

New Reactors Programme
GDA close-out for the AP1000 reactor
GDA Issue GI-AP1000-CC-02: PCSR to support GDA

Assessment Report: ONR-NR-AR-16-038
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EXECUTIVE SUMMARY

Westinghouse Electric Company LLC (Westinghouse) is the reactor design company for the **AP1000**[®] reactor. Westinghouse completed Generic Design Assessment (GDA) Step 4 in 2011 and paused the regulatory process. It achieved an Interim Design Acceptance Confirmation (IDAC) which had 51 GDA issues attached to it. These issues require resolution prior to award of a Design Acceptance Confirmation (DAC) and before any nuclear safety-related construction can begin on site. Westinghouse re-entered GDA in 2014 to close the 51 issues.

This report is the Office for Nuclear Regulation's (ONR's) assessment of the Westinghouse **AP1000** reactor design in the cross-cutting area. Specifically, this report addresses GDA Issue GI-AP1000-CC-02, PCSR to support GDA.

This GDA issue arose in Step 4 due to:

- inadequacies in the generic Pre-Construction Safety Report (PCSR);
- a need to update the design reference on which the regulators' GDA assessments are based; and
- a requirement for a consolidated Master Submission List (MSL) to provide a definitive reference to the documents on which the regulators' assessments are based.

In response to the issue Westinghouse has provided a significantly revised PCSR, updated to take account of changes required in responding to the other GDA issues. This has been supplemented by a revised design reference, updated to include design changes accepted by the regulators during the GDA closure phase. In addition, a revised and updated MSL has been provided.

My assessment conclusion is:

- Westinghouse has revised the PCSR to take account of ONR's comments on and concerns about previous versions and drafts, as well as chapter-specific matters raised by ONR assessors in closing out other GDA issues.
- I have reviewed all comments on individual chapters of the revised PCSR provided by ONR assessors during the GDA closure phase, and I am satisfied that the consolidated version, submitted as UKP-GW-GL-793 Revision 1 represents an adequate response to this issue, and provides a basis for ONR to consider whether to issue a DAC for the UK **AP1000** reactor.
- I consider that the final design reference (UKP-GW-GL-060 Revision 10) provides an accurate compilation of key documents, including proposed design changes, which provide the necessary definition of the design of the UK **AP1000** reactor assessed by the regulators in GDA.
- During the GDA closure phase, ONR has gained a significantly better appreciation of, and confidence in, the design change management processes applied by Westinghouse and I am satisfied that this provides a rigorous means of categorising and tracking the consequences of the approved design changes for the safety case for the UK **AP1000** reactor.
- Westinghouse has fulfilled the requirement of this issue to submit a revised and updated MSL. I have examined the structure of the final MSL and sampled its contents and I have found no inaccuracies or matters of concern.
- I conclude that UKP-GW-GLX-001 Revision 1 and UKP-GW-GLX-001 Revision 2 taken together form an acceptable MSL for the purposes of GDA and provide a basis for a DAC for the UK **AP1000** reactor.

- The Environment Agency is satisfied that Westinghouse's arrangements for the control of updates to the final GDA submission documentation including the ER, MSL and DRP for the UK **AP1000** reactor design, are adequate.

The Environment Agency is satisfied that the GDA issue has been addressed appropriately and can be closed.

In summary I am satisfied that GDA Issue GI-AP1000-CC-02 can be closed.

LIST OF ABBREVIATIONS

ALARP	As low as reasonably practical
CAP	Corrective Action Process
CLB	Current licensing basis
CSA	Conceptual Security Arrangements
DAC	Design Acceptance Confirmation
DCD	Design Control Document
DCP	Design Change Proposal
DRP	Design Reference Point
EDCD	European Design Control Document
ER	Environment Report
GDA	Generic Design Assessment
IAEA	International Atomic Energy Agency
IDAC	Interim Design Acceptance Confirmation
MSL	Master Submission List
MSQA	Management of Safety and Quality Assurance
ONR	Office for Nuclear Regulation
PCSR	Pre-Construction Safety Report
PSA	Probabilistic Safety Analysis
QMS	Quality Management System
RO	Regulatory Observation
RP	Requesting Party
RQ	Regulatory Query
SAPs	Safety Assessment Principles
SoDA	Statement of Design Acceptability
SSD	System Specification Document
TAGs	Technical Assessment Guides
USNRC	United States Nuclear Regulatory Commission
WENRA	Western European Nuclear Regulators Association

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1 INTRODUCTION

1.1 Background

1. This report presents the assessment conducted as part of the close-out of the Office for Nuclear Regulation (ONR) Generic Design Assessment (GDA) for the Westinghouse Electric Company LLC (Westinghouse) **AP1000**[®] reactor design within the cross-cutting topic area.
2. GDA follows a stepwise approach in a claims-argument-evidence hierarchy. In Step 2, the claims made by Westinghouse were examined and in Step 3 the arguments that underpin those claims were examined. The Step 4 assessment reviewed the safety aspects of the **AP1000** reactor in greater detail, by examining the evidence, supporting the claims and arguments made in the safety documentation. Westinghouse completed Step 4 in 2011 and then opted to suspend the process. At that time, it had achieved an Interim Design Acceptance Confirmation (IDAC), which had 51 GDA issues attached to it. These GDA issues require resolution prior to award of a complete Design Acceptance Confirmation (DAC) and before any nuclear safety-related construction of this reactor design can begin. Westinghouse re-entered the GDA process in 2014 to close the 51 GDA issues.
3. The GDA Step 4 report on cross-cutting topics (Ref. 1) is published on the ONR website (www.onr.org.uk/new-reactors/ap1000/reports.htm), and this provides the assessment relevant to this GDA issue. Further information on the GDA process in general is also available on the ONR website (www.onr.org.uk/new-reactors/index.htm).

1.2 Overview of GI-AP1000-CC-02

1.2.1 The AP1000 Reactor PCSR

4. The Westinghouse safety case for the **AP1000** reactor is based around a generic Pre-Construction Safety Report (PCSR) and a suite of supporting documentation.
5. In December 2008, Westinghouse issued their first PCSR for GDA, UKP-GW-GL-732 Revision 0 (Ref. 2). ONR 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), which itself was largely based on the US Design Control Document produced for the US nuclear regulator (USNRC). In April 2009, Westinghouse revised their PCSR and submitted a revision, UKP-GW-GL-732 Revision 1 (Ref. 3). This version addressed several editorial matters but made no technical changes to the report.
6. In reviewing Westinghouse's proposed programme of work to revise the PCSR in mid-2009 ONR reminded Westinghouse that neither the US DCD nor the EDCD address UK-specific needs. 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 (ALARP).
7. To inform ONR's Step 4 assessments, in December 2009 Westinghouse submitted the next revision of the PCSR, UKP-GW-GL-732 Revision 2 (Ref. 4), but ONR found this was still overly reliant on the EDCD and did not contain sufficient claims, arguments and evidence to substantiate the **AP1000** reactor design and demonstrate ALARP. However, by using Regulatory Queries (RQs) and Regulatory Observations (ROs), the assessors were able to complete their Step 4 assessments based on the December 2009 version, and the DAC issued in December 2011 was therefore based on that version of the PCSR.
8. Throughout Step 4 Westinghouse developed a consolidated version of the PCSR to take account of ONR's comments, and responses to ROs and RQs. 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 (see Ref. 5).

9. Westinghouse's review and approval process on the consolidated PCSR involved two steps. The first step was to review each chapter; this was conducted by Westinghouse and involved an initial review to confirm that the chapter meets the basic acceptability criteria followed by a detailed technical review performed by nominated technical leads within Westinghouse. This chapter review process is documented in working instruction UK-GDA-WI-201 Revision 0 (Ref. 6) and involves a number of stages to allow prompt assessment and response if the chapter is unacceptable.
10. The second step is a final review and verification of the consolidated report and was documented in a Westinghouse Level III procedure UKP-GW-GAP-027 Revision 0 (Ref. 7). The key step within this process is the involvement of a Red Book Review Team. The Red Book Review Team is a technical team responsible for the review of the PCSR in its entirety, looking at readability, consistency and technical accuracy.
11. In December 2010, the draft consolidated PCSR was submitted (UKP-GW-GL-793 Revision A (Ref. 8)). ONR assessors were unable to provide substantive comments at the time because they were busy completing their assessment and writing their reports. On 30 March 2011, Westinghouse submitted their final consolidated PCSR, UKP-GW-GL-793 Revision 0 (Ref. 10), but this was too late to be assessed as part of Step 4.
12. As a result, at the end of Step 4, GDA Issue CC-02 was raised (Ref. 11) which required Westinghouse to submit a consolidated PCSR and associated references which provide the necessary claims, arguments and evidence to substantiate the adequacy of the **AP1000** reactor design as described by the up-to-date Design Reference Point (DRP) document.

1.2.2 Design Reference

13. GDA Requesting Parties (RPs) are required to submit a Design Reference which lists all the documents that describe the design of the reactor and associated plant referred to by the GDA submissions. ONR will expect this to be 'frozen' at a specific date known as the DRP.
14. In May 2010, Westinghouse submitted the Design Reference defining the DRP as 23 December 2009, UKP-GW-GL-060 Revision 0 (Ref. 12). Following assessment of the DRP, the regulators concluded that the hierarchy of design documentation was unclear and was not consistent with the corresponding submission tracking sheet.
15. The shortfalls in Westinghouse's control of the Design Reference were communicated in letter WEC70190R (Ref. 13) requesting action to be taken. That letter provided details of a six-step process developed by the regulators to control changes to the GDA Design Reference. Westinghouse was requested to consider this process and incorporate it within their design change arrangements for GDA.
16. A review of the contents of the next submitted Design Reference (UKP-GW-GL-060 Revision 1 (Ref. 14)) with a design freeze date of 16 September 2010 indicated that the design base had changed without formal notification to the regulators. This situation was confirmed during a joint regulators' Management of Safety and Quality Assurance (MSQA) inspection (Ref. 15) when a number of Westinghouse licensing engineers and technical area experts interviewed could not explain the role of the Design Reference in relation to the UK GDA process and therefore were inconsistent in their approach when using the DRP to respond to RQs and ROs.
17. Responding to RO-AP1000-103 (Ref. 16) – which required Westinghouse to provide details of any design changes made during GDA, in November 2010 and subsequently in January 2011 – Westinghouse formally submitted lists of design changes requesting

agreement from the regulators for inclusion into GDA via the six-step process (Refs 17 and 18).

18. However, the impact of design changes on the referenced documents remained unclear and a number of discrepancies were identified. ONR issued a further action under RO-AP1000-103 requesting Westinghouse to provide assurance that the design changes have been considered in the safety submission and assessed where appropriate. In response, in March 2011, Westinghouse agreed to provide a report identifying any gaps caused by design changes in the Design Reference and MSL documentation. It was agreed that this could not be done during Step 4, however, and the regulators confirmed to Westinghouse that this would be included as part of cross-cutting Issue GI-AP1000-CC-02 (Ref. 19).

1.2.3 Master Submission List

19. As discussed in ONR's *Generic Design Assessment: Guidance to Requesting Parties* (Ref. 20), during GDA ONR will request submission of a selection of the PCSR supporting references so that more detailed information can be examined. Consequently, ONR requires the RP to put in place management arrangements to keep track of the documents submitted, of subsequent changes to these documents, and of documents withdrawn, etc. Key to these arrangements is an MSL, which is a 'live' document that allows ONR to understand and reference precisely what constitutes the latest versions of the GDA submissions.
20. In September 2010, Westinghouse was requested by RO-AP1000-088 A4 (Ref. 21 TRIM 2010/431178) to generate an MSL, to meet the requirements of the Interface Protocol (Ref. 22). In response Westinghouse submitted an MSL in October 2010 which aligned to the submission tracking sheet. The MSL was assessed and provided a good base; however, further development was required. For example, it did not include enough details on the submission route of the documentation and did not include the PCSR and Environment Report (ER) chapters.
21. The MSL is a key deliverable of the GDA project; therefore, the QA arrangements supporting the generation and development of the document required assessment. In response to RO-AP1000-103 actions, Westinghouse undertook a 100% review of the MSL against the transmittal log, DRP and PCSR, and rectified errors identified. Further alignment needed to be achieved between the DRP, PCSR and ER, and a revision was submitted in May 2011. With that in mind Westinghouse performed an independent verification of the MSL prior to final submission (Ref. 23). As reported in ONR's Step 4 report on MSQA, the verification performed by Westinghouse provided ONR with confidence in the accuracy and completeness of the submitted MSL (Ref. 24).
22. Following further amendments, Westinghouse submitted a final version of the MSL (Ref. 25) in October 2011. It is this MSL that underpins the IDAC issued in December 2011.

1.2.4 Control of Design Changes

23. There are three sources which can trigger a design change within Westinghouse: designers, utilities and/or regulators. In the current design finalisation stage, a design change is only initiated if a design safety feature could be improved or if a design feature could be improved from an operation perspective; this reduces unnecessary cost and impact to the design documentation. When a Design Change Proposal (DCP) is initiated, it is first classified by the initiator and – dependent on the class – will either be discussed at the Westinghouse Change Control Board or discussed with the responsible manager. DCPs are classified 1, 2 or 3 (Class 1 being the highest), in accordance with the procedural requirements. The criteria are largely associated with the impact to the US DCD commitment and the potential cost to the company; they do

not consider the safety consequence of an inadequately conceived or executed modification, which would be the normal expectation for the UK.

24. To meet UK regulatory expectations, Westinghouse started applying a UK safety categorisation to the DCP process in July 2009 limited to three categories; this was later extended to four categories. This is documented in Westinghouse's DCP initiation form and is termed as 'UK Safety Categorisation for Modification'. There is no correlation between the UK Safety Categorisation for Modification and the DCP class.
25. Westinghouse introduced a project instruction, UKP-GW-GAP-026 Revision 0 (Ref. 26), on controlling the DRP for GDA after the 16 September 2010 freeze. This instruction incorporated the regulators' six-step process, freezing the Design Reference for the purposes of the GDA project.
26. ONR's concerns arising from the MSQA inspection (including the inconsistent and incorrect application of the UK Safety Categorisation for Modification to the categorisation of DCPs) led to a Corrective Action Process (CAP) being raised by Westinghouse to address the findings. The CAP included a number of commitments, looking at increasing the involvement of UK licensing impact assessment, performing training and education on the UK safety categories, and ensuring that the PCSR is flagged as an impacted document for UK impacted changes. Westinghouse's actions to address this CAP are discussed in Section 3.3.1.

1.2.5 Issue and Resolution Plan

27. As discussed in ONR's Step 4 report on cross-cutting issues (Ref. 1), ONR's dissatisfaction with the PCSR, DRP and MSL documents led to Issue GI-AP1000-CC-02 being raised. The substantive matters in this issue (as with the other 50 GDA issues) need to be resolved to ONR's satisfaction before ONR will consider issuing a DAC for the **AP1000** reactor. The issue was raised jointly with the Environment Agency which had similar concerns regarding the **AP1000** reactor ER and its relationship with the DRP and the completeness of the documents referenced in the MSL. At the end of GDA the Environment Agency will, if satisfied, issue a Statement of Design Acceptability (SoDA).
28. GI-AP1000-CC-02 stated:
 - *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.*
29. The SSER referred to in the issue is the *Safety, Security and Environment Report*, an umbrella term for three separate reports covering nuclear safety, nuclear security and environmental matters respectively.
30. ONR identified three actions for Westinghouse to undertake in order to close out the issue and these are set out in detail in Annex 1. In brief the actions required Westinghouse to:
 - (i) deliver final consolidated versions of the SSER and MSL as key references to the DAC/SODA;
 - (ii) apply proper quality control of necessary changes to the SSER, MSL and Design Reference, in particular to ensure that Westinghouse due processes are applied to the management of any proposed design modifications which affect safety; and

- (iii) implement design changes in all impacted documents (DRP, MSL, PCSR and ER).
31. Westinghouse provided a resolution plan for addressing these actions which was accepted by ONR as representing a realistic plan for the issue's closure as part of its decision to issue the IDAC in December 2011. In preparation for the restart of GDA in 2015, a revised resolution plan for Issue CC-02 was submitted by Westinghouse and accepted by ONR (Ref. 27).

1.3 Scope

32. The main focus of this assessment is the adequacy of the final consolidated PCSR to support the granting of a DAC for the **AP1000** reactor. To a large extent, my assessment provides an overview of the assessments of individual PCSR chapters undertaken by ONR topic specialists.
33. This report should be read in conjunction with the Step 4 reports on cross-cutting issues (Ref. 1) and MSQA (Ref. 24) to appreciate the totality of the ONR assessment of the PCSR for the **AP1000** reactor.

1.4 Method

34. This assessment has been undertaken in accordance with internal guidance on the mechanics of assessment within ONR (Ref. 29).

2 ASSESSMENT STRATEGY

2.1 Assessment Approach

35. The assessment draws on the views of ONR assessors across the full range of technical assessment topics. Where appropriate, this evidence was assessed against the expectations and requirements of the SAPs and other guidance considered relevant. Forming the basis of the assessment undertaken to prepare this report were:

- submissions made to ONR in accordance with the resolution plan;
- interaction with ONR technical assessment specialists as appropriate;
- technical (Level 4) meetings to progress lines of enquiry.

36. The following subsections provide an overview of the outcome from each of the information exchange mechanisms in further detail.

2.1.1 Regulatory Queries

37. The resolution of many of the GDA issues required changes to the PCSR. And many RQs have been submitted by ONR (and answered by Westinghouse) during the closure phase; these are listed in individual issue closure reports.

38. The following RQs have been raised by ONR assessors specifically regarding the contents of particular chapters of the PCSR, and are therefore directly relevant to the closure of Issue CC-02. The assessment topic area generating the RQ is also noted, and all RQs are filed in Ref. 30:

- RQ-AP1000-1407 – Fault Studies
- RQ-AP1000-1499 – Reactor Chemistry
- RQ-AP1000-1729 – Reactor Chemistry
- RQ-AP1000-1703 – Structural Integrity
- RQ-AP1000-1786 – Internal hazards
- RQ-AP1000-1670 – Fuel & Core
- RQ-AP1000-1663 – Probabilistic Safety Analysis
- RQ-AP1000-1547 – External Hazards
- RQ-AP1000-1566 – External Hazards
- RQ-AP1000-1749 – Control & Instrumentation
- RQ-AP1000-1318 – Electrical
- RQ-AP1000-1347 – Electrical
- RQ-AP1000-1500 – Electrical
- RQ-AP1000-1787 – Electrical
- RQ-AP1000-1566 – Human Factors
- RQ-AP1000-1685 – Human Factors
- RQ-AP1000-1703 – Structural Integrity

39. In addition a number of RQs have been raised regarding the Design Reference and Westinghouse's management of DCPs. In particular:

- RQ-AP1000-1323
- RQ-AP1000-1331
- RQ-AP1000-1405
- RQ-AP1000-1407

2.1.2 Technical Meetings

40. I held regular, routine Level 4 meetings with Westinghouse to discuss progress with the closure of this issue. Many other meetings and workshops across the full range of technical areas considered aspects which are relevant to this issue, and the output from those meetings is taken into account, as appropriate, in the Assessment Notes/Reports provided to support closure of this issue.

2.2 Standards and Criteria

41. The ONR assessments relevant to this issue were undertaken in line with the requirements of NS-PER-GD-014 (Ref. 31). The standards and criteria adopted within this assessment are principally the SAPs (Ref. 32), internal Technical Assessment Guides (TAGs) (Ref. 33), relevant national and international standards and relevant good practice informed from existing practices adopted on UK nuclear licensed sites. Further details are provided below.

2.2.1 Safety Assessment Principles

42. Due to the range of technical areas covered by Issue CC-02, the relevant SAPs are detailed as appropriate in the individual Assessment Notes. It is worth noting that the 2014 Edition (Revision 0) of the SAPs has been used when performing the assessment described in the Assessment Notes, whereas the original Step 4 assessments used the 2006 Edition.

2.2.2 Technical Assessment Guides

43. The principal TAG (Ref. 34) used as part of this assessment is:
- NS-TAST-GD-051, Revision 4; *The Purpose, Scope and Content of Nuclear Safety Cases*

2.2.3 Other ONR Guidance

44. ONR's *Guidance to Requesting Parties* ONR-GDA-GD-001 Revision 3 (Ref. 20) contains guidance on ONR's expectations of the contents of a generic PCSR and has been consulted in preparing this assessment.

2.2.4 National and International Standards and Guidance

45. There are both International Atomic Energy Agency (IAEA) standards (Ref. 35) and Western European Nuclear Regulators Association (WENRA) Reference Levels (Ref. 36) of relevance. It should be noted that the latest version of the SAPs has been benchmarked against both IAEA and WENRA guidance.

2.3 Use of Technical Support Contractors

46. No technical support work was undertaken to support my assessment of the submissions made in response to GI-AP1000-CC-02.

2.4 Integration with Other Assessment Topics

47. GDA requires the submission of an adequate, coherent and holistic generic safety case. Regulatory assessment cannot therefore be carried out in isolation as there are often safety issues of a multi-topic or cross-cutting nature. To assess the adequacy of the submissions provided by Westinghouse for GI-AP1000-CC-02 I have sought input from all ONR assessment disciplines. In particular, I have requested each discipline to provide an Assessment Note (or Assessment Report, as they considered appropriate) setting out the assessor's views on the adequacy of relevant chapters of the PCSR. The findings of these Assessment Notes are considered in Section 3 below.

2.5 Out-of-scope Items

48. In November 2011, at the end of Step 4, Westinghouse provided a list of items which it considered to be outside the scope of GDA (Ref. 37). In February 2017, at the end of the closure phase for this issue Westinghouse confirmed that the list provided in 2011 remains valid (Ref. 38). I requested ONR's **AP1000** reactor assessment delivery managers to check (Ref. 39) for accuracy; no inaccuracies were reported and I consider Ref. 37 to provide the definitive list of GDA out-of-scope items.

3 ONR ASSESSMENT OF GDA ISSUE GI-AP1000-CC-02

49. This assessment has been carried out in accordance with HOW2 guide NS-PER-GD-014, *Purpose and Scope of Permissioning* (Ref. 31).

3.1 Scope of Assessment Undertaken







50. The bulk of this assessment concerns the adequacy of the revised version of the PCSR to support the awarding of a DAC by ONR. Incidental to that the assessment also looks at the acceptability of the inclusion in the UK **AP1000** reactor of a large number of design changes that have been proposed by Westinghouse, and their incorporation into the DRP.

51. As noted earlier, GI-AP1000-CC-02 is a joint regulatory issue and the assessment of the Environment Agency in relation to the closure of this issue is summarised in Section 4. The aim of the assessment described in this section is to establish whether Westinghouse has addressed the requirements set out in Issue GI-AP1000-CC-02 to the satisfaction of ONR. However, both regulators must be satisfied with Westinghouse’s response to the issue in order for it to be formally closed.

3.2 AP1000 Reactor Pre-Construction Safety Report

52. Action 1 of GI-AP1000-CC-02 (see Annex 1) essentially requires Westinghouse to update the 2009 PCSR and ensure that it is aligned with the Design Reference Point (DRP). The DRP at the end of Step 4 was fixed at 16 September 2010 in UKP-GW-GL-060 Revision 5. During the pause following Step 4, and throughout the closure phase of GDA the DRP has been updated to include changes to the reference documents and, in particular, to include a significant number of DCPs. ONR expects that the final PCSR that underpins the DAC will be made consistent with the design reference documents in the final revision of the DRP.

53. The UK **AP1000** reactor PCSR is arranged into 28 chapters and assigned by Westinghouse into 6 volumes as shown below:

					
Volume 1	Volume 2	Volume 3	Volume 4	Volume 5	Volume 6
Executive Summary and Safety Case Management	Engineering Principles and Plant Overview	Faults and accident Assessment	Engineering Substantiation	Waste and Accident Management	Conclusions
Executive Summary 1. Introduction 2. Safety Case 3. Management of Safety 4. Generic Site Characteristics	5. Engineering Principles 6. Plant Description and Operation 7. Lifecycle Engineering and Safety	8. Fault and Accident Analysis 9. Internally Initiated Faults 10. PSA 11. Internal Hazards 12. External Hazards 13. Human Factors 14. AP1000 Plant ALARP Evaluation	15. Engineering Substantiation 16. Civil Engineering 17. Mechanical Engineering 18. Electrical Systems 19. C&I 20. Structural Integrity 21. Chemistry 22. Fuel Design 23. Containment and Ventilation	24. Radiation Protection 25. Accident management 26. Radioactive waste management 27. Decommissioning and End of Life Aspects	28. Conclusions

3.2.1 PCSR Update Strategy

54. Consistent with the CC-02 resolution plan, in July 2015 Westinghouse submitted individual strategies for the update of each of the 28 chapters (Ref. 40), with each

revised chapter being scheduled for submission between August 2015 and July 2016. Initial revisions of the chapters were designated as Revision 0A.

55. The Westinghouse strategy for revision of the 2009 PCSR was the same for each chapter:
- confirm that weaknesses identified by ONR in the December 2009 PCSR (Ref. 4) have been addressed and improved in the March 2011 PCSR (Ref. 10);
 - review resolution of the comments provided by the ONR on the December 2010 PCSR (Ref. 8);
 - review RQs, ROs, and the Regulatory Issue (RI) generated during GDA Steps 2-4;
 - consider impacts on the chapter of new DCPs included in the 31 January 2015 DRP;
 - identify any expected impacts on the chapter from GDA Issue resolution;
 - explain how references to the EDCD would be removed (and if necessary replaced); and
 - implement self-identified required updates (e.g. Corrective Action items).
56. The general update strategy was discussed at routine Level 4 meetings during 2015 and agreed by ONR as representing an acceptable approach.

3.2.2 ONR Review of the March 2011 PCSR

57. In WEC-REG-0228 (Ref. 40) dated 31 July 2015, Westinghouse identified 11 chapters of the extant March 2011 PCSR (Ref. 10) which were considered ready for ONR to assess, even though they had not been updated to reflect non-technical changes since that time (such as the Health & Safety Executive Nuclear Directorate changing to ONR). These were the opening, non-technical chapters (Chapters 1-5, 7) or the closing chapters which Westinghouse considered to be unlikely to require substantive revision (Chapters 24-28).
58. All ONR **AP1000** reactor assessors were invited to provide comments on these chapters. Most comments related to the already identified lack of updating, with some suggesting areas for improvement. The ONR Internal Hazards Assessor also provided comments on Chapter 11 (which Westinghouse had not been seeking at this stage). The ONR assessors' comments were generally brief and 'high-level'; none of the comments expressed major concerns about the overall thrust or content of the revised chapters. The collated responses were provided to Westinghouse (Refs 42 and 43) in late October 2015 for their consideration in producing the revised versions of these chapters.

3.2.3 ONR Review of PCSR Revision 0A

59. The Westinghouse strategy for updating the March 2011 PCSR chapters involved first 'presenting' to ONR the revisions to the chapter that address each of the seven items identified in the general update strategy (listed above). These presentations were generally made at the relevant Level 4 technical meeting, or sometimes at CC-02 Level 4 meetings.
60. The March 2011 PCSR is designated Revision 0 of Westinghouse document UKP-GW-GL-793. Subsequent revisions to submitted chapters are designated as Revision 0A (and Revision 0B etc. as necessary). Once all chapter revisions had been

presented and all ONR comments addressed, Westinghouse issued the whole PCSR as Revision 1 of UKP-GW-GL-793, and it is the Revision 1 version that underpins the DAC.

61. Westinghouse's PCSR update strategy proposed delivery of Revision 0A chapters between November 2015 and May 2016; in general each of the chapters were delivered according to Westinghouse's PCSR update schedule.
62. ONR assessors were required to ensure that discussion of the relevant Revision 0A chapters took place at the appropriate technical Level 4 meetings and workshops, and led to the generation of a number of RQs (see Section 2.1.1); this provided Westinghouse with some feedback on ONR's views of the chapter updates, although this did not meet Westinghouse's expectations that ONR would undertake formal assessment of each submitted chapter and provide feedback within three months. Pressure of assessors' workload on the closure of individual technical issues meant that formal ONR assessment and feedback to Westinghouse on the Revision 0A chapters was not going to be practicable within the expected three month response time.
63. In order to provide feedback to Westinghouse (as well as informing the regulators' GDA sub-Programme Board), following the delivery of the final Revision 0A chapter in May 2016, ONR developed a 'PCSR Health Check' process in which assessors were asked to complete a standard checklist showing the red-amber-green (RAG) status of the contents of each chapter, including a short narrative explaining the rationale for each RAG marking. The collated responses formed the *UK AP1000 reactor PCSR Technical Health Check* (Ref. 44) which ONR provided to Westinghouse on 8 July 2016.

3.2.4 Findings of PCSR Revision 0A Health Check (July 2016)

64. This section provides a short summary of the findings from ONR's PCSR Health Check. The complete report is in Ref. 44.
65. Assessors were asked to answer 14 questions relating to any PCSR chapters that were relevant to their technical disciplines, giving a RAG rating for each. In addition there was space on the form for assessors to provide a narrative, explaining the RAG ratings and adding any other relevant information.
66. Red ratings were given in answer to at least one question for each chapter except Chapter 7, with a large number of amber ratings across the whole PCSR. ONR assessed the overall 'adequacy rating' derived by allocating a number to each RAG score, of 42%, and concluded that (at the Revision 0A stage) the PCSR "does not yet meet the ONR expectations for this stage of development and that considerable improvement will be necessary before an acceptable generic PCSR can be achieved, and issue CC02 closed" (Ref. 44).
67. Key shortfalls were identified in Chapter 11 (Internal Hazards), Chapter 19 (Control and Instrumentation) and Chapter 21 (Reactor Chemistry). However, ONR's report noted that although significant efforts would be needed by Westinghouse to improve the quality in these areas, ONR's interactions with Westinghouse indicated that these shortfalls could possibly be corrected in time to meet the December 2016 deadline for finalising the PCSR updates.
68. Westinghouse provided feedback on the ONR PCSR Health Check (Ref. 45), noting that in many cases the assessors' concerns had been, or were in the process of being, addressed in further Revisions to the affected chapters. ONR subsequently provided comments on that Westinghouse feedback regarding Chapters 5, 7-11, 14, 16 and 20 (Ref. 46).

3.2.5 Final Development of the AP1000 Reactor Generic PCSR

69. During the period from July 2016 to January 2017 Westinghouse implemented further amendments to all of the PCSR chapters. For some (Chapters 1-4, 7, 24-28), this was a minor tidying-up exercise with no changes of substance, leading to a final update to Revision 0B. For most of the key technical chapters, interactions between ONR and Westinghouse continued at Level 4 and further revisions were provided mostly at Revision 0B, but with some going up to Revision 0E (see Annex 2). The work involved in reaching these final chapter versions is set out in a series of ONR Assessment Notes which I requested from each work-stream area (Ref. 47).
70. As set out in the individual Assessment Notes/Reports (Ref. 48), ONR assessors are generally satisfied with the final content and quality of the PCSR chapters. The level of satisfaction is not uniform although none of the assessors have advised that any of the chapters should be rejected as inadequate.
71. Although ONR assessors are largely satisfied with the individual PCSR chapters, pressures on assessors' time during the closure phase meant that ONR was not able to undertake a holistic review of the complete revised PCSR. Consequently, ONR's view on the acceptability of the complete revised PCSR is a matter of balanced judgement. This is discussed further in Section 3.2.8.
72. In addition, taking into account ONR technical assessors' views from the Assessment Notes/Reports, I propose a 'minor shortfall' is raised in relation to the PCSR (see Section 3.7) This is as follows:
 - To ensure greater clarity in the presentation of the safety case, in developing the generic PCSR into the site-specific version, the licensee should consider making extensive use of the claims-arguments-evidence formalism.

3.2.6 Westinghouse Quality Control of PCSR Changes

73. Westinghouse maintain the configuration of the PCSR, ER and security reports (SSER) in accordance with the Quality Management System (QMS) applicable to the whole Westinghouse corporation. Westinghouse notes that their update and approval of the SSERs is governed by the following quality assurance arrangements.
 - *Project Quality Plan for the UK Generic Design Assessment* UKP-GW-GAH-001 (Ref. 49)
 - *Document Control* WEC 6.1 (Ref. 50)
 - Prescribes that documents are produced and approved in accordance with procedural arrangements and ensures that records are collected, stored and maintained.
 - *Change Control for the AP1000 Plant Program* WEC 3.4.1 (Ref. 50)
 - Defines the process required to propose, evaluate and implement a change to the **AP1000** design.
 - Requires categorisation of modifications based on their safety significance.
 - Requires a Revision History be included in subsequent revisions of all configuration controlled documents, including the SSERs.
 - *Safety Analysis Reports* WEC 3.5.3 (Ref. 50)
 - Establishes the responsibilities and requirements for providing input to nuclear plant safety analysis reports and equivalent documents.
 - *Control of Supplier Generated Documents* WEC 7.7 (Ref. 50)
 - Establishes the responsibilities for disposition of documents submitted by suppliers.
 - *Pre-Construction Safety Report (PCSR) Approval Process* UKP-GW-GAP-027 (Ref. 51)

- Provides for documentation of verification and review of the PCSR chapters by affected functional groups within the corporation as required by WEC 6.1 and WEC 3.5.3*.
74. The Step 4 report on MSQA (Ref. 24) considered the adequacy of the PCSR configuration control arrangements and concluded that:
- “The Chapter review and the Consolidated Report final review and verification processes have suitable arrangements to ensure consistency and technical accuracy of the GDA product”
75. Since that time, the Westinghouse processes for ensuring PCSR configuration control have remained the same apart from some minor updates. I have examined the key document that has been applied to configuration control of the UK **AP1000** reactor PCSR update and consolidation during the GDA closure phase (Ref. 51) and the undertakings with regard to this aspect in the Issue Resolution Plan (Ref. 27) and I am satisfied that, applied diligently, this provides Westinghouse with an acceptable degree of configuration control.

3.2.7 Safety Case ‘Road Map’

76. At the end of Step 4 Westinghouse provided a Safety Case Road Map (UKP-GW-GLX-700, Revision 0 (Ref. 52)) which is a matrix mapping the regulatory submissions made during GDA to sections and subsections of the PCSR and the ER. This was a substantial, 200-page document which mapped every RQ, RO and RI to specific parts of the PCSR and ER. In addition, all DCPs in the 16 December 2010 DRP which were considered to have relevance for the safety case were listed and where appropriate mapped to the most relevant sections of the PCSR/ER. The Step 4 ‘road map’ was not subject to detailed review by ONR and conclusions regarding its accuracy are not possible.
77. The road map is a comprehensive document reflecting Westinghouse’s judgement of the safety case matrix at the end of Step 4, but applying its format to cover the closure phase submissions is less onerous provided configuration control of PCSR/ER changes is properly implemented. As discussed above, since late Step 4 Westinghouse has applied a rigorous configuration control process to all PCSR/ER updates. This obviates the need for mapping of changes due to RQs in the closure phase. Consequently, the road map for the GDA closure phase (UKP-GW-GL-700, Revision 1 (Ref. 53)) only maps onto the PCSR/ER those DCPs accepted into GDA during the closure phase.
78. In addition the document provides a mapping to PCSR/ER chapters of documents generated by Westinghouse at the request of the UK regulators, the results of which may impact the UK ‘current licensing basis’ (ie the PCSR/ER and supporting references). Westinghouse procedure UKP-GW-GAP-147 Revision 0 (Ref. 54) requires the UK current licensing basis (CLB) to be reviewed whenever it undertakes an **AP1000** plant ‘activity’. An **AP1000** plant activity is defined as anything that alters or creates configuration information. This includes:
- creation of new UK-specific documents that may or may not be submitted to ONR;
 - modification, addition or removal of a structure, system, or component;
 - modification or creation of a procedure (eg operating, start-up, maintenance, testing and pre-operational procedures) that affects plant performance or a method of control of a function described in the UK CLB;

* Note that in February 2016 Westinghouse notified the regulators of a change in numbering of documents in their Global Management System including the QMS. The QMS documents referred to in this report use the numbering system in existence prior to this change.

- change to a method of evaluation supporting the claims and arguments underpinning the UK CLB or used in the safety analyses; and
 - modification or creation of a new test or experiment.
79. Westinghouse notes (Ref. 54) that **AP1000** activities include (but are not limited to):
- DCPs (all classes);
 - non-conformances;
 - revision of design documentation;
 - issuance of new specifications;
 - issuance of a new calculation note;
 - issuance of a new drawing;
 - changes to any of the UK CLB (including editorial and consistency changes); and
 - changes to Codes or Standards, and Engineering & Design Coordination Reports.
80. As a consequence, various activities undertaken by Westinghouse in the closure phase are designated as '**AP1000** activities' and reviewed against the procedure. Those activities that are identified as potentially altering configuration documentation are assigned as 'Affected Document List' items and are included in the mapping set out in the closure phase road map.
81. I have examined the UK CLB review process document (Ref. 54) and sampled the documents in the Safety Case Road Map 'Affected Documents List' and I am satisfied that the process is robust and that it has been duly applied by Westinghouse in identifying documents in that list.

3.2.8 Conclusions on the PCSR

82. As discussed above, although ONR technical assessors noted some caveats regarding individual revised chapters of the PCSR, there are none that fundamentally undermine the document's overall adequacy as an exposition of the safety case for the UK **AP1000** reactor. One minor shortfall has been raised in relation to the claims-arguments-evidence chain of reasoning and this will be for a future licensee to consider.
83. However, pressures on assessors' time during the closure phase meant that ONR was not able to undertake a holistic review of the complete revised PCSR, and so ONR's view on the acceptability of the complete PCSR, as an accurate representation of the **AP1000** reactor safety case, is a matter of balanced judgement. That judgement must take account of:
- the acceptability to ONR technical assessors of individual PCSR chapters;
 - ONR's satisfaction with the extensive work undertaken by Westinghouse to close all of the GDA issues;
 - the application by Westinghouse of strict quality control processes to the revision of the PCSR; and
 - reassurance from the safety case road maps, both for Step 4 and for the closure phase, that Westinghouse has incorporated the changes into the PCSR that are necessary to take account of matters raised by ONR throughout GDA.
84. Taking into account all of these, my conclusion is that overall the revised UK **AP1000** reactor PCSR (UKP-GW-GL-793 Revision 1 (Ref.55)) provides an adequate underpinning for ONR to issue a DAC.
85. Clearly it will be a matter for a future licensee to develop its site-specific PCSR to justify the start of construction, and that must accurately reflect the basis for the Design Acceptance Confirmation. ONR's assessment of the adequacy of the generic PCSR

gives confidence that UKP-GW-GL-793 Revision 1 will provide an acceptable starting point for the licensee's development of the site-specific PCSR. Nevertheless, to ensure that a future licensee takes full cognisance of all of ONR's findings throughout both Step 4 and the closure phase, I recommend the following Assessment Finding:

- **CP-AF-AP1000-CC-01:** The future licensee should undertake a thorough review of the generic PCSR and ensure that the basis for the site-specific PCSR is consistent with all commitments arising both from the resolution of Regulatory Observations and Regulatory Issues from Step 4, and from the closure phase of GDA.

3.3 Design Reference Point

86. As stated in Section 1.2.2, Westinghouse submitted a design reference during Step 4, UKP-GW-GL-060 Revision 1 (Ref. 14) reflecting a DRP of 16 September 2010. This document was revised several times to address inaccuracies leading to Revision 5 (Ref. 56) in November 2011 (with the same September 2010 freeze date), but this was too late to allow interrogation by ONR within GDA Step 4. Nevertheless, ONR accepted this version of the design reference to support the iDAC.
87. The design reference, UKP-GW-GL-060 Revision 5 comprised five tables:
- Table 1: A list of the principal reference documents (Tier 1) which describe the criteria to which the **AP1000** plant was designed and the principles upon which design documentation is dependent.
 - Table 2: A list of system specification documents (Tier 2) which describe the safety-significant **AP1000** plant systems, the safety and environmental issues associated with them and how these issues are addressed and controlled.
 - Table 3: A list of design specifications (Tier 3) for safety-significant **AP1000** plant components and systems which establish the requirements for design, fabrication, quality assurance, inspection, test, analysis, construction and operation of a component and/or embedded software.
 - Table 4: A list of DCPs written before 16 September 2010 that should be considered part of the UK **AP1000** design. These DCPs largely resulted from design work and learning outside of the GDA process and were also applicable to the standard **AP1000** design being developed outside the UK. Whether they are incorporated in the Tier 1 - 3 design documents was indicated.
 - Table 5: A list of DCPs that ONR had, at the request of Westinghouse, accepted into GDA during Step 4 (under the six-step process discussed in Section 1.2.2). Some were GDA-driven, while others were initiated separately by Westinghouse and identified for inclusion in the UK **AP1000** design. Many of these were written after the declared reference date of 16 September 2010. Almost all were marked as being unincorporated into the Tier 1 - 3 design documents.
88. Following the resumption of GDA, in May 2015 Westinghouse submitted Revision 6 of the DRP (UKP-GW-GL-060, Revision 6 (Ref. 57)) updated to the freeze date of 31 January 2015. Table 6 of the DRP document listed more than 1500 DCPs approved by Westinghouse between September 2010 and January 2015 for inclusion in the **AP1000** reactor standard plant. Westinghouse had assessed these DCPs against the UK criteria for categorising modifications according to safety significance. All the DCPs in Table 6 were judged by Westinghouse to be Category 3 or 4.

89. In Table 7 of the revised DRP, Westinghouse listed 63 DCPs approved during the period September 2010 to January 2015 which it had assessed as being UK safety significance Category 1 or 2. In compliance with the arrangements put in place during Step 4 (the six-step process), Westinghouse formally requested ONR's agreement for these DCPs to be brought within the scope of GDA. I requested the paperwork associated with each of these DCPs from Westinghouse and sought the advice of relevant ONR assessors on the acceptability of each DCP. Following advice from ONR assessors, in February 2016 (Ref. 58) I informed Westinghouse that although ONR accepted 22 that of these DCPs could be brought within the scope of GDA, further consideration would be required of the remainder.
90. While ONR was considering acceptance of the DCPs in DRP Revision 6, Westinghouse requested that the regulators accept a further nine category 1 or 2 DCPs into GDA. As with the previous set of DCPs, I circulated the detailed descriptions of each DCP to relevant ONR assessors for advice. Following advice from ONR assessors, in May 2016 I was able to write to Westinghouse to confirm that these DCPs plus those outstanding from ONR's review of the 63 in Table 7 of the DRP could be accepted into GDA (Ref. 59). Similarly, I was able to confirm acceptance into GDA of the final tranche of three Category 2 DCPs in September 2016 (Ref. 60).
91. Following minor textual amendments to the DRP, in January 2017 Westinghouse submitted Revision 10 (Ref. 61) with a freeze date of 31 March 2016. Table 8 of that document notes those DCPs (all Category 3 and 4) generated to implement changes that resulted from GDA close-out and accepted by Westinghouse into the UK design after 31 March 2016. As discussed earlier, Category 3 and 4 DCPs do not require acceptance by the regulators.

3.3.1 Westinghouse Design Change Management

92. As discussed in the Step 4 cross-cutting report (Ref. 1), ONR's primary concern regarding the design reference was the extent to which the UK **AP1000** reactor safety case was affected by the design changes listed in Tables 4 and 5 of the September 2010 DRP. Westinghouse has stated that its strategy for UK-specific design changes is not to undertake any detailed design work (including incorporating them in the design basis transient analysis) until quality assurance arrangements and a programme of deliverables are in place with a UK customer (ie during site licensing). In the Fault Studies area, ONR raised Issue GI-AP1000-FS-02 (Design Reference Point and Adequacy of Design Basis Analysis) (Ref. 62) to better understand the Westinghouse approach to the incorporation of DCPs into the transient analysis.
93. With regard to the DRP, GI-AP1000-CC-02 requires Westinghouse to update the design reference and to ensure that due processes are applied to the management of any proposed design modifications which affect safety. It is therefore vital that the regulators have confidence in the processes which Westinghouse applies to the categorisation and control of DCPs, their incorporation into the Tier 1-3 documents in the DRP and tracking of unincorporated DCPs to ensure that they are implemented as appropriate in the licensing phase.
94. As discussed in Section 1.2.4 following an MSQA inspection Westinghouse raised a Corrective Action relating to the inconsistency in the application of the UK safety category to DCPs. An update on the progress made against the Corrective Action was provided under the cover of letter WEC000541 (DCP_JNE_000569) dated 1 April 2011 (Ref. 63). This was too late for ONR to review the application of the revised arrangements during Step 4.
95. The Westinghouse procedure for assigning a UK safety category to DCPs is set out in UKP-GW-GAP-026 *Design Reference Point Change for GDA* (Ref. 26). A Category (from 1 to 4) is chosen initially by the responsible 'licensing engineer' and is

subsequently reviewed and confirmed by a DRP panel. All DCPs confirmed by the panel as UK Category 1 and 2 are required to be submitted to the regulators for acceptance into GDA before inclusion in the DRP. Category 3 and 4 design changes do not need acceptance by the regulators and can be automatically included in the DRP.

96. To test Westinghouse's application of this categorisation process I sampled the forms for 11 DCPs which had been through the DRP panel review process (Ref. 64) and found no inconsistencies in the licensing engineer's or the panel's judgement.
97. To gain a better understanding and appreciation of the processes by which design changes were included within the safety case documentation several meetings were held with Westinghouse during the closure phase. Meetings were initiated by ONR assessors in the Fault Studies, Control & Instrumentation, Structural Integrity and Cross-Cutting areas, some of which involved the participation of the Environment Agency.
98. The following key observations can be drawn from the Contact Records from these meetings (Refs 65 to 68):
 - The **AP1000** reactor design at a point in time is described by:
 - System Specification Documents (SSDs) – which are summarised in Table 2 of the DRP;
 - Design Specification Documents – which are summarised in Table 3 of the DRP; and
 - Lower-level documents such as datasheets and drawings which are referenced from SSDs and Design Specification Documents but not included in the DRP.
 - DCPs do not define the design or provide functional requirements. They do not represent signed-off design requirements.
 - The UK **AP1000** plant DRP, against which the PCSR is written (and supporting 'licensing documents' and environmental/security reports), does include DCPs. So the PCSR could state that a particular UK-specific feature exists (or will exist) and take credit for it, even if a DCP is unincorporated.
 - The PCSR, supporting "licensing documents" and environmental reports are not design documents and therefore do not appear in the DRP (Tables 1 - 3).
 - The basis of safety case reports are 'licensing documents' and not design documents. As a result they do not appear in the DRP (Tables 1 - 3). They can be considered to be extensions to the PCSR, where complex material has been pulled out to be reported separately.
 - Westinghouse applies a 'stage gate' process for each DCP, i.e. every DCP must pass through at least one stage gate to proceed further. Gates 1 - 4 include increasing levels of senior oversight and widening impacts (eg generic design versus all projects). GDA issues tend to be considered at Stage Gate 3 level. There is scope for iteration between Westinghouse and the customer as to whether a design change is required (eg if commercial aspects are key).
 - Design release is at different stages (eg procurements, construction, commissioning etc.). The design and supporting documentation are progressed accordingly at each stage through a formal process. Detailed design (c.f.

functional design) may only be pursued at an appropriate stage. This can be at different stages in different projects.

- Westinghouse's design release process (APP-GW-GAP-615 (Ref. 69)) pulls together a configuration set; from this all changes are considered in the round (ie all open items and impacts are considered as a package at release). Each plant project has an associated Project Execution Plan and this rolls up any country-specific aspects reflecting technical requirements.
 - A DCP that was raised in eg Step 4, or during the 'GDA pause' when Westinghouse was away from the UK, that applies to the standard plant is likely to result in SSDs and Design Specification Documents being updated, as well as being reflected in any applicable licensing documents (US, China and, going forward, the UK PCSR).
 - A DCP that is UK specific, whether raised during Step 4 or the closure phase, will not result in any changes being made to SSDs and Design Specification Documents during GDA – this is delayed until a customer is in place and UK design work starts. However, 'licensing documents' (the PCSR, basis of safety case reports etc.) will, if necessary, be updated to reflect the DCP during GDA.
 - Operational aspects are dealt with in integrated system validation testing, where Westinghouse works jointly with future operators throughout the build programme to plant commissioning. There are some fleet-level manuals but Westinghouse implements the integrated system handover with the customer directly.
 - Westinghouse uses a database tool called SmartPlant™ Foundation to control the incorporation of DCPs. For any particular DCP, it will list all the documents impacted by the described change and whether they have been updated or not at the point in time the database is consulted.
 - A DCP would be shown as incorporated in the DRP report if all impacted documents identified in Tables 1-3 and the MSL have been updated. However, there could be lower level documents which SmartPlant™ is tracking that remain to be updated ie SmartPlant™ would say a DCP remains unincorporated while the DRP states it is incorporated.
 - A modification identified in a partially incorporated DCP can be part of the design if eg an SSD has been updated, while other documents (potentially very low significance) remain to be updated. In other words, the change does not become live at the point at which the DCP is declared incorporated. Design documents are likely to be updated at different times. However, as stated above, UK-specific DCPs are highly unlikely to be reflected in the design documentation during GDA.
 - The UK **AP1000** reactor design, as set out in Tables 2 and 3 of the DRP will effectively be the same as the standard plant. The PCSR and other 'licensing documents' will be against the broader DRP which includes future commitments for UK-specific design changes captured in DCPs.
99. These interactions with Westinghouse during the closure phase have greatly enhanced the regulators' collective understanding of, and confidence in, the Westinghouse design change processes and their application to the UK plant.
100. Nevertheless, GI-AP1000-FS-02 (Ref. 62) points out that Westinghouse does not link its fault analysis to a UK DRP and a lot of Westinghouse and ONR effort was

expended to establish that transient analysis in the PCSR can be shown to be appropriate for the GDA DRP. Future difficulties could be avoided if such calculations are demonstrably linked to the UK design reference. This is a matter for a future licensee to take on board in developing its site-specific safety case.

3.3.2 Conclusions on the Design Reference Point

101. I consider that the final design reference (UKP-GW-GL-060 Revision 10) provides an accurate compilation of key documents, including proposed design changes, which provide the necessary definition of the design of the UK **AP1000** reactor assessed by the regulators in GDA.
102. During the GDA closure phase, ONR has gained a significantly better appreciation and understanding of the design change management processes applied by Westinghouse and I am satisfied that this provides a rigorous means of categorising and tracking the consequences of the approved design changes for the safety case for the UK **AP1000** reactor.

3.4 Master Submission List

103. As reported in Section 1.2.3 Westinghouse submitted the end of Step 4 MSL (UKP-GW-GLX-001 Revision 1 (Ref. 25)) in October 2011, and it is this MSL that underpins the IDAC issued in December 2011. Section 1.2.3 also notes that in ONR's Step 4 report on MSQA the verification of the MSL performed by Westinghouse provided ONR with confidence in the accuracy and completeness of the document (Ref. 24).
104. An updated MSL is a key deliverable for the closure of Issue GI-AP1000-CC-02. Westinghouse submitted the updated MSL (UKP-GW-GLX-001 Revision 2) in January 2017 (Ref. 70), but with a note that this was a draft version pending the addition of responses to a late RQ in the Internal Hazards area and other minor updating. I undertook a sampling review of this document, comparing the documents listed in the MSL as submitted in relation to the closure of five GDA issue actions, with the referenced submissions in the related ONR Assessment Reports; I found agreement with the MSL in each case.
105. At the suggestion of the regulators, the MSL submitted at the end of Step 4 separated documents into four 'levels'. Level 1 design documentation consists of the SSERs. Level 2 design documentation consists of the direct references cited in the SSERs. Level 3 design documentation consists of supporting documentation not cited in the SSERs that is specific to the UK **AP1000** reactor design. Level 4 consists of documentation submitted for information purposes only (including, for example, PowerPoint presentations). The latter (very large list) was not included in the MSL document itself, but was provided as an addendum in the form of an Excel spreadsheet.
106. For the Revision 2 MSL submitted in January 2017, Westinghouse retained a similar scheme but separated the documents submitted during the closure phase into just three levels (or 'tiers'). Level 4 documents which had been submitted for information purposes only were not listed; I consider this to be a sensible decision.
107. I have examined the structure and sampled the contents of Revision 2 of the MSL and have found no obvious errors or inconsistencies. The final version of Revision 2 of the MSL was submitted on March 23rd 2017 (Ref. 71).
108. The contents of Revision 1 of the MSL were not repeated in Revision 2 and so UKP-GW-GLX-001 Revision 1 remains an extant reference for Steps 1-4 of GDA. Revision 1 in conjunction with Revision 2 provides the full MSL for the purposes of the DAC.

3.4.1 Conclusions on the Master Submission List

109. Westinghouse has fulfilled the requirement of this issue to submit a revised and updated MSL. I have examined the structure of the final MSL and sampled its contents and I have found no inaccuracies or matters of concern.
110. I therefore conclude that UKP-GW-GLX-001 Revision1 (Ref. 25) and UKP-GW-GLX-001 Revision 2 (Ref. 71) taken together form an acceptable MSL for the purposes of GDA and provide a basis for a DAC for the UK **AP1000** reactor.

3.5 Conceptual Security Arrangements

111. The Conceptual Security Arrangements (CSA) document is referenced in Issue GI-AP1000-CC-02 as being part of the SSER suite of key 'licensing' documents. There were no security-related issues were raised in 2011 with regard to the CSA (reflected in the Assessment Report ONR-GDA-AR-11-015 (Ref. 72)).
112. As part of re-engagement in the GDA, ONR requested that Westinghouse undertake a revalidation of the CSA against any design changes implemented since 2011 specifically in the areas of:
- Vital Area Identification
 - Identification of Computer Based Systems Important to Safety
 - Security Barrier Identification
 - Access Control
113. Westinghouse has undertaken the revalidation (Ref. 73) of the CSA against Revision 9 of the Design Reference Point, which concluded that the CSA detailed in the 2011 submission remain valid. It will be for a future licensee to apply the UK design basis threat to the CSA in order to start developing the site specific security plan.

3.6 Comparison with Guidance and Relevant Good Practice

114. ONR assessors contributing Assessment Notes to support the closure of this Issue were required to consider the application to their assessment of any relevant guidance and good practice. Primarily these are the ONR SAPs and relevant TAGs (particularly TAG 51 – *The purpose, scope and content of safety cases*). Individual Assessment Notes should be consulted for assessors' comments in relation to their assessment of specific chapters (Ref. 34). My assessment of the case for closure of this issue has primarily drawn on this TAG.

3.7 Assessment Findings

115. Assessment Findings are matters that do not undermine the generic safety submission and are, for the most part, concerned with the provision of site-specific safety case evidence, which will usually become available as the project progresses through the detailed design, construction and commissioning stages. ONR will expect a future licensee to address all of the Assessment Findings raised during GDA on a timescale appropriate to its plant construction and commissioning schedule.
116. As a result of my assessment I have identified one matter relating to the GDA PCSR which I propose as an Assessment Finding for a future licensee to address when developing its own site-specific PCSR. The Assessment Finding is set out in Annex 3.

3.8 Minor Shortfalls

117. A residual concern regarding the safety case is recorded as 'minor shortfall' if it does not:
- undermine ONR's confidence in the safety of the generic design;
 - impair ONR's ability to understand the risks associated with the generic design;
 - require design modifications;

- require further substantiation to be undertaken.
118. As discussed in Section 3.2 above, the Assessment Notes supporting the closure of this Issue have identified one minor shortfall in the safety case which is not considered serious enough to require specific action to be taken by any future licensee. Details are contained in Annex 4

4 ENVIRONMENT AGENCY CONSIDERATIONS

119. The Environment Agency has considered changes to the ER (UKP-GW-GL-790 Revision 6) and associated references (which together represent the 'environment case' for GDA). The Environment Agency (EA) focused on the design change process that Westinghouse follows and Westinghouse's GDA project arrangements for control of GDA submission documents.
120. At an early stage following recommencement of GDA, the EA issued a regulatory query (RQ) seeking a view from Westinghouse as to which GDA issues were likely to impact on the 'environment case' (RQ-AP1000-1307, 'Early view on environmental implications of GDA issue close-out', December 2014).
121. In response to RQ-AP1000-1307, Westinghouse provided an overview of the impact evaluation process and considered each GDA issue in turn. Other than GDA Issues CC-02 and CC-03, Westinghouse identified potential impacts associated with only three issues, namely GDA Issues: GI-AP1000-RP-01, GI-AP1000-FS-01 and GI-AP1000-RC-02. For all other 46 GDA issues it was suggested by Westinghouse that, "There are no significant impacts to the existing environment assessment bases, including additional generation of radioactive or other wastes, spent fuel management, changes to plant design or site layout, changes to decommissioning planning, or changes to anticipated operational actions as the result of planned responses to the GDA issue."
122. Westinghouse updated the consideration against each GDA issue at the time of issue of DRP (Revision 8). Westinghouse confirmed that further analysis during the GDA issue close-out programme (at that time) had not altered this early view, although it was further noted that addressing CC-03 had also resulted in no significant impact (see next section). Overall, impacts on the environment case are very limited and we agree with this outcome based on our assessment.
123. A significant number of DCPs have been incorporated in the DRP (Revision 10) since DRP (Revision 5) was assessed prior to issue of the iSoDA. The EA reviewed and inspected Westinghouse's process for design change control and the management of configuration control, including a joint inspection of such aspects with ONR in July 2015. The EA also considered updates to the ER and DRP to ensure comprehensive coverage of environmental aspects and consolidation across these important GDA deliverables. Westinghouse was able to demonstrate appropriate configuration records and linkages to supporting documentation (on-line) when we sampled particular DCPs, noting that the relevant databases may link numerous (even hundreds) of documents (including technical drawings) via a single DCP.
124. For each DCP, Westinghouse's Smart Plant Foundation (SPF) system and related DCP database capture the affected documents and related impacts for all assessment areas. For GDA purposes, specific forms are completed by Westinghouse (F-UKP-GW-GAP-026-1), which capture the UK documents that are relevant to the GDA DRP. The completed forms identify the affected PCSR and SSER documents, often with details of the affected section. The EA sampled a number of DCPs and found the process to be consistent and traceable. This provided confidence that the approach is systematic and has been appropriately applied.
125. The EA also reviewed the process used by Westinghouse to consider the environmental impact of proposed design changes, to inform our view on inclusion of these design changes in the GDA reference design and supporting documentation. We sampled a range of DCPs and reviewed the Westinghouse considerations as to any associated impact on the environment case. We concluded that Westinghouse

appeared to be adequately assessing the impacts of design change on the environment case and suitably incorporating those changes into the supporting documentation for GDA.

126. Design changes are evaluated for incorporation into the DRP by Westinghouse in accordance with UKP-GW-GAP-026 Design Reference Point Change for GDA (Ref. 26). This includes a review of each new design change to determine potential impact of the PCSR and SSER (including the ER). The process involves completion of F-UKP-GW-GAP-026-1 forms to ensure a systematic appraisal of any impacts. The EA wrote to Westinghouse recommending inclusion of specific environmental considerations in associated guidance to authors and reviewers of the F-UKP-GW-GAP-026-1 forms. In response, Westinghouse confirmed that guidance supporting the design change process was supplemented by additional advice covering such aspects. Subsequently, Westinghouse has incorporated this advice directly into the F-UKP-GW-GAP-026-1 forms (Revision 2).
127. The EA found Westinghouse's project arrangements to be robust and are satisfied that the final GDA deliverables, including the ER, MSL and reference design, are consistent based on the EA's sampling.
128. Westinghouse has not fully incorporated all design changes identified during GDA. Some of the design changes have not been fully implemented into the supporting design documentation that underpins the SSER. Such unincorporated DCPs are clearly identified in the DRP and incorporation will be carried over to future detailed design for consideration in nuclear site licensing and environmental permitting activities. The EA has placed an assessment finding to ensure that any future operator uses appropriate arrangements to demonstrate how changes from GDA design to site-specific design are compliant with future permit requirements. The EA's view is that the design changes identified in the GDA and yet to be fully incorporated are not significant in relation to the environmental performance of the design. Any future operators will need to fully assess and incorporate these design changes during development of the site-specific design and we will seek assurances through our future regulatory activities.
129. The EA is satisfied that Westinghouse's arrangements for the control of updates to the final GDA submission documentation, including the ER, MSL and DRP for the AP1000 reactor design, are adequate. EA is satisfied that the GDA issue has been addressed appropriately and can be closed.

5 CONCLUSIONS

130. This report presents the findings of my assessment of GDA Issue GI-AP1000-CC-02 relating to the **AP1000** reactor GDA closure phase.
131. Westinghouse has undertaken a significant revision of the PCSR submitted to ONR in March 2011. That revision has taken account of ONR's comments on and concerns about previous versions and drafts, as well as chapter-specific matters raised by ONR assessors in closing out other GDA issues.
132. I have reviewed all comments on individual chapters of the revised PCSR provided by ONR assessors during the GDA closure phase, and I am satisfied that the consolidated version, submitted as UKP-GW-GL-793 Revision 1 represents an adequate response to this issue, and provides a basis for ONR to consider whether to issue a Design Acceptance Confirmation for the UK **AP1000** reactor.
133. I consider that the final design reference (UKP-GW-GL-060, Revision 10) provides an accurate compilation of key documents, including proposed design changes, which provide the necessary definition of the design of the UK **AP1000** reactor assessed by the regulators in the GDA.
134. During the GDA closure phase, ONR has gained a significantly better appreciation of, and confidence in, the design change management processes applied by Westinghouse and I am satisfied that this provides a rigorous means of categorising and tracking the consequences of the approved design changes for the safety case for the UK **AP1000** reactor.
135. Westinghouse has fulfilled the requirement of this issue to submit a revised and updated MSL. I have examined the structure of the final MSL and sampled its contents and I have found no inaccuracies or matters of concern.
136. I conclude that UKP-GW-GLX-001 Revision1 and UKP-GW-GLX-001 Revision 2 taken together form an acceptable Master Submission List for the purposes of GDA and provide a basis for a Design Acceptance Confirmation for the UK **AP1000** reactor.
137. The Environment Agency is satisfied that Westinghouse's arrangements for the control of updates to the final GDA submission documentation including the ER, MSL and DRP for the UK **AP1000** design are adequate. The Environment Agency is satisfied that the GDA issue has been addressed appropriately and can be closed.
138. In summary therefore, I conclude that Issue GI-AP1000-CC-02 can be closed.

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ANNEX 1. REGULATORY ISSUE GI-AP1000-CC-02: PCSR TO SUPPORT GDA

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 the Environment Agency</p>
Action A1*	<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 the DRP UKP-GW-GL-060 Revision 2 and make available via the Westinghouse website a public version of the consolidated PCSR, the DRP and the MSL.</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 effect 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 RQs, 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, DRP (UKP-GW-GL-060) and the MSL (UKP-GW-GLX-001) and place subsequent updates on their website (removing commercial information and security sensitive information)</p>
Action A2*	<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 DRP 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 the GDA.</p> <p>This should involve the incorporation of all relevant amendments into the impacted documentation associated with design changes, including the DRP, 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 DRP to address <ol style="list-style-type: none"> 1.1. GDA issue resolution 1.2. Agreed design changes

	<p>1.3. Any other updates agreed with the Regulators.</p> <p>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:</p> <p>2.1. Evidence that review comments have been managed and incorporated in the final consolidated documentation as necessary.</p> <p>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 on their website. To facilitate our assessments /inspections in this area, in addition to the submission of the documentation the joint regulators will require:</p> <p>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 the Environmental Agency may issue any DAC/SODA</p>
<p>Action A3*</p>	<p>Westinghouse to implement the outstanding GDA agreed design changes, by incorporating the change details into all impacted DRP documents, 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 DRP that shows the DCPs agreed by the regulators for inclusion in the GDA which were not fully incorporated at the DRP of 16 September 2010. 2. A delivery schedule which; <ul style="list-style-type: none"> ▪ 2a. 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.b 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 DRP and update the 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>

* With agreement from the Regulator these actions may be completed by alternative means

ANNEX 2: AP1000 PCSR – COVERAGE OF ONR TECHNICAL ASSESSMENT NOTES/REPORTS

PCSR Volume	Chapter	Version	WEC Submittals	TRIM	Considered in ONR topic Assessment Notes/Reports*
Volume 1 <i>Executive Summary & Safety Case Management</i>	1. Introduction	0B	WEC-REG-01264R – 16 September 2016	2016/364519	All
	2. Safety Case	0B	WEC-REG-01298R – 29 September 2016	2016/382134	All
	3. Management of Safety	0B	WEC-REG-01210R – 23 August 2016	2016/335512	All
	4. Generic Site Characteristics	0B	WEC-REG-01210R – 23 August 2016	2016/335516	CE, EH, CC
Volume 2 <i>Engineering Principles & Plant Overview</i>	5. Engineering Principles	0B	WEC-REG-01298R – 29 September 2016	2016/382157	CE, FS, IH, RC, ME, CC
	6. Plant Description & Operation	0C	WEC-REG-1531R – 13 January 2017	2017/18995	CE, RP, IH, RC, CC
	7. Lifecycle Engineering & Safety	0B, Rev 1	WEC-REG-01319R – 7 October 2016	2016/392434	CC
Volume 3 <i>Faults & Accident Analysis</i>	8. Fault & Accident Analysis	0C	WEC-REG-01346N – 23 October 2016	2016/411261	FS, ME, RC, IH, EH
	9. Internally Initiated faults	0B – mostly 0C – 9.8 0D – App 9C	WEC-REG-01335N – 17 October 2016 WEC-REG-01521N – 11 January 2017 WEC-REG-01521N – 11 January 2017	2016/404207 2017/13861 2017/13880	FS, RP, ME
	10. Reactor Faults: Probabilistic Safety Assessment and Severe Accident Analysis	0C	WEC-REG-01290N – 28 September 2016 Attached to RQ-AP1000-1663 Full Response	2016/379689	PSA, ME, RC
	11. Internal Hazards	0D	WEC-REG-01549N – 20 January 2017	2017/29228	IH, CE
	12. External Hazards	0C	WEC-REG-01359R – 31 October 2016	2016/421168	EH, CE
	13. Human Factors	0D	WEC-REG-01519N- 10 January 2017	2017/12179	HF
	14. AP1000 Plant ALARP Evaluation	0B	WEC-REG—01516R - 6 January 2017	2017/8423	FS, PSA
Volume 4 <i>Engineering Substantiation</i>	15. Engineering Substantiation	0B	WEC-REG-01359R – 31 October 2016	2016/421178	CE, RC, ME
	16. Civil Engineering	0B	WEC-REG-01359R – 10 March 2016	2016/421181	CE, IH
	17. Mechanical Engineering	0B	WEC-REG-01298R – 29 September 2016	2016/382166	ME
	18. Essential Electrical Systems	0D	WEC-REG-01400N – 15 November 2016	2016/446306	EE
	19. Control & Instrumentation	0C	WEC-REG-01430N – 30 November 2016	2016/469365	C&I
	20. Structural Integrity	0B	WEC-REG-01358N – 31 October 2016 Attached to RQ-AP1000-1703 Full Response	2016/422121	SI
	21. Reactor Chemistry	0D	WEC-REG-01386N 10 November 2016	2016/439566	RC
	22. Fuel System, Nuclear & Thermal Hydraulic Design	0C	WEC-REG-01399N – 15 November 2016	2016/446139	FC

	23. Containment & Nuclear Ventilation Systems	0B	WEC-REG-01343R – 20 October 2016	2016/410264	ME
Volume 5 Waste & Accident Management	24. Radiation Protection	0B	WEC-REG-01319R – 7 October 2016	2016/392474	RP
	25. Accident Management	0B, Rev 1	WEC-REG-01298R – 29 September 2016	2016/382184	CC
	26. Waste Management	0B, Rev 1	WEC-REG-01319R – 7 October 2016	2016/392494	CC
	27. Decommissioning & End of Life Aspects	0B, Rev 1	WEC-REG-01319R – 7 October 2016	2016/392508	CC
Volume 6 Conclusions	28. Conclusions	0B, Rev 1	WEC-REG-01398R – 15 November 2016	2016/445407	CC

* ONR Assessment Notes/Reports provide feedback on the adequacy of the PCSR chapters in the following ONR topic areas:
 FS = Fault Studies; ME= Mechanical Engineering; PSA= Probabilistic Safety Analysis; C&I= Control & Instrumentation; IH=Internal Hazards;
 EH= External Hazards; RC=Reactor chemistry; HF=Human Factors; CE=Civil Engineering;
 EE=Electrical Engineering; FC=Fuel & Core; RP=Radiological Protection; SI=Structural Integrity; CC=Cross Cutting

TRIM references for individual ONR assessment notes/reports are given in Ref. 48

ANNEX 3: ASSESSMENT FINDING

Number	Description
CP-AF-AP1000-CC-01	The future licensee should undertake a thorough review of the generic PCSR and ensure that the basis for the site-specific PCSR is consistent with all commitments arising both from the resolution of Regulatory Observations and Regulatory Issues from Step 4, and from the closure phase of GDA.

ANNEX 4: SAFETY CASE MINOR SHORTFALL

Number	Description of minor shortfall
MS-AP1000-CC-01	To ensure greater clarity in the presentation of the safety case, in developing the generic PCSR into the site-specific version, the licensee should consider making extensive use of the claims-arguments-evidence formalism

FIGURE 1

