Säteilyturvakeskus - The Radiation and Nuclear Safety Authority of Finland
TQ	Technical query
WEC	Westinghouse Electric Company LLC

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