

Generic Design Assessment – New Civil Reactor Build
Step 4 Cross-cutting Topics Assessment of the Westinghouse AP1000[®] Reactor

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PREFACE

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 (ND) and has the same role. Any references in this document to Nuclear Directorate, ND, Nuclear Installations Inspectorate (NII), or NII should be taken as references to ONR.

The assessments supporting this report, undertaken as part of our Generic Design Assessment (GDA) process, and the submissions made by Westinghouse relating to the AP1000[®] reactor design, were established prior to the events at Fukushima, Japan. As a result, consequent on the Fukushima accident in March 2011, ONR has raised a further GDA Issue on Westinghouse to address any lessons to be learnt for the generic design. GDA Issue **GI-AP1000-CC-03** requests Westinghouse to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including from Westinghouse's internal reviews and from those lessons and recommendations that are identified in the ONR Chief Inspector's interim and final reports. This GDA Issue and its actions are detailed in Annex 2 of this report and are available on the HSE website at www.hse.gov.uk/newreactors/index.htm.

EXECUTIVE SUMMARY

This report presents the findings of the Cross-cutting Topics assessment of the AP1000 reactor undertaken as part of Step 4 of the Health and Safety Executive's Generic Design Assessment carried out by the Nuclear Directorate of the Health and Safety Executive. The assessment has been carried out on the December 2009 Pre-construction Safety Report and supporting documentation submitted by Westinghouse during Step 4.

This assessment has followed a step-wise-approach in a claims-argument-evidence hierarchy. In Step 2 the claims made by Westinghouse were examined, in Step 3 the arguments that underpin those claims were examined.

The scope of the Step 4 assessment was to review the safety aspects of the AP1000 reactor in greater detail, by examining the evidence, supporting arguments and claims made in the safety documentation, building on the assessments already carried out for Steps 2 and 3, and to make a judgement on the adequacy of the Cross-cutting Topics information contained within the December 2009 Pre-construction Safety Report and supporting documentation.

My Step 4 assessment was based on my assessment of the December 2009 Pre-construction Safety Report, the European DCD and Westinghouse's responses to Technical Queries and Regulatory Observations contained in the Master Submission List and the design reference documentation. The December 2009 Pre-construction Safety Report was found to have significant shortfalls in terms of content and quality. Recognising the shortfalls with the December 2009 Pre-construction Safety Report, Westinghouse submitted a replacement draft Pre-construction Safety Report in December 2010, which extensively restructured and enhanced the December 2009 Pre-construction Safety Report in order to address Nuclear Directorate's concerns. Westinghouse then submitted a formally approved version of the draft Pre-construction Safety Report in March 2011, but this was too late for a meaningful assessment during Step 4. Notwithstanding the Generic Design Assessment Issues raised within my assessment, I have no fundamental reasons to believe that Westinghouse can not produce an adequate Pre-construction Safety Report to support their Generic Design Assessment application, based on the information I have reviewed. I will need to assess a revised Pre-construction Safety Report, which Westinghouse must provide as part of a Cross-cutting Generic Design Assessment Issue which may be a further update to the March 2011 Pre-construction Safety Report.

It is seldom possible, or necessary, to assess a safety case in its entirety, therefore sampling is used to limit the areas scrutinised, and to improve the overall efficiency of the assessment process. Sampling is done in a focused, targeted and structured manner with a view to revealing any topic-specific, or generic, weaknesses in the safety case. In some cases there have been matters which affect several technical areas and these are the topics I considered for Cross-cutting assessment. The sampling for the Cross-cutting Topics was based on the outstanding concerns from Step 3 and discussions with the technical topic leads.

My assessment has focussed on:

- Control of the Pre-construction Safety Report and Master Submission List against the Design Reference.
- Arrangements to identify the Limits and Conditions necessary in the interests of safety.
- Metrication of the AP1000.
- Classification of Structures, Systems and Components and Safety Function Categorisation.
- Spent Fuel Pond.

From my assessment, I have concluded that:

- I accepted the Design Reference in October 2010 subject to some clarifications, which were substantially resolved in subsequent issues, but there is uncertainty about the status of design changes. At this time Westinghouse set the Design Reference Point to the 16 September 2010. There is an ongoing work stream to incorporate the design changes that have been agreed by Nuclear Directorate for inclusion in Generic Design Assessment, but these may require further assessment if new evidence is introduced. There is a six step process for introducing any further changes into Generic Design Assessment, thus no further changes will be made to the Design Reference Point unless agreed by the Joint Regulators.
- Revision 2 of the first Pre-construction Safety Report for the AP1000 was issued in December 2009, which was found to have significant shortfalls in terms of content and quality. Technical Queries, Regulatory Observations and Regulatory Issue responses have made up for many of the gaps and shortfalls in the December 2009 Pre-construction Safety Report. The replacement Pre-construction Safety Report was issued at the end of March 2011, which may require further revision, and it will require assessment to confirm it is fit for purpose.
- There are up to 1500 Design Change Proposals from Step 3 and Step 4 listed in the tables of the Design Reference, many of which have not been fully incorporated into the design, safety and other engineering documentation. Some documents in the Design Reference and Master Submission List are awaiting changes related to UK requirements and in these cases the documentation is currently limited to US requirements. Our expectation is that Westinghouse will fully implement all the Design Change Proposals in the Design Reference during Generic Design Assessment or will justify and implement an agreed process to transfer any outstanding Design Change Proposal information into the site specific phase.
- I found that the Westinghouse arrangements for defining limits and conditions did not meet our expectations. They principally described how US regulatory requirements can be met, reflecting the US DCD Rev. 17 AP1000 design. I expected Westinghouse to derive the limits and conditions through Design Basis Analysis, together with all those necessary from all parts of the safety case analysis, and in particular from the engineering analysis, the Probabilistic Safety Assessment and the severe accident analysis.
- I found that the extent of non-metric items is excessive and could have a significant impact on safety, particularly in respect to maintenance activities and construction. In particular, I noted the extensive use of imperial bolts and steel plates. It will require further work to modify the design to ensure it meets UK requirements with respect to Generic Design Assessment or to provide a safety justification for remaining imperial elements.
- I consider that Westinghouse has recognised the UK requirements to classify their Systems, Structures and Components, and has developed appropriate internal guidance. However, this methodology should be cascaded through all necessary AP1000 design and safety documentation.

I have identified 4 areas of concern with the Spent Fuel Pool design through discussion with the relevant Technical Assessors related to Criticality, Spent Fuel Cooling, Containment and long-term storage of Spent Fuel:

- The Criticality Control Arrangements of Spent Fuel

Westinghouse's criticality safety case for the AP1000 Spent Fuel Pool relies on the presence of soluble boron to assure criticality safety during normal conditions. Nuclear

Directorate has concluded that the proposed reliance on the presence of soluble boron to assure sub-criticality under normal conditions would not be in-line with relevant good practice.

- Safety Case for the Spent Fuel Pool; Suitability of Cooling systems

Westinghouse has agreed to make modifications to improve the reliability of their Class 2 cooling systems which limits the frequency of pool boiling to less than 1×10^{-3} per year. Based on this Westinghouse has submitted a new design basis safety case for the Spent Fuel Pool. Nevertheless, Nuclear Directorate will need to ensure that Westinghouse further develops its design basis safety case into a suitable safety case for the Spent Fuel Pool and incorporates it in its Pre-construction Safety Report and supporting documents.

- Spent Fuel Pond Containment

The main concern is that there are potential leakage paths for borated water from the Spent Fuel Pond, which could go undetected for a long period of time (chronic leaks), and could result in significant damage/contamination. The primary liner has a leak chase detection system. The claimed secondary containment is the Spent Fuel Pond structural steel module. For this to truly act as secondary containment this must have its own leak detection and retention system to ensure that the risk of chronic leaks being undetected or leaking to the environment are minimised.

- Long Term Fuel Storage

The design of the spent fuel storage facilities on the nuclear island should allow a licensee to address the needs of the long-term storage requirements so that spent fuel remains in a condition that would allow it to be transported for disposal. However, the size of the AP1000 reactor spent fuel pool may constrict the licensee's flexibility and therefore early work by a future Licensee will be needed to show how this could be addressed.

This assessment report only addresses Cross-cutting aspects but there are some areas within the detailed assessment of the associated topics where there has been a lack of detailed information which has limited the extent of our assessment.

Some of the observations identified within this report are of particular significance and will require a multi-discipline response to resolve them before Nuclear Directorate would agree to the commencement of nuclear safety related construction of an AP1000 reactor in the UK. There are other observations which are specific to single technical areas and these are addressed in the relevant individual assessment reports. The significant Cross-cutting observations are identified in this report as Generic Design Assessment Issues and are listed in Annex 2. In summary these relate to:

- Establishing arrangements to identify and advise the future Licensee of the conditions and limits necessary in the interests of safety.
- Providing final consolidated versions of Generic Design Assessment submission documentation, including the Pre-construction Safety Report, supporting documentation, the Master Submission List and other design reference documents as the key references to any Design Acceptance Confirmation or Statement of Design Acceptance the Regulators may issue at the end of Generic Design Assessment (this is a joint Generic Design Assessment Issue).
- Demonstration of how Westinghouse will be taking account of the lessons learnt from the unprecedented events at Fukushima, including from Westinghouse's internal reviews and from those lessons and recommendations that are identified in the ONR Chief Inspector's interim and final reports.

Overall, based on the sample undertaken in accordance with Nuclear Directorate procedures, I am broadly satisfied that the claims, arguments and evidence laid down within the 2009 December Pre-construction Safety Report and supporting documentation submitted as part of the Generic Design Assessment process present an adequate safety case for the generic AP1000 reactor design. The AP1000 reactor is therefore suitable for construction in the UK, subject to satisfactory progression and resolution of Generic Design Assessment Issues to be addressed during the forward programme for this reactor and assessment of additional information that becomes available as the Generic Design Assessment Design Reference is supplemented with additional details on a site-by-site basis.



LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
BMS	Business Management System
C&I	Control and Instrumentation
CCW	Cooling Water System
DAC	Design Acceptance Confirmation
DBA	Design Basis Analysis
DCD	Design Control Document
DCP	Design Change Proposal
DR	Design Reference
DRP	Design Reference Point
EDCD	European Design Control Document
EMIT	Maintenance, Inspection and Testing
FPS	Fire Protection System
GDA	Generic Design Assessment
HEPA	High Efficiency Particulate Arrestor
HHOR	High Hazard Operating Rules
HSE	Health and Safety Executive
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
LHOR	Low Hazard Operating Rules
MCR	Main Control Room
MSL	Master Submission List
ND	Nuclear Directorate (of the HSE)
NI	Nuclear Island
NNS	Nuclear Seismic Category
OR	Operating Rules
ONR	Office for Nuclear Regulation (formerly the Nuclear Directorate of the HSE)
ORE	Operator Radiation Exposure
OTS	Operating Technical Specifications
PCSR	Pre-construction Safety Report
PSA	Probabilistic Safety Analysis
RC	Reinforced Concrete

LIST OF ABBREVIATIONS

RCS	Reactor Coolant System
RGP	Relevant Good Practice
RNS	Heat Removal System
RO	Regulatory Observation
ROA	Regulatory Observation Action
RTNSS	Regulatory Treatment of Non-Safety Systems
SABL	Safety Case Bounding Limits
SAP	Safety Assessment Principles
SFAIRP	So Far As Is Reasonably Practicable
SFS	Pool Cooling System
SIS	Safety Instrumented Systems
SODA	Statement of Design Acceptance (Environment Agency)
SSC	Structures, Systems and Component
SSE	Safe Shutdown Earthquake
SWS	Service Water System
TAG	(Office for Nuclear Regulation) Technical Assessment Guide
TQ	Technical Query
TSC	Technical Support Contractor
US NRC	Nuclear Regulatory Commission (United States of America)
VAS	SFP Ventilation System
VFS	Containment Ventilation System
Westinghouse	Westinghouse Electric Company LLC
WENRA	Western European Nuclear Regulators' Association

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Table 1: Relevant Safety Assessment Principles for Cross-cutting Topics Considered During Step 4

Table 2: AP1000 Design Changes Requested by Westinghouse for Inclusion in GDA

Annexes

Annex 1: Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business – Cross-cutting Topics – AP1000

Annex 2: GDA Issues – Cross-cutting Topics – AP1000

1 INTRODUCTION

- 1 This report presents the findings of the Step 4 Cross-cutting Topics assessment of the AP1000 reactor December 2009 Pre-construction Safety Report (PCSR) (Ref. 13) and supporting documentation provided by Westinghouse under the Health and Safety Executive's (HSE) Generic Design Assessment (GDA) process. Assessment was undertaken of the PCSR and the supporting evidentiary information derived from the Master Submission List (MSL) (Ref. 21). The approach taken was to assess the principle submission, i.e. the PCSR, and then undertake assessment of the relevant documentation sourced from the Master Submission List on a sampling basis in accordance with the requirements of (HSE) Nuclear Directorate (ND), now the Office for Nuclear Regulation (ONR), Business Management System (BMS) procedure AST/001 (Ref. 2). The Safety Assessment Principles (SAP) (Ref. 4) have been used as the basis for this assessment. Ultimately, the goal of assessment is to reach an independent and informed judgment on the adequacy of a nuclear safety case.
- 2 During the assessment a number of Technical Queries (TQ) and Regulatory Observations (RO) were issued and the responses made by Westinghouse assessed. Where relevant, detailed design information from specific projects for this reactor type has been assessed to build confidence and assist in forming a view as to whether the design intent proposed within the GDA process can be realised.

2 NUCLEAR DIRECTORATE ASSESSMENT STRATEGY FOR CROSS-CUTTING ISSUES

3 During GDA ND's Assessors have identified matters, which affect several technical areas and these are the topics I considered for Cross-cutting assessment. This report relies heavily on the detailed assessments undertaken in various topic areas and provides a summary of the key Cross-cutting aspects from these assessments, but detailed findings and specific GDA Issues are also contained in the individual assessment reports (Ref. 8).

4 The individual technical topic assessment reports have identified the need for additional information to underpin their conclusions and these are identified as Assessment Findings to be carried forward as normal regulatory business. These Assessment Findings are listed in relevant technical area assessment reports in their respective Annexes 1 and topic specific GDA Issues in Annexes 2 of those reports. The Cross-cutting assessment has concentrated on points of principle arising from the technical area assessments rather than the detailed information and so this report has not identified specific Assessment Findings.

5 The Cross-cutting topics chosen were based on the outstanding concerns from Step 3 and discussions with the technical topic leads as their Step 4 assessments progressed.

2.1 Assessment Plan

6 There was no formal assessment plan for Cross-cutting topics as they were a sub set of the individual area topic plans. This report was produced to provide a single source of assessment for the key Cross-cutting matters arising from topic area assessments.

2.2 Standards and Criteria

7 The main standards and criteria used are the HSE Safety Assessment Principles (SAP), Ref. 4. Due to the wide range of technical areas considered the relevant SAPs are detailed in the individual assessment reports and where necessary are cited in the subsections of this report.

8 In addition to HSE SAPs, elements of the following technical assessment have been used where appropriate.

- T/AST/057 - design safety assurance (Ref. 77)

2.3 Assessment Scope

9 The objective of Step 4 assessment was to review the safety aspects of the proposed reactor design in a more detailed way by examining the evidence supporting arguments and claims made in the Westinghouse safety documentation, building on the assessment already carried out for Steps 2 and 3 and make a judgment on the adequacy of the safety case supporting Cross-cutting matters.

10 The assessment has concentrated on providing an overview of the assessments undertaken by topic specialists. A consequence of this is that I have only identified issues where there is a systemic weakness affecting several topic areas and where resolution is Cross-cutting in nature. Most Issues from GDA of the AP1000 design have arisen through the detailed assessments undertaken within individual topic areas and

resolution would be specific to that topic. Assessment findings are also left to the topic areas to identify.

11 My assessment is focused on:

- Control of PCSR and Master Submission List against the design reference (DR)
- Arrangements to identify the Limits and Conditions necessary in the interest of safety
- Metrication of the AP1000
- Classification of Structures, Systems and Components
- Design of the Spent Fuel Pond

2.3.1 Findings from GDA Step 3

12 The conclusions of Step 3 assessment were detailed in the Step 3 Public Report on the Generic Design Assessment of New Nuclear Reactor designs (Westinghouse Electric Company LLC AP1000 Nuclear Reactor) (Ref. 9). That report identified that there was significant additional work to be done by Westinghouse to satisfy our questions and to make and present an adequate safety case in the majority of technical topic areas.

13 The topic of safety function categorisation and safety system classification was identified as significant for a number of technical topic areas such as electrical and mechanical and Control and Instrumentation (C&I). The conversion of design and safety documentation to metric units was ongoing at the end of Step 3 and we said that we will require any AP1000 that is to be constructed in the UK to be fully metric.

14 The safety submission freeze and the design reference point for GDA (sometimes referred to as the “design freeze” for GDA) were identified at the commencement of GDA as a key Regulator expectation, and were the subject of ongoing discussion with Westinghouse from mid-2008. The design reference point is key to ensuring that there will be a sound basis against which to issue a GDA “Design Acceptance Confirmation” (DAC) (HSE) or Statement of Design Acceptability (SODA) (Environment Agency), should this be appropriate at the end of our assessments.

2.3.2 Additional Areas for Step 4 – Cross-cutting Matters

15 For the most part, the Cross-cutting topics assessed in Step 4 are broadly the same as those in Step 3, but the level of detail has been more focused on establishing the evidence to support a safety case. Two additional Cross-cutting areas have been identified:

- arrangements to identify Limits and Conditions; and
- design aspects of the Spent Fuel Pond.

2.3.3 Use of Technical Support Contactors

16 No TSCs were used in my Cross-cutting assessment, but individual topic area assessments have utilised them.

2.3.4 Integration with Other Assessment Topics

17 The nature of Cross-cutting topics means that there's been significant dialogue with all technical areas but in particular fault studies, mechanical engineering, civil engineering, MSQA and electrical engineering.

2.3.5 Out of Scope Items

18 Westinghouse letter WEC00512 (Ref. 75) clarified out of scope items, however further details are contained in the individual Assessment Reports (Ref. 8). In addition, the following items have been agreed with Westinghouse as being outside the scope of GDA:

- Documentation provided for information only, rather than part of the Master Submission List, such as:
 - i) Detailed design with supplier specific information.
 - ii) Site/specific or operator specific documentation.

This type of documentation has been provided within GDA, as part of the Regulators detailed assessment, to give confidence in the deliverability of the design or demonstrate that the design intent can be achieved. However, such documentation is not considered to be a formal part of the GDA submission.

3 WESTINGHOUSE'S SAFETY CASE

- 19 Westinghouse's safety case is presented in their December 2009 PCSR, which was submitted at the beginning of Step 4, UKP-GW-GL-732 Rev. 2 (Ref. 13). The PCSR has been essentially rewritten during Step 4 and a draft revised version was submitted in December 2010 for comment, UKP-GW-GL-793 Rev. A (Ref. 14). A formally approved version of this PCSR was submitted on 30 March 2011, UKP-GW-GL-793 Rev. 0 (Ref. 16), which was too late to allow assessment within GDA Step 4.
- 20 Westinghouse submitted their first design reference point in December 2009, UKP-GW-GL-060 Rev. 0 (Ref. 17), which was not accepted by ND as the basis for GDA. This was subsequently replaced by a revised design reference in October 2010 and the design reference point was set for the 16 September 2010, UKP-GW-GL-060 Rev. 1 (Ref. 18). The final version of the design reference was submitted on 31 March 2011, UKP-GW-GL-060 Rev 3. (Ref. 19), but this was too late to allow interrogation within GDA Step 4.
- 21 In February 2011 Westinghouse submitted a draft Master Submission List, which incorporated submissions made through to 14 January 2011, UKP-GW-GLX-001 Rev. A (Ref. 20). [The final submission of the Master Submission List was made in May 2011, UKP-GW-GLX-001 Rev. 0 (Ref. 21), which incorporated submissions up to the end of March 2011.
- 22 In February 2011 Westinghouse submitted a draft route map of the UK Generic Design Assessment of the European AP1000 design, UKP-GW-GLX-700 Rev. A (Ref. 22). This document provides a linkage between the various Regulatory Observations, Regulatory Issue and Technical Queries raised by the Regulators and the final consolidated PCSR. [The final version of the consolidated route map was submitted in May 2011, UKP-GW-GLX-700 Rev. 0 (Ref. 23)]. This version will need updating before ND assess the March 2011 PCSR (Ref. 16) as it is incomplete. Additional information is needed on outstanding work related to DCPs and some Regulatory Observations do not have a link to the PCSR (Ref. 68).

4 GDA STEP 4 NUCLEAR DIRECTORATE ASSESSMENT FOR CROSS-CUTTING TOPICS

4.1 Control of PCSR, Master Submission List and Design Reference

23 The Generic Design Assessment process for the AP1000 is based on ND's assessment of the safety case for the generic design submitted by Westinghouse. The assessment could lead to issue of Design Acceptance Confirmation (DAC) if the outcome is positive. Thus, it was imperative that Westinghouse provided both a clear unambiguous definition of the generic design in their design reference and the supporting safety case which aligns with this design reference.

4.1.1 Assessment

24 This section considers the 3 main documents which form the basis of Westinghouse's GDA submission:

- Design Reference
- Master Submission List
- PCSR

4.1.1.1 Design Reference

25 During Step 3 ND agreed with Westinghouse on the design reference point requirements and these were described in letter WEC70116R (Ref. 27). Following acceptance of these design reference point principles in letter WEC00114 (Ref. 28), Westinghouse provided an outline of their design reference in letter WEC00124 (Ref. 29). In December 2009 Westinghouse sent their formal submission of their design reference, UKP-GW-GL-060 Revision 0 (Ref. 17). The design reference contained a wide range of documentation much of which was subject to ongoing change whilst design change proposals were being incorporated.

26 The MSQA Assessor noted several discrepancies within the tables of the design reference and raised concerns in letter WEC70190R (Ref. 30) over the design change arrangements. Further to this letter an ROA, RO-AP1000-88.A3 (Ref. 11) was raised requiring Westinghouse, amongst other actions, to review the design reference submitted in December 2009. In response to this Westinghouse provided a revised design reference document, UKP-GW-GL-60 Rev. 1 (Ref. 18). This design reference document was based on a Design Reference Point (DRP) of the 16 September 2010 and this DRP was accepted by the Regulators as the basis for GDA in letter WEC70249 (Ref. 34), but further work was required on the Design Reference document.

27 The design reference, UKP-GW-GL-060 Revision 1 (Ref. 18) comprised four tables:

- Table 1 – Principal design criteria.
 - Table 2 – System specifications.
 - Table 3 – Design specifications.
 - Table 4 – Approved Category 1 and 2 design changes accepted into or excluded from GDA (Westinghouse left this table blank, awaiting completion at the end of GDA).
-

- 28 The MSQA Assessor and I established that many of the documents in Tables 1 to 3 of the Design Reference Revision 1 were awaiting design change proposals to be incorporated. Furthermore some of the principal documents in it are based on US standard plant but were subject to change for the UK.
- 29 Regulatory Observation, RO-AP1000-103 (Ref. 11) was raised to resolve the discrepancies in the design reference documentation and seek clarification on what design change proposals (DCP) were applicable to the UK and what their impact would be on the design documentation. In response Westinghouse provided a revised design reference document, UKP-GW-GL-060 Revision 3 (Ref. 19), but retained the design freeze at 16 September 2010. This version of the design reference now shows all the changes that had occurred during Step 3 and the applicable design change proposals for Step 4, many of which have not been incorporated into the design documentation. It should be noted that since the DRP of 16 September 2010 there have been 40 DCPs requested and accepted for inclusion within GDA.
- 30 Westinghouse does not intend to fully update the design reference documentation or MSL documentation until it is awarded a contract to build an AP1000 in the UK. The Design Reference Revision 3 (Ref. 19) lists in the order of 1500 design change proposals in the design reference documentation. This casted doubt on whether these design changes had been included within the safety case submissions. In order to resolve this matter a series of further actions were raised against RO-AP1000-103 (Ref. 11). A particular emphasis of these actions was to establish that the various documents ND had received for assessment had taken due account of the design changes which Westinghouse wanted to be included in GDA. The intent was to ensure that the PCSR, the design reference and the master submission list aligned and could be used as basis of GDA.
- 31 In response to RO-103, in May 2011 Westinghouse provided a document (Ref. 24) to confirm the alignment of the design reference (Ref. 19), the consolidated 2011 PCSR (Ref. 16) and the final Master Submission List (Ref. 21). However, it is not clear whether the documentation listed in these documents had taken due account of the various design changes cited in Tables 4a, 4b, and 5 of the design reference (Ref. 19). This will be progressed as part of the GDA Issue identified in Section 4.1.2.
- 32 Although there is a considerable amount of work for Westinghouse to do to update the design reference documentation, I consider it is a sufficient basis for an interim assessment. The changes however will need to be incorporated before we could issue a Design Acceptance Confirmation (DAC) or else a justification would need to be provided for those aspects of the design changes that Westinghouse did not finalise during GDA. This will be progressed as part of the GDA Issue identified in Section 4.1.2.

4.1.1.2 Master Submission List

- 33 Regulatory Observation Action, RO-AP1000-088.A4 (Ref. 11) was raised requiring Westinghouse to submit a master submission list in accordance with the Interface Protocol (Ref. 31) that it agreed at the start of GDA. Westinghouse's initial response was provided under cover of letter WEC00408 (Ref. 32) but it was recognised that this would need significant revision. It included many superfluous documents not related to the generic design, such as detailed information from China and other communications rather than formal documentation.
- 34 Several meetings were held to discuss the way forward and in February 2011 Westinghouse submitted a revised master submission list, UKP-GW-GLX-001 Revision A

(Ref. 20). This document had more than four thousand references in it, and once again not all of them were applicable to the generic design.

35 [In May 2011 Westinghouse resubmitted their revised Master Submission List, UKP-GW-GLX-001 Revision 0, (Ref. 21)]. The Master Submission List now cites the key safety, security and environmental reports namely the PCSR, the ER and the Conceptual Security Plan in the level 1 Section, and all the primary references from these reports are listed in the level 2 Section. During the assessment process there has been a vast amount of information exchanged but not all of this information was directly applicable to the UK generic plant. Westinghouse undertook an extensive review of the documentation submitted to ND to determine which documents were directly applicable to the UK generic design, and these are listed in the level 3 Section of the Master Submission List. It should be noted that the Master Submission List is based on the final consolidated (March 2011) PCSR, UKP-GW-GL-793 Revision 0 (Ref. 16) and ND will need to assess this version of the PCSR to confirm it is consistent with the safety case documentation we have assessed.

36 As with the design reference document (Ref. 19), there is a considerable amount of work for Westinghouse to do to update documentation from the MSL to incorporate DCPs. The MSL is linked to the consolidated PCSR (Ref. 16) which has not been assessed. Some of the documentation within the MSL may need review as it could be based on a later version than that assessed during step 4. In addition, the agreed design changes will need to be incorporated before we could issue a DAC, or else a justification provided for those aspects of the design changes that Westinghouse would not finalise during GDA. This will be progressed as part of the GDA Issue identified in Section 4.1.2.

37 Westinghouse must ensure that ND and Environment Agency are advised of any changes or likely changes to the GDA safety submission documentation. This also applies to changes to documents that have been made when DCPs were incorporated since the document was last submitted to GDA. Where Westinghouse identifies that DCPs may have a significant impact on GDA safety submission documentation, Westinghouse should advise ND and Environment Agency about the specific impact of the change and make arrangements to resubmit the relevant documentation in a timely manner. This will be progressed as part of the GDA Issue identified in Section 4.1.2.

4.1.1.3 Design Changes

38 The design reference was not frozen until the 16 of September 2010 and a significant number of DCPs had been approved by Westinghouse prior to this date, as part of the ongoing detailed design. Westinghouse has an established process for controlling Design Change Proposals (DCP) and this is discussed in the MSQA Assessment Report ONR-GDA-AR-11-013 (Ref. 8).

39 Westinghouse has categorised the various DCPs in accordance with its design change arrangements NSNP 3.4.1 (Ref. 25). The majority of the design changes have been allocated as "UK" Category 3 and 4 changes, which Westinghouse consider only have the potential to lead to minor radiological hazard.

40 Westinghouse letter WEC00317N (Ref. 33) provided a complete list of the DCPs raised during Step 3 and Step 4 in response to Regulatory Observation Action (ROA) RO-AP1000-88.A2 (Ref. 11). We note that 21 of the Step 3 design changes are Category 1 or 2, i.e. they may have a significant impact on safety if inadequately conceived or executed.

- 41 During the MSQA inspections I noted that a significant number of DCPs had not been incorporated into the design reference documentation and this led to extensive discussions with Westinghouse.
- 42 All the changes prior to Step 4 (December 2009) were agreed with the Regulators to be part of the GDA assessment (Table 4a of the DR [Ref. 19]), as were Category 3 and 4 DCPs prior to the DRP of 16 September 2010 (Ref. 34) (Table 4b of the DR).
- 43 Westinghouse was required to submit to ND any changes (i.e. Category 1, 2, 3 and 4) it wished to make to the design reference point after the 16 of September 2010 (Ref. 34). This also applied to any UK safety Category 1 or 2 changes raised during Step 4 prior to the 16 September 2010.
- 44 In November 2010 Westinghouse provided a description of its' approved DCPs for which it sought acceptance into GDA in the response to TQ-AP1000-1120 (Ref. 36), then in letter WEC00508N (Ref. 35) Westinghouse formally requested that 41 DCPs be considered for inclusion within GDA. These were accepted in letter WEC70292R (Ref. 61) and are now included in Table 5 of the design reference (Ref. 19), and listed in Table 2 of this report.
- 45 Westinghouse will need to implement the outstanding GDA agreed design changes cited in the DR, by incorporating the change details into all impacted DR documents, and the MSL documentation including the PCSR. This will be progressed as part of the GDA Issue identified in Section 4.1.2.

4.1.1.4 Pre-construction Safety Report

- 46 In December 2008 Westinghouse issued their first PCSR for GDA, UKP-GW-GL-732 Revision 0 (Ref. 37). ND found that the report referred out to various documents rather than making the case for safety and relied too heavily on the European Design Control Document (EDCD) (Ref. 42). ND provided specific comments in a letter to Westinghouse, WEC70064 (Ref. 38). In April 2009 Westinghouse revised their PCSR and submitted a revision, UKP-GW-GL-732 Revision 1 (Ref. 39). This version addressed several editorial matters but made no technical changes to the report.
- 47 Westinghouse undertook a programme of work to revise the PCSR and made a presentation to the Regulators in July 2009 after which ND wrote to Westinghouse, WEC70101N (Ref. 40) summarising the Regulators views on Westinghouse's proposed approach. In particular, ND reminded Westinghouse that the US Design Control Document (DCD) they produced for the US Nuclear Regulatory Commission (US NRC) does not address UK specific needs and the same applied to the EDCD (Ref. 42), which is derived from the US DCD. Westinghouse was asked to develop a safety case which marshalled the claims, arguments and evidence to show that the risks from operating this plant will be as low as reasonably practicable.
- 48 Particular concerns were raised with respect to:
- the derivation of faults for the design basis analysis;
 - categorisation and classification of systems structures and components;
 - justification for codes and standards;
 - reliability and Probabilistic Safety Analysis (PSA) sensitivity studies for C&I;
 - a lack of consideration of human factors; and
 - how responses to TQs, ROs and RIs are incorporated into the PCSR.

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- 49 In December 2009 Westinghouse submitted the next revision of the PCSR, UKP-GW-GL-732 Revision 2 (Ref.13). Once again the Regulators found that the safety submission was overly reliant on the EDCD (Ref. 42). It still did not contain sufficient claims, arguments and evidence to substantiate the AP1000 design and demonstrate that the risks were controlled to be As Low As Reasonably Practicable (ALARP).
- 50 However by using TQs and ROs the assessors have been able to complete their assessments, but this has led to the need for Westinghouse to produce a replacement PCSR. Westinghouse has been developing a revised PCSR throughout Step 4 to take account of comments, and responses to ROs, TQs and this has involved potential utility companies in the review process. As a consequence of not having the consolidated PCSR prior to writing the assessment reports, the assessments were based on information assessors had already received through RI, RO and TQ responses and the December 2009 PCSR (Ref. 13).
- 51 An early draft of the intended revised PCSR was issued to interested Utility firms and made available to the Regulators in the summer of 2010. Where work allowed, assessors commented on the content and format of revised sections of the PCSR in a series of letters (Ref. 41).
- 52 In December 2010 a draft version of the consolidated PCSR was issued to ND, UKP-GW-GL-793 Revision A (Ref. 14). There was little opportunity for Environment Agency and ND assessors to comment at the time because they were busy completing their assessment and writing their reports. However, some assessors did manage to briefly review the draft PCSR and pass comment back to Westinghouse. On 30 March 2011 Westinghouse submitted their final consolidated PCSR, UKP-GW-GL-793 Revision 0 (Ref. 16) but this was not assessed as part of Step 4.
- 53 Various topic assessors have raised specific GDA Issues on the adequacy of the safety case. These will give rise to changes to the GDA safety submissions, which will result in further changes to the PCSR being required. This will be progressed as part of the GDA Issue identified in Section 4.1.2.

4.1.2 Findings on the Control of PCSR, MSL and DR

- 54 The Regulators have interfaced with Westinghouse throughout Step 4 and have encouraged it to submit a complete and consistent documentation package.
- 55 The consolidated assessment package comprising the PCSR, MSL, DR and the roadmap have only recently been produced and the Regulators have not had time to assess it. Based upon the assessment of the status of the various documents described in Section 4.1 above, I have identified the following joint GDA issue which requires resolution before nuclear island safety-related construction of a reactor could be considered:

GI-AP1000-CC-02: Westinghouse to submit a safety case to support the GDA Design Reference and then to control, maintain and develop the GDA submission documentation, including the PCSR, the MSL and the Design Reference document and deliver final consolidated versions of these as the key references to any DAC/SODA the Regulators may issue at the end of the GDA process.

- 56 The complete GDA Issue and associated actions are formally defined in Annex 2 of this report.

4.2 Limits and Conditions

4.2.1 Background

- 57 Westinghouse must have adequate arrangements to derive suitable Limits and Conditions necessary in the interests of safety, which will enable a Licensee to translate them into the operating and maintenance documentation, and application into working practices for the UK-AP1000. These Limits and Conditions should be derived from the safety case and cover such matters as: operating envelope, set-points on protection systems, and equipment availability. It is important to recognise that this applies to any condition or limit deriving from (whether appearing explicitly or being implicit in) the safety case, not just to the subset of Limits and Conditions that the future licensee may choose to designate as its highest level Limits and Conditions.
- 58 The key objective of setting plant operation limits is the prevention of situations from arising which might lead to accident conditions, and the mitigation of the consequences of such accident conditions should they arise. These result in a need to consider operational limits and safe boundary conditions beyond those effecting Class 1 Systems, Structures and Components (SSC) (see Section 4.4.1). It is also important to recognise that Limits and Conditions must apply to the whole plant for all operating modes, not just to the reactor i.e. they must also apply to the Spent Fuel Pond, Radwaste Buildings etc. Furthermore, it is important that the operational limits are set within the safety assumptions contained in the safety case.
- 59 The safe operation of the plant requires a wide range of operational parameters to be kept within acceptable limits. Such limits may relate to temperature, pressure, primary coolant flow rate and chemistry, secondary water and steam conditions and so on. It is our expectation that the design basis limits for all SSCs that provide the means of delivery of a safety function will be clearly identified in the GDA submission.
- 60 I issued RO-AP1000-094 (Ref. 11), which required Westinghouse to describe the limits and conditions. However the response in WEC00446N (Ref. 43) did not meet my expectations. Overall I found that the response was driven by US regulatory criteria and standards and was not derived from the safety analysis such as the PCSR and Westinghouse's assessments of the AP1000, including those produced in response to Regulatory Observations. It principally described how the current arrangements developed reflecting the US DCD Rev. 17 AP1000 design (Ref. 44) and how US regulatory requirements can be met/taken into account.
- 61 RO-AP1000-094 introduced the concept of High Hazard Operating Rules (HHOR) and Low Hazard Operating Rules (LHOR) and how they may be derived. HHOR is determined primarily through Design Basis Analysis (DBA), but should also include Limits and Conditions as necessary from all parts of the safety case analysis, and in particular from the engineering analysis, the PSA and the severe accident analysis. The PSA should be used to identify any additional safeguards required for beyond design basis accidents including severe accident mitigation measures and to provide an aid to the judgement on the need for any additional control of availability requirements. It is important that Westinghouse, as design authority for the AP1000, provides this information to enable a future Utility to develop suitable and sufficient Limits and Conditions, Technical Specifications etc. to meet UK regulatory requirements including Nuclear Site Licence Condition LC 23 (Ref. 68).

4.2.2 Fault Studies Assessment

- 62 The Fault Studies Assessor recognised that Westinghouse's discussion of specific faults in Chapter 16 of the EDCD (Ref. 42) refers to the reduced availabilities allowed by the generic Technical Specifications. In a small number of cases, transient analysis is presented which supports the availability requirements specified in US Technical Specifications.
- 63 The EDCD (Ref. 42) and the Westinghouse response to RO-AP1000-094 in letter WEC 00446N (Ref. 43) would not allow a future licensee to systematically define a set of Limits and Conditions attributable to the design basis safety case. It is not clear how the currently available design basis analysis for shutdown faults will provide an input to Technical Specifications, safety limits, safety classification etc. as required by SAP FA.9 (Ref. 4), which the future Licensee will need as part of their site Licence condition arrangement for LC23 (Ref. 68).
- 64 The Fault Studies Assessors considered that the checklist which Westinghouse uses to reconcile core modifications with the assumptions in the fault analysis, WCAP-9272-P-A AP1000 (Ref. 15) could be used to assist the development of Limits and Conditions. However, the list of parameters in the document is not complete and does not reflect the analysis performed specifically for GDA. This checklist will need to be developed further to define the Safety Case Bounding Limits (SABL) for the reactor core to ensure any modifications to the core design are consistent with the assumptions made in the fault analysis.
- 65 Fault studies have raised an action against GDA Issue **GI-AP1000-FS-02**: *Provide a complete set of core design limits reflecting the final design basis analysis in the PCSR and the Design Reference Point to determine the compliance of candidate core designs* (Ref. 8).

4.2.3 Reactor Chemistry Assessment

- 66 The Reactor Chemistry Assessors reviewed the Technical Specifications for the AP1000, which are presented in Chapter 16 of the EDCD (Ref. 42), and the response to RO-AP1000-094 in WEC00446 (Ref. 43). They noted that some of the most important chemistry parameters, for example primary circuit lithium, are not included in these. Westinghouse's response to the RO did not provide the links between the Limits and Conditions and the AP1000 safety case presented for GDA and did not indicate which chemistry parameters Westinghouse expect to be part of the plant limits and conditions. Such Limits and Conditions are a fundamental part of the nuclear safety case and Westinghouse should be able to identify those chemistry parameters which are related to safety. This will need to be addressed before nuclear safety-related construction can begin.
- 67 Relatively few chemistry parameters have a direct and immediate impacts on reactor safety so do not tend to appear in the top tier of Limits and Conditions. Many parameters may have a slower effect on reactor safety, albeit with similar consequences and are often 'classified' at a lower level. The treatment of this latter group of chemistry parameters within the safety case is also important as these can often influence other related hazards such as Operator Radiation Exposure (ORE) and waste production. Overall, our expectations were that the AP1000 safety case would demonstrate that all safety significant chemistry parameters had been captured and the relative importance of these to plant safety would be presented or could be inferred by a potential operator/licensee from the suite of documentation.

- 68 Westinghouse has made some positive steps in producing guidance for AP1000, particularly the 'chemistry manual' (Ref. 46) and supplementary guidance, which could be used by a licensee to help with developing and justifying the operating chemistry. The licensee can use these as a basis for further development as the safety case is supplemented with additional information and evolves through the site-licensing process.
- 69 In "*Safe and Simple: The Genesis and Process of the AP1000 Design*" (Ref. 55), Westinghouse identifies a number of design features of AP600/AP1000 that are different from other non-passive PWRs. Westinghouse has not yet adequately explained how any of the chemistry related differences are covered by the Westinghouse documentation.

4.2.4 Findings on Limits and Conditions

- 70 The current Technical Specifications and Regulatory Treatment of Non-Safety Systems (RTNSS) evaluation required by the US NRC do not take into account the outcome of the development of Westinghouse's AP1000 UK Safety Categorisation and Classification Methodology (Ref. 55). They also do not take into account the changes and extensions to the design basis analysis that have been identified through the GDA process, e.g. as a result of RO-AP1000-046 (List of Design Basis Faults), RO-AP1000-054 (Spent Fuel Pool and Shutdown Faults) and RO-AP1000-047 (Diversity for Frequent Faults) (Ref. 11). I expect Westinghouse to describe a process for developing a complete set of Technical Specifications. This will need to be more substantial than a simple re-classification of availability controls placed on a small number of active "non-safety related" systems identified by the AP1000 RTNSS evaluation carried out for US NRC.
- 71 My expectation is that Westinghouse will provide further information over and above that provided in EDCD Chapter 16 (Ref. 42) to demonstrate how plant Operating Rules (OR) or Operating Technical Specifications (OTS), chemistry guidelines and maintenance documentation can be derived from the design basis limits and claims made in the GDA PCSR. Further information is also required on the processes that will be followed to ensure that the ORs or OTSs and the maintenance schedules ultimately adopted are consistent with the design basis limits.
- 72 Based upon the assessment of the arrangements for developing suitable limits and conditions for the UK AP1000 described in Section 4.2 above, I have identified the following GDA issue which requires resolution before nuclear island safety-related construction of a reactor could be considered:

GI-AP1000-CC-01: *In respect of any operation that may affect safety, Westinghouse should have arrangements to identify and advise a future licensee of the conditions and limits necessary in the interests of safety.*

- 73 The complete GDA Issue and associated actions are formally defined in Annex 2 of this report.

4.3 Metrication

4.3.1 Background

- 74 The Guidance to Requesting Parties (Ref. 5) requires that documents submitted for Generic Design Assessment (GDA) use SI units. However, recognising that the AP1000 was not designed in SI units, the Interface Protocol, JPO-003 Issue 2 (Ref. 31) allows that specific non-SI documents may be accepted in specific cases with the prior agreement of the Regulators.

75 Throughout GDA, we have discussed metrication of the AP1000 with Westinghouse and have re-stated our expectations that we will require any UK built plant to be essentially metric, using metric Structures, Systems and Components. This will require Westinghouse to re-design some components using the SI system, or translate the current US units into SI units, if Westinghouse wishes to retain non metric components it will need to provide adequate justification why such a redesign is unnecessary, impractical, or unreasonable. In addition, we will require that all documentation or other information in the possession of an eventual licensee in the UK will be in SI units. This will include design documentation, drawings, specifications, operational procedures, maintenance instructions, technical specifications, supporting analyses etc, and this might affect the documentation submissions.

4.3.2 Assessment

76 Westinghouse intends to use some non-metric items within the AP1000 design and this has been the focus of our discussions. Some of these items are not clearly specified and unambiguously identified and there is not sufficient justification for their use. In particular it is noted that Westinghouse do not intend to use metric fasteners, nuts, bolts, and other threaded features across the majority of the AP1000. We do not believe this is appropriate, although the Structural Integrity Assessors did however accept the argument that this is appropriate for the large nuclear pressure boundary components in their report ONR-GDA-AR-11-010 (Ref. 8). A subsequent submittal on metrication has been made APP-GW-G1-011 Rev. 4 (Ref. 71) to ND, which I have not had time to assess.

77 Based on our understanding of the extent to which Westinghouse has used non-SI units for the UK AP 1000 design, it could require extensive work to modify the design to ensure it meets UK requirements in respect to GDA.

4.3.2.1 Mechanical Assessment

78 The Mechanical Engineering Step 4 Assessment Report, ONR-GDA-AR-11-010 (Ref. 8), includes a detailed description of the assessment progress on metrication for AP1000 as they were the principal lead on this topic. I have summarised the key stages below for ease of reference.

79 Westinghouse provided a response to RO-AP1000-038 on 1 December 2009 which comprised document APP-GW-G1-011 Rev.0, AP1000 Standard Plant Metrication (Ref. 50). This initial response was not considered to be adequate and following a meeting with Westinghouse, ND issued further guidance via letter WEC70154R dated 17 March 2010 (Ref. 48), which reminded Westinghouse, amongst other matters, that:

- We expected the design and associated equipment should be fully metric or 'quasi metric' (i.e. initially conceived as imperial, but now designated and designed as metric using metric codes / standards, and fully dimensioned as metric).
- All fastenings shall be metric.
- All documentation and information displayed within the constructed facility will need to be fully metric.

80 Westinghouse then issued AP1000 standard plant metrication Revision 1 (Ref. 51) in a further response to the above RO on 29 April 2010. Following discussions at the subsequent Mechanical Engineering technical meeting in Pittsburgh, Revision 2 of APP-GW-G1-011 was issued on 17 September 2010 (Ref. 52). Westinghouse accepted the

principles described by the ND guidance, and the assessment attention then focussed on the proposed exceptions list in APP-GW-G1-011 Rev. 2 (Ref. 52).

81 ND responded to this latest RO Action response by letters WEC70251N (Ref. 49) and WEC70243 (Ref. 45), which collated the assessment views from each of the affected technical areas. The Mechanical Assessors perspective is summarised below:

- Permanent Structures: the proposal is not acceptable for piping, flanges, valves and bolting, since it includes wide-scale use of imperial bolting / fastenings.
- Design analysis: any future design work associated with installation design, (e.g. pipe loadings etc), should be undertaken fully in metric.
- Control Rod Drive Mechanisms: we are content with this equipment being an exception to metrication, except that the interface with lifting equipment will need to be specifically controlled.
- Integrated Head Package: we are content with this equipment being an exception to metrication, except that the interface with lifting equipment will need to be specifically controlled.
- Squib valves: we stated that we are content with the squib valve internals etc being imperial, including thread forms, but the connecting flanges should utilise metric fastenings.
- Light and heavy load handling systems: this category groups a large number of lifting equipments together which we advised should be metric. Although we would accept structural shapes as being quasi metric, all fastenings should be metric.

82 The subject of metrication was discussed again from a Mechanical Engineering perspective in December 2010 at the final Mechanical Engineering assessment meeting in Pittsburgh. Subsequent to the meeting Westinghouse issued a further update to document APP-GW-G1-011 Rev. 3, (Ref. 47). In this revision Westinghouse has now made commitments for various cranes in regard to metrication (discussed in the mechanical Step 4 report ONR-GDA-AR-11-010 (Ref. 8).

83 In summary, the Mechanical Assessors considered that Westinghouse has made significant progress in this area; nevertheless, there still remain residual concerns with the final position reached with Westinghouse during Step 4, specifically relating to flange bolting, and fasteners associated with engineered connectors. Some further clarification is also required in respect of design analysis in order to address concerns raised in RO-AP1000-038. These concerns are to be progressed as part of the GDA Issue identified in Section 4.3.3.

4.3.2.2 Civil Engineering Assessment

84 The Civil Assessors noted that AP1000 civil engineering generic design is all based on imperial units. However, Westinghouse plan to provide construction information to suppliers for UK plants in metric by converting from the original imperial values i.e. quasi-metric, but there would be some exceptions. The Civil Assessor noted that this list of exceptions is lengthy e.g. it includes all structural steelwork, steelwork connections, welds, bolts, plates and reinforcing bar.

85 The Civil Assessment Report ONR-GDA-AR-11-002 (Ref. 8) made the following comments on the proposed exceptions to metrication as shown in Table A-1 of APP-GW-G1-011 rev 2 (Ref. 52):

- It is noted that Westinghouse plan to use US structural steel sections by rolling these sections in UK steel mills. However, the steel material strengths will also need to be maintained to the US standards used in the approved design, and so the UK steel mills will need to substantiate the material properties accordingly.

86 Westinghouse's intention is to use imperial bolts extensively. Westinghouse state this has no impact and that "there is strict quality control of the products during construction, when the piece-parts are vulnerable to units of measure confusion."

87 Westinghouse issued a further revised RO response on 31 December 2010 (Letter UN REG WEC 000467) (Ref. 53) and Revision 3 of APP-GW-G1-011 (Ref. 47). This states that *"the AP1000 meets the "quasi-metric" expectation, where the design was originally conceived in US units, but will be delivered fully metric with [certain] exceptions."*

88 The Civil Assessor considered that Westinghouse should fully review the practicalities of using US standards in the UK. The primary concerns with the approach are:

- Previous experience of a similar project has shown that suppliers are likely to request many alternatives, and, the process of approving and justifying substitutions from US to UK standards was very protracted for all parties. This led to time pressures on the licensee's staff and increased the potential for errors to be made.
- Construction teams will not have extensive experience of the US system, and management and supervision on site will require more intensive quality control. This increases the risk of workmanship errors.

89 These concerns are to be progressed as part of the GDA Issue identified in Section 4.3.3.

4.3.2.3 Control and Instrumentation Assessment

90 The C&I Assessors noted that Westinghouse's design is based on the use of imperial rather than metric units. The AP1000 C&I components such as, electronic systems cards, chassis and cabinets are all built to accepted standard sizes. AP1000 uses a number of specialist instruments (e.g. neutron flux instrumentation) that are designed using imperial units. There would be a potential significant safety detriment if equipment of this type was to be redesigned and re-qualified to meet a requirement of basing the design of all C&I components on standardised metric units. Westinghouse's proposal to retain the existing C&I designs that includes equipment using imperial units was accepted in our letter WEC 70251N (Ref. 49).

4.3.3 Findings on Metrication

91 My view is that the current extent of the proposed non-metric items is excessive and could have a significant impact on safety. Westinghouse should fully review the practicalities of using US standards in the UK. ND's primary concerns with Westinghouse's approach are:

- There is the potential to fit wrong sized components to safety important equipment which could leave the installation with latent errors which would only be revealed following failure from demand on that component.
- The choice of imperial over metric will affect the initial erection quality control requirements. During operation dismantling for maintenance will be required and modifications to the plant are likely, as a result of periodic safety reviews or plant improvements. This gives rise to the possibility of errors.

- Suppliers are likely to request many alternatives to US standards. The process of approving and justifying substitutions from US to UK standards is very protracted for all parties with the potential for errors to be made.
- Construction teams will not have extensive experience of the US system, and management and supervision on site will require more intensive quality control. This increases the risk of workmanship errors.

92 Based upon the assessment of the application of metrication for the UK AP1000 described in Section 4.3 above, the Mechanical and Civil Assessors have identified the following GDA issue which requires resolution before nuclear island safety-related construction of a reactor could be considered (Ref. 8):

GI-AP1000-ME-02: Westinghouse is required to ensure that documents submitted for GDA use SI units. As a corollary it is the expectation that the design submitted by the Requesting Party is essentially metric, using metric Structures, Systems and Components.

93 This GDA Issue relates particularly to the exceptions list for Civil and Mechanical Engineering structures and components and requires Westinghouse to:

- Re-design equipment and Civil Steelwork SSCs in line with the guidance, or provide a much more rigorous justification for any exceptions to metrication.

4.4 Classification of Structures, Systems and Components

4.4.1 Background

94 Classification of Structures, Systems, and Components (SSC) is used to identify those SSCs that play an important part in ensuring nuclear safety. This in turn helps to define the quality requirements placed on those SSCs during design and manufacture, and through life. In particular, the safety class of a given SSC can be used to determine which codes, standards, and seismic design considerations are appropriate to the design and manufacture of that SSC.

95 Westinghouse has to generate their own classification structure to reflect the principles described above, based on considerations of hazard and risk. This subject affects a wide range of topic areas:

- mechanical components;
- electrical components;
- instrumentation and control systems;
- civil structures and
- Structural Integrity.

96 Classification of SSCs is an input to the definition of design requirements, procurement processes (specifically assurance activities), installation and commissioning activities. The future licensee will need support from Westinghouse to ensure it has suitable and sufficient mechanisms, devices and circuits properly connected and in good working order under Nuclear Site Licence Condition 27 and arrangements for the Examination, Maintenance, Inspection and Testing (EMIT) requirements which are regulated during plant operation under Nuclear Site Licence Condition 28 (Ref. 68).

4.4.2 Assessment

97 Westinghouse existing system of safety function categorisation and equipment classification was heavily tied to meeting the requirements of the US Regulator. The US Regulator has a different approach to functional categorisation and equipment classification and categorisation than the UK Regulator. Westinghouse has therefore devised a UK specific classification system.

98 Westinghouse has described its classification methodology in, 'AP1000 UK Safety Categorisation and Classification Methodology' (Ref. 55), and provided listing of safety functional categorisation and the SSC categorisation and Classification in, 'AP1000 UK Safety Categorisation and Classification of Systems, Structures, and Components' (Ref. 56). The Westinghouse AP1000 design categorisation / classification system to meet UK expectations is summarised as follows:

- **Category A**

Principal means for maintaining nuclear safety; failure has potential for significant core damage or release to the environment within 72 hours of accident, e.g. decay heat removal, reactivity control, Main Control Room (MCR) habitability, Reactor Coolant System (RCS) integrity, RCS inventory control, containment heat removal / integrity, spent fuel cooling.

- **Category B**

Significant contributor to maintaining nuclear safety; failure may reduce safety margins significantly, but not result in a DBA, e.g. radwaste system integrity, instruments to monitor category A functions, functions required beyond the initial 72 hours of an accident, isolation of control systems which could reduce margins.

- **Category C**

Contribution to nuclear safety; failure will not result in a DBA, e.g. long-term support of category A and B functions, beyond DBA events, monitoring of environmental releases.

99 For the associated equipment classification levels, Westinghouse described the specified design and quality standards which were applicable, including application of appropriate seismic categories.

100 Class 1 SSCs provide the principal means of fulfilling a Category A safety function. All AP1000 Class 1 SSCs are located in the Nuclear Island (NI).

101 Class 1 SSCs are standby or normally operating SSCs required to protect against, or mitigate, the consequences of DBAs consistent with the design basis safety analysis. These SSCs provide the principal means for the protection of the health and safety of the public and workforce and are selected using deterministic methods.

102 Class 2 SSCs are the principal means of fulfilling Category B safety functions, or significant contributors to fulfilling Category A safety functions. A significant contributor is defined as an SSC that provides a supplementary capability for those SSCs utilised in the principal response to DBAs.

103 Class 3 SSCs are all other SSCs that are not Class 1 or Class 2 and provide contributions to maintaining nuclear safety, including SSCs identified to support the operation of Class 1 and Class 2 SSCs.

4.4.2.1 Mechanical Engineering

104 The Mechanical Assessors considered 'AP1000 UK Safety Categorisation and Classification Methodology' (Ref. 55) and "AP1000 UK Safety Categorisation and Classification of Systems, Structures, and Components" (Ref. 56). The Mechanical Assessors are satisfied with the Westinghouse safety function categorisation and equipment classification methodology, and application, for the AP1000, from a Mechanical Engineering GDA perspective against SAPs ECS.1 and ECS.2. However, they consider that this revised methodology should be cascaded through all necessary AP1000 design and safety documentation.

4.4.2.2 Civil Structures: Seismic Categorisation of Safety Related Systems

105 The Civil Assessor reviewed the seismic categorisation methodology adopted for the AP1000 design. The Westinghouse method for categorisation of safety functions and classification of SSCs is presented in detail in Chapter 5 of the December 2010 PCSR (Ref. 14).

106 Structures are assigned a seismic category depending on their required performance during and following a seismic event. Civil engineering structures are categorised according to their safety function and are classified according to their significance in delivering this function according to UK practice. A seismic category is assigned accordingly.

107 Section 12.6 of the December 2010 PCSR (Ref. 14) outlines the Westinghouse safety design approach to the treatment of earthquake hazard and states that the Safe Shutdown Earthquake (SSE) is used as a design basis for AP1000 plant Class 1 SSCs. In specifying design criteria for the SSE, consideration is given to lower magnitude earthquakes having a greater probability of occurrence, as well as to larger magnitude earthquakes having a lower probability. Westinghouse state that the AP1000 plant has been designed so that any seismic event within the design basis will not prevent the delivery of Category A safety functions.

108 The seismic category definitions are:

- **Seismic Category I (C-I)** – Applies to safety-significant SSCs. C-I SSCs are designed to maintain both functionality and integrity under seismic loading within the design basis.
- **Seismic Category II (C-II)** – Seismic C-II SSCs are designed so that an SSE does not cause unacceptable structural failure of, or interaction with, C-I items that could degrade the functioning of a safety significant SSC to an unacceptable level, or could result in incapacitating injury to occupants of the MCR.
- **Non-Nuclear Seismic Category (NNS)** – NNS SSCs are those that are not classified as C-I or C-II. Even though a structure has been assigned as NNS, some form of seismic justification is undertaken.

109 Non-seismic structures are evaluated to determine that their seismic response does not preclude the safety functions of C-I SSCs. This is satisfied by compliance with one of three options:

- The collapse of the non-seismic structure will not cause the non-seismic structure to strike a C-I SSC.
- The collapse of the non-seismic structure will not impair the integrity of C-I SSCs.

- The structure is reclassified as C-II and is analysed and designed to prevent its collapse under the SSE.

110 The Civil Engineer found Westinghouse's approach and application of UK categorisation to be acceptable for the buildings included in the GDA scope. The turbine building and the annex building have split categorisations, but a deep sample of the turbine building found this to be appropriate. The classification of the radwaste building had been raised as a concern during Step 3. Westinghouse have declared the design of radwaste facilities will be determined by the licensee organisation as they are outside of the nuclear island (Ref. 75), thus this issue is out of scope and will be considered during the site specific stage.

4.4.2.3 Control and Instrumentation

111 The Westinghouse scheme for categorisation of C&I functions is similar to but not identical to that of IEC 61226 (Ref. 60). AP1000 UK Safety Categorisation and Classification Methodology' (Ref. 55) identifies how the functional categorisation requirements of IEC 61226 Categories A, B and C are captured in the Westinghouse scheme.

112 Westinghouse stated that the categorisation of functions will be completed in accordance with its QMS as the design is "finalised" and the procedure for this has now been set down (Ref. 58) following discussion with ND. This procedure (Ref. 58) relates category of function to the class of system required to implement the functions.

113 Westinghouse identified a C&I specific document for categorisation of functions (Ref. 59); this follows the requirements of IEC61226 (Ref. 60). The document also provides a cross reference table for Safety Instrumented Systems (SIS) requirements between US regulatory requirements, Institute of Electrical and Electronic Engineers (IEEE) standards, and International Electrotechnical Commission (IEC) standards.

114 In general, the Westinghouse procedure for the categorisation of functions and classification of systems, (Ref. 55), is broadly in line with our expectations.

115 There are specific areas which will require clarification both during GDA (GDA Issues) and as part of site specific activities (Assessment Findings) and these are discussed in ONR-GDA-AR-11-006 (Ref. 8). A particular example being that the GDA Step 3 observation of a lack of Class 1, equipment other than in the main control room is now confirmed as a GDA Issue, **GI-AP1000-CI-10**.

4.4.2.4 Structural Integrity

116 SAP ECS.3, paragraphs 157-161, expect codes and standards should reflect the functional reliability requirements of the structures, systems and components and be commensurate with their safety classification. Codes and standards should preferably be nuclear specific codes and standards, but Class 3 components may use appropriate non-nuclear specific codes.

117 Westinghouse have applied Nuclear specific codes to Class 1 pressure equipment and storage tanks but non-nuclear standards have been applied for Class 2 pressure equipment and storage tanks (Ref. 56).

118 In the case of pressure equipment and storage tanks there are nuclear design and construction codes available in the form of a number of nuclear specific codes, for

example ASME III. Thus applying non-nuclear codes for the design and construction of Class 2 pressure equipment and tanks does not meet ONR's normal expectations.

119 Where non-nuclear pressure equipment and storage tank design and construction codes are used in the design of Class 2 components Westinghouse will need to fully justify each case to show the arguments and evidence which support the use on non-nuclear codes.

120 Furthermore, the Accumulator Tanks in the Passive Core Cooling System are assigned an Equipment Class C and are therefore designed and constructed to ASME III Class 3 requirements. However the ANS classification for pressurised water reactors defined in ANS-51.1-1983 (Ref. 76) states that Accumulator Tanks are ANS Safety Class 2 and should therefore be designed to ASME III Class 2 requirements.

121 In addition a problem was found with the evidence to support the allocation of a standard Class 1 structural integrity classification for the reactor coolant pump bowl.

122 The Structural Integrity Step 4 Assessment Report, ONR-GDA-AR-11-011 (Ref. 8), provides further details on these matters and the Structural Integrity assessor has taken these matters forward in GDA Issue, **GI-AP1000-SI-06**.

4.4.3 Findings on Safety Classification

123 Several assessors have reviewed Westinghouse's methodology (Ref. 55) and Categorisation (Ref. 56) and consider that Westinghouse has made good progress in this area. Based on their assessments, I consider that Westinghouse has recognised the UK requirements to classify their Systems, Structures and Components, and Westinghouse has developed appropriate internal guidance. I am generally satisfied with their safety function categorisation and equipment classification methodology, and application, for the AP1000, but there are concerns related to the design standards applied to specific SSC. Therefore, there are GDA Issues and Assessment Findings in the individual assessment reports (ONR-GDA-AR-11-002, ONR-GDA-AR-11-004a, ONR-GDA-AR-11-006, ONR-GDA-AR-11-007, ONR-GDA-11-009, ONR-GDA-AR-11-010 and ONR-GDA-AR-11-011 (Ref. 8) which require that this revised methodology should be cascaded through all necessary AP1000 design and safety documentation and taken account of in preparing equipment purchase specifications. GDA Issues are identified in paras 115 and 122 of this report.

4.5 Spent Fuel Pond

124 The primary function of the fuel handling area is to provide for the handling and storage of new and spent fuel.

125 The nature of the diverse hazards from storage of spent fuel makes this a Cross-cutting topic. 4 areas of concern have arisen during the various technical assessments:

- Criticality Control
- Cooling Provisions
- Containment of water
- Long-term storage

126 This report draws upon the detailed assessments undertaken by Fault studies, Criticality, Civil and Radwaste Assessors and I present the key aspects of the ND assessments below for ease of reference.

4.5.1 Criticality

4.5.1.1 Background

- 127 Westinghouse has described the fuel storage systems in the DCD (Ref. 44). The fuel pond consists of a concrete structure with free-standing high density fuel storage racks to maintain a defined separation between fuel elements which, together with integral neutron absorbing material, is intended to maintain the required degree of sub criticality. These rack modules are free-standing, neither anchored to the pool floor nor braced to the pool wall. The spent fuel racks have storage locations for 884 fuel assemblies and five defective fuel assemblies.
- 128 Westinghouse submitted a design based on the use of racks constructed from stainless steel supplemented by sheets of neutron absorber, Metamic™. The pond is designed to store fuel of maximum enrichment 5w% ²³⁵U and utilises two design of racks:
- Region 1 racks maintain the fuel assemblies on a pitch of 278mm and are designed to be sub-critical for fuel of any irradiation, conservatively modelled with unirradiated fuel elements of 5w% ²³⁵U.
 - Region 2 racks maintain a pitch of 228mm and are designed for storage of fuel which complies with design limits on the combination of initial enrichment and irradiation i.e. it relies on the reduction in reactivity due to burnup, e.g. fuel of initial enrichment of 5w% ²³⁵U would require a minimum irradiation of 40Gwd/tU before being placed in a Region 2 rack.
- 129 In Region 1 criticality control is achieved by the geometrical spacing defined by the racking system together with the neutron absorption properties of the boron in the Metamic™.
- 130 Region 2 can not maintain sub-criticality for unirradiated fuel without the presence of soluble boron. Soluble boron concentration of at least 1300ppm is required to satisfy the criteria of $k_{\text{eff}} < 0.95$. This is further discussed in assessment report ONR-GDA-AR-11-009 Appendix A (Ref. 8).

4.5.1.2 Assessment

- 131 It has not been practice in the UK to take into account the reduction in reactivity due to burnup or to rely on soluble neutron poisons; these have been regarded as an additional unquantified safety margin.
- 132 The Criticality Assessor raised RO-AP1000-73 (Ref. 9) asking Westinghouse to demonstrate that:
- the chosen design was ALARP;
 - the calculations were based on appropriate validation; and
 - all appropriate accident scenarios had been considered
- Westinghouse responded in August 2010 by presenting four options:
- i) the burnup credit case described above;
 - ii) replacing the Region 2 racks with Region 1 racks;
 - iii) the same racking arrangements but blanking 2 out of every 4 locations in Region 2;

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- iv) the same racking arrangements but blanking 1 out of every 4 locations in Region 2, i.e. utilising 3 out of 4 locations.
- 133 The Criticality Assessor did not consider that the Westinghouse response to RO-AP1000-073 adequately showed that the spent fuel pond design reduced the risks from storage of spent fuel to ALARP. In particular, some options required a concentration of 1300ppm of boron to ensure sub-criticality under non-accident conditions. This is not consistent with relevant good practice nor IAEA draft guidance (Ref. 63) which recommends that:
- “the presence of a soluble neutron absorber in the storage pond water should not be taken into account in the criticality safety demonstration for normal operation.”*
- 134 At a meeting in Pittsburgh we discussed that options iii and iv appeared to rely on presence of soluble boron and Westinghouse put forward arguments why the loss of boron is unlikely. ND’s view was that that a new design should not have to rely on soluble poisons to ensure sub-criticality and it should be possible to control criticality through geometrical and fixed poisons alone. At the end of the meeting the matter was still unresolved.
- 135 Following the meeting in Pittsburgh ND wrote in letter WEC70261R (Ref. 64) to clarify the position and request that Westinghouse should re-evaluate the options for spent fuel storage and present a solution that achieves criticality control through geometrical control and fixed poisons alone. Westinghouse responded (Ref. 65) with a proposal for a variant of the 3 out of 4 option discussed above, but with credit taken for burnup. ND reviewed this and did not accept that it met relevant good practice.
- 136 A meeting was convened in Manchester in February 2011 to allow Westinghouse to present the early outcomes of their ALARP study. At this meeting, Westinghouse reviewed the options already discussed above and in addition considered:
- Enlarging the pond
 - Building an additional pond
 - Inserting poisoning devices into fuel assemblies
- 137 Westinghouse emphasised that in its view it was not reasonably practicable to enlarge the pond because of civil and seismic requirements, meaning that any solution had to be within the constraint of the existing pond size. It is ND’s view that Westinghouse will need to provide evidence to support their assertion that increasing the size of the spent fuel pond is not reasonably practicable.
- 138 ND identified that the option of all Region 1 racking (option ii) was in line with Relevant Good Practice (RGP) and that the 2 out of 4 (option iii) may offer an equivalent level of safety
- 139 Early calculations indicated that it might be possible to demonstrate safety for option iv with the use of poison inserts placed in the fuel assemblies and this would not need to take credit for burn-up or soluble boron. But ND would need to be convinced that this solution provides an equivalent level of safety as would be achieved from relevant good practice represented by the geometrical control solutions e.g. 2 out of 4 or replacing all Region 2 racks with Region 1.
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4.5.1.3 Findings on Criticality

140 Since no solution was identified which would obviously satisfy both Westinghouse and ND the criticality assessor raised a GDA Issue (see Ref. 8):

***GI-AP1000-RP-01:** Westinghouse to provide a safety case, which demonstrates that criticality control of the spent fuel pool is assured for all foreseeable operating conditions through geometrical control and fixed poisons alone.*

4.5.2 Fuel Cooling

4.5.2.1 Background

141 The spent fuel pool is cooled in normal operation by the Class 2 Spent Fuel Pool Cooling System (SFS). In addition, the Class 2 Normal Residual Heat Removal System (RNS) has the capability of being aligned to take over the cooling function of the SFS. This mode of cooling is limited because it is only fully available when the RNS is not needed for normal shutdown cooling of the reactor (and potentially long-term safety injection for the reactor).

142 Westinghouse states that the AP1000 Spent Fuel Pool design is based on a defence in depth approach that relies on both Class 2 active systems and Class 1 passive systems to provide protection against potential heat-up leading to damage to the stored fuel.

143 Following a postulated complete loss of the Class 2 cooling chain, the pool will heat up and rely on boiling to provide the necessary cooling to the spent fuel. The original Westinghouse assessment predicted this to be a frequent event ($>1 \times 10^{-3}$ per year).

4.5.2.2 Assessment

144 The fault studies assessors had concerns with the design basis safety case for loss of cooling and loss of water inventory faults, which could result in a threat to the cooling of the spent fuel and raised RO-AP1000-54 (Ref. 11).

145 In response to RO-AP1000-54 Westinghouse has proposed two design modifications to reduce the frequency and consequences of pool boiling:

- The calculated frequency for the loss of Class 2 active cooling of the spent fuel pool is dominated by the probability of losing the Component Cooling Water System (CCW) and the Service Water System (SWS). To reduce the frequency of the total loss of active cooling of the spent fuel pool, such that pool boiling is an infrequent event ($< 1 \times 10^{-3}$ per year), Westinghouse has initiated a design change proposal to enhance an existing connection of the Fire Protection System (FPS) to the CCW such that fire protection water can be provided at a sufficient flow rate to allow it to cool the RNS and SFS heat exchangers.
- To relieve the pressure build up within the fuel building as a result of the steam produced by pool boiling, the original AP1000 design had blowout panels which opened to atmosphere on elevated ambient temperature. Westinghouse has predicted that the radiological consequences to a member of the public from steam released via this unfiltered route are small (< 1 mSv). However these calculations do not take into account uncertainties due to the potential presence of fuel crud which could become mobile due to the boiling. The problems associated from the presence of fuel crud are discussed in the Reactor Chemistry Report, ONR-GDA-AR-11-008 (Ref. 8). Also, a non-filtered route to atmosphere is not consistent with SAPs ECV.1, ECV.2 and FA.7. ND and the Environment Agency raised RO-AP1000-43.A5 (Ref.

11) on this topic and in response Westinghouse has initiated a design change proposal to add a passive filtering capability to the blowout panel flowpath, which meets our regulatory expectations and can be progressed during the site specific phase.

146 Completion of the proposed design changes is fundamental to making an acceptable safety case which limits the frequency of pool boiling to less than 1×10^{-3} per year and which meets HSE's expectations on ventilation and preservation of barriers set out in SAPs.

4.5.2.3 Findings on Spent Fuel Pond Cooling

147 In light of the planned modifications, Westinghouse has submitted a new design basis safety case for the spent fuel pool. ND has not the opportunity, yet, to review the submission. ND needs to ensure that Westinghouse develops their safety case for the spent fuel pool and incorporates it in its PCSR and supporting documents.

148 It is therefore not possible to finalise the assessment of the spent fuel pool at this stage and the Fault Studies Assessor has raised a GDA Issue **GI-AP1000-FS-01** (see ONR-GDA-AR-11-004a, Ref. 8). This requires the design basis case developed in GDA Step 4 for the spent fuel pool for the Fault Studies topic area to be cascaded into other technical areas and any new claims clearly identified in the PCSR

4.5.3 Containment of Water

4.5.3.1 Background

149 Civil pool structures that are required to contain water in nuclear plant must employ multiple barriers to prevent leakage. The number of barriers is dependent on the radiological hazard, but the UK Regulator expects in a modern design that at least two barriers would be provided for a spent fuel pool to achieve defence in depth.

150 The minimum barriers required are:

- a primary liner with a leak detection and collection system;
- secondary containment with its own leak detection system and method of collecting or retaining the leak.

4.5.3.2 Assessment

151 The Step 4 civil assessment, ONR-GDA-AR11-002 (Ref. 8) has considered the potential for leakage of borated water through the primary liner and into the structural wall behind.

152 The main concern is that these potential leakage paths could go undetected for a long period of time (chronic leaks), and could result in significant damage/contamination and if finally detected the effect would not be readily quantifiable.

153 The secondary barrier is the CA module structure or the Reinforced Concrete (RC) walls. Currently no measures are included in the design of the SC walls (composite steel-concrete-steel sandwich walls) or HSC suspended floors (half SC construction used for floors which only have one steel plate on the soffit of the slab) to allow detection of leaks through/into these structures. The December 2009 PCSR (Ref. 13) states that a programme of inspection and maintenance will also help prevent such chronic accidents. The steel face plates mask the outer surfaces of walls and the pool floor slab, which will limit any visual inspection.

4.5.3.3 Findings on Containment of Water

154 There is a GDA Issue (**GI-AP1000-CE-04**, see Ref. 8) requesting Westinghouse to carry out an engineering optioneering study of the details for CA20 to ensure that secondary containment, with its own separate leak detection and collection system, is provided. The option should be selected using ALARP principles and should satisfy the following:

- provide secondary collection such that the potential for leakage through the base slab is minimised;
- give positive notice that leakage through the structure was/was not occurring, with appropriate monitoring and measurement; and
- justify that the integrity of the structure will be maintained throughout the lifecycle.

4.5.4 Long-term Storage of Spent Fuel

4.5.4.1 Background

155 Prior to disposal the spent fuel will be stored in the spent fuel pond for a period of time, followed by long-term storage on the site prior to transport for disposal. So at the time of disposal the thermal output of the fuel will have reduced making transport and disposal less onerous. Before the fuel can be transferred from the pond the Licensee will need to ensure that the thermal output is low enough so that during long-term storage on site it does not suffer degradation from thermal radiation which could compromise disposal and transport criteria. This will mean that the required pond capacity must be sufficient to allow the decay heat to reduce to acceptable levels.

4.5.4.2 Radwaste Assessment

156 Whilst operating the fuel handling facilities is the responsibility of the future licensee, it is imperative that Westinghouse ensures the design of the pond is fit for purpose and ALARP. The spent fuel pool was sized for the AP600 and had sufficient capacity to store 619 spent fuel assemblies (Ref. 62) but the increased power rating of the AP1000 over the AP600 led to Westinghouse exploring an increase in the storage capacity (Ref. 62). However, Westinghouse decided that the UK AP1000 design reference would be based on the existing (AP600) size with modified racking to increase the capacity. The sizing of the pool is discussed further in ONR-GDA-AR-11-014 (Ref. 8). This report says that the size of pond needs to take account of many factors such as :

- Operating regime i.e. amount of spent fuel generated per year.
- Acceptable thermal output for fuel to meet interim safe storage criteria.
- Level of radiation from the fuel to which the fuel must have decayed to allow safe transfer from the pond to the interim storage.

4.5.4.3 Radiological Protection Assessment of Spent Fuel Pond Storage

157 The Radiological Protection Assessor considered the pond design from an operator dose point of view. The principal concern is the depth of the pool, because as long as there's enough water between the tops of the assemblies and the water's surface then external dose rates won't be an issue. He was satisfied with this aspect of the design in respect to GDA but there are assessment findings discussed in ONR-GDA-AR-11-009 (Ref. 8).

4.5.4.4 Reactor Chemistry Assessments of Spent Fuel Pond Storage

158 The Reactor Chemistry Assessor considered that fundamental design provisions to control activity in AP1000 appear reasonable, but there is a concern about fuel crud in the pond water becoming mobilised and creating an inhalation hazard and this is discussed further in ONR-GDA-AR-11-008 (Ref. 8). The original AP1000 SFP Ventilation System (VAS) did not include any filtration prior to discharge under normal operations but switched to the Containment Ventilation System (VFS) upon detection of radiation. The VFS system has both High Efficiency Particulate Arrestor (HEPA) filters and charcoal filters on the exhaust. Due in part to concerns of active particulate (fuel crud) by-passing this system ND raised RO-AP1000-43.A5 (Ref. 11) and as a result Westinghouse implemented a design change to include HEPA filtration to the exhaust going to the plant vent. The AP1000 will retain the switching to the VFS train upon detection of radiation to ensure that radioiodine isotopes are absorbed in the VFS carbon bed.

4.5.4.5 Findings for Long-term Storage

159 The design of the spent fuel pool on the nuclear island has to allow a licensee to address the needs of the long-term storage requirements so that spent fuel remains in a condition that would allow it to be transported for disposal. However, the radwaste assessor has raised several assessment findings related to long-term storage of spent fuel, which could impact on the pool design and operation. There is further discussion on this topic in ONR-GDA-AR-11-014 (Ref. 8).

4.5.5 Overall Findings on Spent Fuel Pond

160 ND have raised GDA issues on the spent fuel pond in respect to:

- Criticality
- Fuel cooling
- Containment of water

4.6 Interface with Other Regulators

161 This was undertaken and reported in the individual topic area reports (Ref. 8).

4.7 Fukushima

162 The submissions made by Westinghouse relating to the AP1000 reactor design, and consequently ONR's Step 4 assessment based on them, pre-date the Japanese earthquake and tsunami on 11 March 2011 and the subsequent events at the Fukushima Dai-ichi site in Japan.

163 In the UK, the Secretary of State for Energy and Climate Change requested Her Majesty's (HM) Chief Inspector of Nuclear Installations to examine the circumstances of the Fukushima accident to see what lessons could be learnt to enhance the safety of the UK nuclear industry. HM Chief Inspector has produced Interim and Final Report (Refs 78 and 79) which identify any implications for the UK nuclear industry.

164 To ensure that the lessons learnt in the Interim and Final Reports are applied to the AP1000 reactor design, ONR has raised a further GDA Issue on Westinghouse to

address any lessons to be learnt for the generic AP1000 design. GDA Issue **GI-AP1000-CC-03** requests Westinghouse to demonstrate how they will take account of the lessons learnt from the unprecedented events at Fukushima, both from those lessons and recommendations that are identified in the HM Chief Inspector's Interim and Final Reports (Refs 78 and 79), and including those arising out of Westinghouse's own internal reviews. The complete GDA Issue and associated actions are formally defined in Annex 2 of this report.

5 CONCLUSIONS

- 165 In my opinion, Westinghouse has improved its control of the design and there is now in place a Design Reference based on a Design Reference Point of the 16 September 2010. However there is an ongoing work stream to incorporate the design changes that have been agreed by ND for inclusion in GDA. Through TQ, RO and RI responses we have made up for many of the gaps and shortfalls in the December 2009 PCSR. A replacement PCSR was issued at the end of March 2011, which was not assessed at this stage and will require assessment to confirm it is fit for purpose. I have raised a GDA Issue on this subject.
- 166 I found that the Westinghouse arrangements for defining limits and conditions did not meet our expectations. They principally described how US regulatory requirements can be met, reflecting the DCD Rev. 17 AP1000 design. I have raised a GDA Issue on this subject.
- 167 The extent of non-metric items appears excessive and could have a significant impact on safety. Westinghouse need to undertake further work to modify the design to ensure it meets UK requirements in respect to GDA or provide a safety justification for remaining imperial elements. A GDA Issue has been raised by mechanical engineering.
- 168 I consider that Westinghouse has developed an appropriate methodology to meet the UK requirements for the classification of their Systems, Structures and Components. The methodology has been applied reasonably in most areas except for Structural Integrity and Control and Instrumentation where GDA Issues have been raised. However, this methodology should be cascaded through all necessary AP1000 design and safety documentation and to be taken account of in preparing equipment purchase specifications.
- 169 I identified concerns with the Spent Fuel Pool design related to Criticality, Spent Fuel Cooling, Containment and long-term storage of spent fuel and ND have raised GDA issues on the spent fuel pond in respect to:
- Criticality
 - Fuel cooling
 - Containment of water
- 170 The GDA Issues from the Cross-cutting assessment are listed in Annex 2. In summary these relate to:
- Establishing arrangements to identify and advise the future Licensee of the conditions and limits necessary in the interests of safety.
 - Providing final consolidated versions of GDA submission documentation, including the SSER, the MSL and design reference document as the key references to any DAC / SODA the Regulators may issue at the end of GDA.
 - Demonstration of how Westinghouse will be taking account of the lessons learnt from the unprecedented events at Fukushima, including from Westinghouse's internal reviews and from those lessons and recommendations that are identified in the ONR Chief Inspector's interim and final reports.
- 171 Overall, based on the sample undertaken in accordance with ND procedures, I am broadly satisfied that the claims, arguments and evidence laid down within the PCSR and supporting documentation submitted as part of the GDA process present an adequate

safety case for the generic AP1000 reactor design. The AP1000 reactor is therefore suitable for construction in the UK, subject to satisfactory progression and resolution of GDA Issues to be addressed during the forward programme for this reactor and assessment of additional information that becomes available as the GDA Design Reference is supplemented with additional details on a site-by-site basis.

5.1 Key Findings from the Step 4 Assessment

172

The assessment has concentrated on providing an overview of the assessments undertaken by topic specialists. A consequence of this is that I have only identified issues where there is a systemic weakness affecting several topic areas and where resolution is Cross-cutting in nature. Most GDA Issues on the AP1000 have arisen through the detailed assessments undertaken within individual topic areas and resolution would be specific to that topic. Assessment findings are also identified in the individual topic areas reports.

5.2 Cross-cutting GDA Issues

173

I conclude that the GDA Issues listed in Annex 2 must be satisfactorily addressed before Consent will be granted for the commencement of nuclear island safety related construction.

6 REFERENCES

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 - 3 *ND BMS. Technical Reports.* AST/003 Issue 3. HSE. November 2009.
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 - 4 *Safety Assessment Principles for Nuclear Facilities.* 2006 Edition. Revision 1. HSE. January 2008. www.hse.gov.uk/nuclear/SAP/SAP2006.pdf.
 - 5 *Nuclear power station generic design assessment – guidance to requesting parties.* Version 3. HSE. August 2008. www.hse.gov.uk/newreactors/guidance.htm.
 - 6 *Western European Nuclear Regulators' Association (WENRA). Reactor Harmonization Working Group. WENRA Reactor Safety Reference Levels.* WENRA. January 2008.
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 - 7 AP1000 Step 4 Assessment Plans:
 - *GDA Step 4 Internal Hazards Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 09/068. December 2009. TRIM Ref. 2009/449193.
 - *GDA Step 4 Civil Engineering and External Hazards Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 10/001. June 2010. TRIM Ref. 263191.
 - *GDA Step 4 Probabilistic Safety Analysis Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 09/059. Revision 1. April 2010. TRIM Ref. 2009/466174.
 - *GDA Step 4 Fault Studies Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 09/048. April 2010. TRIM Ref. 2009/455978.
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 - *GDA Step 4 Mechanical Engineering Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 09/045. November 2009. TRIM Ref. 2009/437146.
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 - *GDA Step 4 Radioactive Waste and Decommissioning Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 09/067. November 2009. TRIM Ref. 2009/457050.
 - *GDA Step 4 Security Assessment Plan for the Westinghouse AP1000.* HSE-ND Assessment Plan AR 09/072. April 2010. TRIM Ref. 2010/62497.

8 AP1000 Step 4 Assessment Reports:

- *Step 4 Internal Hazards Assessment of the Westinghouse AP1000[®] Reactor.* ONR Assessment Report ONR-GDA-AR-11-001, Revision 0. TRIM Ref. 2010/579786.
- *Step 4 Civil Engineering and External Hazards Assessment of the Westinghouse AP1000[®] Reactor.* ONR Assessment Report ONR-GDA-AR-11-002, Revision 0. TRIM Ref. 2010/581528.
- *Step 4 Probabilistic Safety Analysis Assessment of the Westinghouse AP1000[®] Reactor.* ONR Assessment Report ONR-GDA-AR-11-003, Revision 0. TRIM Ref. 2010/581527.
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- *Step 4 Radiological Protection Assessment of the Westinghouse AP1000[®] Reactor.* ONR Assessment Report ONR-GDA-AR-11-009, Revision 0. TRIM Ref. 2010/581522.

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Table 1

Relevant Safety Assessment Principles for Cross-cutting Topics Considered During Step 4

SAP No.	SAP Title	Description
n/a	No specific SAPs have been cited in this report, however individual topic assessments have cited the relevant SAPs to their detailed assessment (Ref. 8).	n/a

Table 2

AP1000 Design Changes Requested by Westinghouse for Inclusion in GDA

DCP Number	Title	Category
EPS-GW-GEE-005	1 st Bay ventilation and sump (BDS)	(4)
EPS-GW-GEE-009	Battery Room Ventilation	(3)
APP-GW-GEE-2083	Addition of HVAC HEPA Filtration to Radwaste Building Exhaust	(3)
APP-GW-GEE-2085	Addition of HVAC HEPA Filtration to the Fuel Handling Area Exhaust (VAS)	(3)
APP-GW-GEE-2084	VAS, VFS, and VHS HVAC Changes (Area monitoring)	(3)
APP-GW-GEE-1942	Increase in the Exhaust Vent Stack Height to meet UK Regulations (Applicability Extension for DCP-916)	(2)
APP-GW-GEE-2286	Changes to Diverse Actuation System (DAS) Voting Logic and Associated Architecture	(2)
APP-GW-GEE-2287	Changes to Diverse Actuation System (DAS) Platform Implementation	(2)
APP-GW-GEE-2411	PMS modification (interlocks)	(1)
APP-GW-GEE-2409	Implementation of IEC standards for EPS electrical systems design	(2)
APP-GW-GEE-2517	Addition of Passive Filtration to the Fuel Handling Area Blow-out Panel	(1)
APP-GW-GEE-2070	Changes to RNS Cooldown Using the Fire Protection System	(4)
EPS-GW-GEE-010	Pump casing material change for KSB Main Coolant Pumps	(2)
APP-GW-GEE-796	DWS, FPS, and VWS Containment Penetration Area Thermal Overpressure Protection	(2)
APP-GW-GEE-908	Squib Valve Actuation Time Adjustments	(2)
APP-GW-GEE-963	Waste Gas System Components Compliance with the National Electrical Code	(2)
APP-GW-GEE-1099	Proposed Change to Increase Pressurizer Span due to RCS Depressurization Issues	(1)

Table 2
AP1000 Design Changes Requested by Westinghouse for Inclusion in GDA

DCP Number	Title	Category
APP-GW-GEE-1119	Additional Miscellaneous Changes to the Enhanced Shield Building Design	(2)
APP-GW-GEE-1193	Changes to AP1000 Containment Vessel Design Specification	(2)
APP-GW-GEE-1195	Squib Valve Activation Loads on Piping/Modules and Valve Envelope Changes	(1)
APP-GW-GEE-1258	Addition of Reactor Trip to Mitigate the Inadvertent PRHR Transient	(2)
APP-GW-GEE-1294	FWS/CVS Isolation on SGS High Alarm	(2)
APP-GW-GEE-1307	Shield Building Air Inlet Flow Area Design Change	(1)
APP-GW-GEE-1378	VES Eductor Bypass Line	(2)
APP-GW-GEE-1402	PXS Changes due to Gas Accumulation	(1)
APP-GW-GEE-1422	Design change to Variable Frequency Drives for 50 Hz plants	(2)
APP-GW-GEE-1630	Add Hatch and Padeyes to RNS Valve Room for Maintenance	(2)
APP-GW-GEE-1636	Correction of PSS Fluid System Sampling Deficiencies	(2)
APP-GW-GEE-1656	MP50 Expansion Joint Additions	(2)
APP-GW-GEE-1766	Separation of Chemical and Volume Control System (CVS) Zinc Acetate and Hydrogen Injection Paths	(2)
APP-GW-GEE-1793	ADS Stage 4 Piping Temperature Increase under Plant Normal Operating Conditions	(1)
APP-GW-GEE-1879	Modifications to CCS Containment Isolation Logic and Piping	(2)
APP-GW-GEE-1938	Modification of Pressurizer Pressure Low-2 and Low-3 Setpoints	(2)
APP-GW-GEE-1958	Containment Vacuum Relief Design Change	(2)

Table 2

AP1000 Design Changes Requested by Westinghouse for Inclusion in GDA

DCP Number	Title	Category
APP-GW-GEE-2019	Revised Technical Specifications for PCS Air Cooling and Spent Fuel Pool Makeup	(2)
APP-GW-GEE-2081	MSIV Compartment Structural Design Changes	(2)
APP-GW-GEE-2189	PXS High Point Level Switch Pipe Size Change	(2)
APP-GW-GEE-2129	Revised Leak Chase Details	(4)
APP-GW-GEE-2090	Structural Module Design Details Including Connections to the Reinforced Concrete Basemat	(3)
APP-GW-GEE-2434	CA Module Liner Plate Material Change	(4)

Annex 1

Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business - Cross-cutting Topics – AP1000

There are no assessment findings for this topic area.

Annex 2

GDA Issues - Cross-cutting Topics – AP1000

WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

GDA ISSUE

LIMITS AND CONDITIONS

GI-AP1000-CC-01 REVISION 0

Technical Area		CROSS CUTTING	
Related Technical Areas		All	
GDA Issue Reference	GI-AP1000-CC-01	GDA Issue Action Reference	GI-AP1000-CC-01.A1
GDA Issue	In respect of any operation that may affect safety, Westinghouse should have arrangements to identify and advise the future Licensee of the conditions and limits necessary in the interests of safety. These arrangements need to ensure that there is an appropriate link between the analysis documented in its safety case and the associated operational limits and conditions derived from the safety case, such that the Licensee can operate in accordance with the safety case.		
GDA Issue Action	<p>Westinghouse to demonstrate how the necessary safety-related limits and conditions during plant operations or maintenance are specified during the design stage. As part of this demonstration Westinghouse need to show that they have arrangements to establish an appropriate link between the analysis documented in its safety case and eventual operational limits and conditions it devises such that the Licensee will be able to operate in accordance with the safety case.</p> <p>ONR expect Westinghouse to:</p> <ul style="list-style-type: none"> Describe a process for developing a complete set of Tech Specs and provide further information to demonstrate how plant Operating Rules (ORs) or Operating Technical Specifications (OTSs), chemistry guidelines and maintenance schedules can be derived from the design basis limits and claims made in the GDA PCSR. Describe the processes that will be followed to ensure that the ORs, OTSs and/or maintenance schedules ultimately adopted are consistent with the design basis limits. Describe how it is intended to capture, track and review significant safety assumptions derived from the safety case in particular those supporting PSA and fault studies which could effect siting, design, construction or operations. Undertake a targeted and proportionate (graded) approach in which the greatest attention and care is applied to the identification and implementation of conditions and limits with the greatest importance to safety. The safety case methodologies should therefore employ a hierarchical approach to deriving Limits and Conditions that are appropriate to the risks and hazards addressed. <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

Annex 2

WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

GDA ISSUE

LIMITS AND CONDITIONS

GI-AP1000-CC-01 REVISION 0

Technical Area		CROSS CUTTING	
Related Technical Areas		All	
GDA Issue Reference	GI-AP1000-CC-01	GDA Issue Action Reference	GI-AP1000-CC-01.A2
GDA Issue Action	<p>Westinghouse to provide evidence of the application of their arrangements for devising Limits and Conditions and how these may be subsequently converted into Operating Rules and other procedures which ensure the plant is capable of being operated safely within the design basis envelope defined by the GDA. As part of the evidence Westinghouse to provide:</p> <ul style="list-style-type: none"> • A tabulated list of the key limits and conditions for those systems, structures and components (SSCs), including high integrity items, that provide the delivery of important safety functions for the UK AP 1000. Such limits and conditions may relate to temperature, pressure, primary coolant flow rate, chemistry, secondary water and steam conditions and so on. • A list of the key Examination, Maintenance, Inspection and Testing (EMIT) requirements for the UK AP 1000 which are assumed within the safety case. <p>The GDA AP1000 fault schedule could be used to identify the SSCs for each operating state.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

Annex 2

**WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT
GDA ISSUE
LIMITS AND CONDITIONS
GI-AP1000-CC-01 REVISION 0**

Technical Area		CROSS CUTTING	
Related Technical Areas		All	
GDA Issue Reference	GI-AP1000-CC-01	GDA Issue Action Reference	GI-AP1000-CC-01.A3
GDA Issue Action	Produce PCSR sub-chapter on Limits and Conditions as appropriate to capture the outcome of Actions 2 and 3 within this GDA Issue. With agreement from the Regulator this action may be completed by alternative means.		

Annex 2

WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

GDA ISSUE

PCSR TO SUPPORT GDA

GI-AP1000-CC-02 REVISION 3

Technical Area		CROSS CUTTING	
Related Technical Areas		None	
GDA Issue Reference	GI-AP1000-CC-02	GDA Issue Action Reference	GI-AP1000-CC-02.A1
GDA Issue	<p>Westinghouse to submit a safety case to support the GDA Design Reference and then to control, maintain and develop the GDA submission documentation, including the SSER, the MSL and design reference document and deliver final consolidated versions of these as the key references to any DAC/SODA the ONR or the Environment Agency (the joint Regulators) may issue at the end of GDA.</p> <p>This GDA Issue is raised by both the ONR and Environment Agency</p>		
GDA Issue Action	<p>Westinghouse to submit to the joint Regulators a consolidated PCSR and associated references which provides the necessary claims, arguments and evidence to substantiate the adequacy of the AP1000 described by Design Reference Point (DRP) UKP-GW-GL-060 revision 2 and make available via the Westinghouse Website a public version of the consolidated PCSR, the Design Reference Document and the Master submission List.</p> <p>Westinghouse is required to carry out a review and reassessment of their PCSR. This review should cover:</p> <ul style="list-style-type: none"> • PCSR UKP-GW-GL-793 Revision 0. • Weaknesses identified with the PCSR UKP-GW-GL-732 Revision 2. • Alignment of the DRP and MSL with the PCSR and associated references and ensure there is no adverse affect on impacted documents from the DCPs awaiting incorporation. • The application of UK safety classification for modifications. • Comments against the draft replacement PCSR UKP-GW-GL-793 Revision A. • Agreed responses TQs, ROs and RIs generated during GDA Steps 2, 3, and 4. <p>Based on their review, Westinghouse should either confirm that their PCSR UKP-GW-GL-793 Revision 0 is the extant GDA safety case and is suitable and sufficient to substantiate the design defined in UKP-GW-GL-060 Revision 3 or submit a revised PCSR to the Regulators as necessary.</p> <p>Westinghouse is required to provide their safety case, Design Reference Document UKP-GW-GL-060 and the Master Submission List UKP-GW-GLX-001 and place subsequent updates on their website (removing commercial information, and security sensitive information)</p> <p>With agreement from the joint Regulators this action may be completed by alternative means.</p>		

Annex 2

WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

GDA ISSUE

PCSR TO SUPPORT GDA

GI-AP1000-CC-02 REVISION 3

Technical Area		CROSS CUTTING	
Related Technical Areas		None	
GDA Issue Reference	GI-AP1000-CC-02	GDA Issue Action Reference	GI-AP1000-CC-02.A2
GDA Issue Action	<p>Westinghouse is required to make and implement arrangements to control, maintain and develop the GDA safety submission documentation. This must include the SSER, MSL and design reference documents. As part of this action, Westinghouse shall deliver final consolidated versions of these documents as the key references to any DAC/SODA ONR or the Environment Agency (the joint Regulators) may issue at the end of GDA.</p> <p>This should involve the incorporation of all relevant amendments into the impacted documentation associated with design changes, including the Design Reference UKP-GW-GL-060 MSL and the PCSR. This should include any other additionally agreed design changes associated with other GDA issue Resolution Plans.</p> <p>Westinghouse arrangements shall ensure no modification to the design or safety case, which may affect safety, is made except in accordance with agreed arrangements and will provide for the classification of modifications according to their safety significance.</p> <p>Evidence the joint Regulators expect to see to address this action:</p> <ol style="list-style-type: none"> 1. Application of Westinghouse due processes, including QA and technical reviews for the control and development of the GDA submission documentation contained within the SSER, MSL and design reference document to address <ol style="list-style-type: none"> 1.1. GDA Issue resolution, 1.2. Agreed design changes 1.3. Any other updates agreed with the Regulators. 2. Application of Westinghouse due processes, including technical reviews, Independent Review and QA consolidation checks on final GDA submission documentation contained within the SSER, MSL and design reference document to be referenced from any DAC/SODA ONR or the Environment Agency may issue. The joint Regulators will require: <ol style="list-style-type: none"> 2.1. Evidence that review comments have been managed and incorporated in the final consolidated documentation as necessary. 3. Timely delivery of final consolidated GDA submission documentation including SSER, MSL and design reference document to be referenced from any DAC/SODA ONR may issue. Westinghouse will need to provide a public version of these documents made available via their website. To facilitate our assessments /inspections in this area, in addition to the submission of the documentation the joint Regulators will require: <ol style="list-style-type: none"> 3.1. the programme of deliverables of amended impacted design change documentation which will need to allow sufficient time for us to complete our assessments before ONR or Environmental Agency may issue any DAC/SODA. <p>With agreement from the joint Regulators this action may be completed by alternative means.</p>		

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WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT
GDA ISSUE
PCSR TO SUPPORT GDA
GI-AP1000-CC-02 REVISION 3

Technical Area		CROSS CUTTING	
Related Technical Areas		None	
GDA Issue Reference	GI-AP1000-CC-02	GDA Issue Action Reference	GI-AP1000-CC-02.A3
GDA Issue Action	<p>Westinghouse to implement the outstanding GDA agreed design changes, by incorporating the change details into all impacted DR, the MSL documentation including the PCSR, ER.</p> <p>The scope of this work should include those design changes already agreed for inclusion in GDA Step 4 but not incorporated and any additional design changes arising as part of other GDA issues resolution plans or arising during the GDA close out stage.</p> <p>Evidence ONR or the Environment Agency (the joint Regulators) expect to see to address this action includes:</p> <ol style="list-style-type: none"> 1. A revised Design Reference Document that shows the DCPs agreed by the regulators for inclusion in GDA which were not fully incorporated at the DRP of 16 September 2010. 2. A delivery schedule which; <ol style="list-style-type: none"> 2.1. Identifies when those DCPs identified in item 1 above and any subsequent DCPs agreed by the regulators for inclusion in GDA will be incorporated into the impacted support documentation in the MSL and DR 2.2. Identifies what design change details will be carried over into the site specific Phase, supported by a justification for this later delivery 3. Delivery of 2a part of the schedule and define the quality assurance arrangements to be applied for 2b. <p>To facilitate our assessments in this area the programme of deliverables of impacted GDA submission documentation should be phased to allow for early assessment of the process performance.</p> <p>It is noted that some changes may not be incorporated into the GDA submission documentation until the site specific phase. This work needs to be clearly identified and agreed with the joint Regulators prior to the end of GDA.</p> <p>Westinghouse to review the Design Reference Point and update the Design Reference Document as necessary to reflect incorporation of the design changes, submit this to the regulators and place any update on their website (removing commercial information, and security sensitive information) prior to the final GDA SSER submission.</p> <p>With agreement from the joint Regulators this action may be completed by alternative means.</p>		

Annex 2

WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

GDA ISSUE

CONSIDER AND ACTION PLANS TO ADDRESS THE LESSONS LEARNT FROM THE
FUKUSHIMA EVENT

GI-AP1000-CC-03 REVISION 2

Technical Area		CROSS CUTTING	
Related Technical Areas		All	
GDA Issue Reference	GI-AP1000-CC-03	GDA Issue Action Reference	GI-AP1000-CC-03.A1
GDA Issue	Westinghouse are required to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including those lessons and recommendations that are identified in the HM Chief Inspector's interim and final reports.		
GDA Issue Action	<p>Westinghouse to address the lessons learnt from their internal review following the Fukushima event relevant to GDA for the AP1000.</p> <p>Evidence we expect to see provided to address this action includes:</p> <ol style="list-style-type: none"> 1) Internal review summary report 2) A plan for the necessary actions arising from the internal review report 3) Modification of the following, as appropriate: <ol style="list-style-type: none"> a. Design Reference and SSERs b. Submission Master List documentation (Levels 1-3), including amendments to submission level 2 design information such as SDMs in accordance with GDA Issue GI-AP1000-TR.02 c. Resolution Plans in response to other relevant GDA Issues 4) Confirmation that any design changes resulting from these reviews for inclusion into GDA will be managed in accordance with the Westinghouse Level III Procedure Design Reference Point Change for GDA. UKP-GW-GAP-026 Revision 0. <p>With agreement from the Regulators this action may be completed by alternative means.</p>		

Note. GDA Issue G-AP1000-TR.02 above should read GI-AP1000-CC-02.

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WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

GDA ISSUE

CONSIDER AND ACTION PLANS TO ADDRESS THE LESSONS LEARNT FROM THE
FUKUSHIMA EVENT

GI-AP1000-CC-03 REVISION 2

Technical Area		CROSS CUTTING	
Related Technical Areas		All	
GDA Issue Reference	GI-AP1000-CC-03	GDA Issue Action Reference	GI-AP1000-CC-03.A2
GDA Issue	Westinghouse are required to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including those lessons and recommendations that are identified in the HM Chief Inspector's interim and final reports.		
GDA Issue Action	<p>Westinghouse to address the lessons learnt that are relevant to GDA for AP1000 from HM Chief Inspector Nuclear Installations' interim and final reports.</p> <p>Evidence we expect to see provided to address this action includes:</p> <ol style="list-style-type: none"> 1) A Plan to address the relevant actions arising from HM Chief Inspector's interim and final reports. 2) Modification of the following, as appropriate: <ol style="list-style-type: none"> a. Design Reference and SSERs b. Submission Master List documentation (Levels 1-3), including amendments to submission level 2 design information such as SDMs in accordance with GDA Issue GI-AP1000-TR.02 c. Resolution Plans in response to other relevant GDA Issues 3) Confirmation that any design changes resulting from these reviews for inclusion into GDA will be managed in accordance with the Westinghouse Level III Procedure Design Reference Point Change for GDA. UKP-GW-GAP-026 Revision 0. <p>With agreement from the Regulators this action may be completed by alternative means.</p>		

Note. GDA Issue G-AP1000-TR.02 above should read GI-AP1000-CC-02.

Further explanatory / background information on the GDA Issues for this topic area can be found at:	
GI-AP1000-CC-01 Revision 0	Ref. 72.
GI-AP1000-CC-02 Revision 3	Ref. 73.
GI-AP1000-CC-03 Revision 2	Ref. 74.