New Reactors Programme

AP1000 reactor GDA closure phase

Close-out of Issue GI-AP1000-CC-01: Limits and Conditions

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EXECUTIVE SUMMARY

Westinghouse Electric Company LLC 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 the 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 topic area. Specifically, this report addresses GDA Issue GI-AP1000-CC-01.

A vital part of any nuclear safety case is the definition of plant-specific limits and conditions (or Operating Rules – ORs). The prime purpose of setting limits and conditions is to prevent operation in unsafe conditions and to limit the consequences of accident conditions should they arise. The safety case should define what these conditions are and how the plant is operated and controlled to stay within them.

The December 2009 generic Pre-Construction Safety Report (PCSR), which underpinned ONR's Step 4 assessments, provided little discussion of ORs. At that time, Westinghouse interpreted ORs to be equivalent to the Technical Specifications for the **AP1000** reactor, which were presented in Chapter 16 of the European Design Control Document and were based solely on the design basis analysis. Some of the most important parameters, for example relating to primary circuit chemistry, were not included in these.

Although Westinghouse made amendments to the PCSR, the March 2011 version was submitted too late to allow ONR to assess it in Step 4. Consequently, based on the 2009 PCSR, ONR judged that it was deficient in its treatment of the development of limits and conditions for the UK plant, although that deficiency was not so great as to prevent the awarding of an IDAC. Consequently, ONR published GDA Issue GI-AP1000-CC-01 to address the PCSR shortfalls. The GDA issue had three actions which broadly required Westinghouse to do three things: describe its approach and process for deriving ORs, to apply this approach (though not for everything, nor at the same level of definition), and to update the PCSR to reflect these.

My assessment conclusion is that Westinghouse's approach and submissions adequately address the three actions of GDA Issue GI-AP1000-CC-01. This judgement is based on the review of the Westinghouse deliverables:

- **UKP-GW-GL-500:** ONR considers that this document sets out a logical, well-structured and comprehensive process for the development of ORs for the UK **AP1000** reactor by a future licensee.

- **UKP-GW-GL-501:** Although ONR considers that the list of key generic Technical Specifications set out in this document falls short of what was anticipated, ONR acknowledges that, overall, the generic safety case provides sufficient information for a competent future licensee to be able to fully define the complete set of ORs for the UK **AP1000** reactor.

- **UKP-GW-GL-502:** ONR considers this to be a useful supplement to the process document (UKP-GW-GL-500).

- **Revised PCSR (UKP-GW-GL-793):** Westinghouse has made a number of amendments and additions to the 2009 PCSR, and ONR considers that these changes are broadly adequate to address the PCSR revisions required for this issue. Some deficiencies, particularly in the area of reactor chemistry, are considered to remain in the treatment of limits and conditions in generic PCSR, however. These will need to be addressed by future licensees in developing site-specific Operational Technical Specifications and Operating Rules.

In summary, I am satisfied that GDA Issue GI-AP1000-CC-01 can be closed.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
DAC	Design Acceptance Confirmation
EDCD	European Design Control Document
EMIT	Examination, Maintenance, Inspection and Testing
GAC	General Availability Controls
GDA	Generic Design Assessment
IAEA	International Atomic Energy Agency
IDAC	Interim Design Acceptance Confirmation
ONR	Office for Nuclear Regulation
OR	Operating Rule
OTS	Operational Technical Specifications
PCSR	Pre-Construction Safety Report
PSA	Probabilistic Safety Analysis
RO	Regulatory Observation
RQ	Regulatory Query
SAPs	Safety Assessment Principles
SSC	System, Structure and Component
TAG	Technical Assessment Guide
TRM	Technical Requirements Manual
TS	Technical Specification
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's (ONR's) Generic Design Assessment (GDA) for the Westinghouse Electric Company LLC **AP1000®** reactor design within the cross-cutting topic area.

2. GDA follows a stepwise approach in a claims–argument–evidence hierarchy. Step 2 examined the claims made by Westinghouse and Step 3 examined the arguments underpinning those claims. 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 the award of a complete Design Acceptance Confirmation (DAC) and before any nuclear safety-related construction of this reactor design can begin on site. Westinghouse re-entered the GDA process in 2014 to close the 51 GDA issues.

3. This report specifically addresses cross-cutting GDA Issue GI-AP1000-CC-01 – Limits and Conditions (Ref. 1), which relates to the identification of plant limits and conditions necessary in the interests of safety.

4. The related GDA Step 4 report (Ref. 1) is published on the ONR website (www.onr.org.uk/new-reactors/ap1000/reports.htm), and this provides the assessment underpinning 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 GDA Issue GI-AP1000-CC-01

1.2.1 The AP1000 Reactor Safety Case

5. The Westinghouse safety case for the **AP1000** reactor is based on a generic Pre-Construction Safety Report (PCSR) and a suite of supporting documentation. The PCSR evolved throughout GDA steps 1 to 4, as discussed more fully in Ref. 2.

6. The PCSR that was intended to fully inform ONR's Step 4 assessments (GW-GL-732 Revision 2; Ref. 3) was submitted by Westinghouse in December 2009. However, ONR found that, as with an earlier version, the PCSR did not contain sufficient claims, arguments and evidence to substantiate the **AP1000** reactor design and demonstrate that risks were reduced As Low As Reasonably Practicable (ALARP). The report also 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, the US Nuclear Regulatory Commission.

7. Throughout Step 4, Westinghouse was developing a further revision to the PCSR to take account of ONR's comments and to incorporate its responses to Regulatory Observations (ROs) and Regulatory Queries (RQs). An early draft of the intended revised PCSR was issued to interested utility companies 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. 2).

8. In December 2010, a draft consolidated PCSR was submitted (UKP-GW-GL-793 Revision A; Ref. 4). ONR assessors were unable to provide substantive comments at the time because they were busy completing their assessment and writing their reports, although some assessors did manage to provide some brief comments. On 30

March 2011, Westinghouse submitted its final consolidated PCSR, UKP-GW-GL-793 Revision 0 (Ref. 5), but this was too late to be assessed by ONR as part of Step 4.

9. Nevertheless, by using RQs and ROs the assessors were able to complete their Step 4 assessments based on the December 2009 version. The IDAC issued in December 2011 and all the associated GDA issues, including GDA Issue GI-AP1000-CC-01, were therefore underpinned by that version of the PCSR.

1.2.2 Limits and Conditions or Operating Rules

10. A vital part of any nuclear safety case is the definition of plant-specific limits and conditions (or Operating Rules – ORs). The prime purpose of setting limits and conditions is to prevent operation in unsafe conditions and to limit the consequences of accident conditions should they arise. The safety case should define what these conditions are and how the plant is operated and controlled to stay within them.

11. The December 2009 PCSR (Ref. 3) provided little discussion of ORs. At that time, Westinghouse interpreted ORs to be equivalent to the Technical Specifications for the **AP1000** reactor, which were presented in Chapter 16 of the EDCD and were based solely on the design basis analysis. Some of the most important parameters, for example relating to primary circuit chemistry, were not included in these. ONR issued Regulatory Observation RO-AP1000-094 (Ref. 6) to Westinghouse during Step 4 to request evidence of how all limits and conditions specific to the **AP1000** reactor would be developed.

12. In summary, the response to RO-AP1000-094 (Ref. 6) did not provide an adequate definition or sufficient evidence for how ORs can be derived from the safety case presented in the PCSR. This represented a significant departure from the expectations for GDA, which was that, through presentation and documentation, Westinghouse would demonstrate:

- how any safety-related limits and conditions during plant operations or maintenance are specified at the design stage; and
- how these may be subsequently converted into ORs and other procedures which ensure that the plant is capable of being operated safely within the design basis envelope defined by the GDA.

13. As a consequence of ONR's dissatisfaction with the Westinghouse position on this matter, at the end of Step 4 it raised GDA Issue GI-AP1000-CC-01 (Ref. 1), which stated:

> *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.*

14. 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:

1. set out a process for developing a complete set of Technical Specifications and demonstrate how plant ORs, chemistry guidelines and maintenance schedules can be derived from design basis limits and claims in the PCSR;
2. provide evidence of the application of that process; and
3. produce a PCSR sub-chapter on limits and conditions to capture the outcome of actions 1 and 2.

15. 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 GDA Issue GI-AP1000-CC-01 was submitted by Westinghouse and accepted by ONR (Ref. 7).

1.3 Scope

16. The assessment in this report focuses on considering whether Westinghouse's submissions to ONR for GDA Issue GI-AP1000-CC-01 provide an adequate response to justify the closure of the issue. It is recommended that you read this report in conjunction with the Step 4 report on cross-cutting issues (Ref. 1) to appreciate the totality of the ONR assessment of the evidence on limits and conditions for the **AP1000** reactor.

1.4 Method

17. This assessment has been undertaken in accordance with internal guidance on the mechanics of assessment within ONR (Ref. 8).

2 ASSESSMENT STRATEGY

2.1 Assessment Scope

18. This report presents the ONR assessments relevant to the resolution of GDA Issue GI-AP1000-CC-01. Section 3 of this report provides a brief overview of the background to the GDA issue, in particular the ONR assessment undertaken during GDA Step 4.

19. This assessment does not revisit aspects of the safety case already accepted as being adequate during previous stages of GDA.

20. As discussed in Section 1, a consolidated PCSR was submitted for ONR consideration in March 2011 (Ref. 5), which was too late for ONR to undertake a comprehensive assessment. Given the significance of the PCSR, both in terms of being the highest-level summary of the safety case for the **AP1000** reactor and being a key document against which a DAC would be given, GDA Issue GI-AP1000-CC-02 was raised. That issue requires Westinghouse to revise the March 2011 PCSR as necessary and to present a final consolidated version at the end of the GDA closure phase.

21. Although there is clearly a link between the PCSR required under GI-AP1000-CC-02 and the arrangements for developing ORs required under GI-AP1000-CC-01, this report only discusses those aspects of the PCSR that are relevant to the resolution of this issue. ONR's report on the resolution of GI-AP1000-CC-02 is provided separately (Ref. 2).

2.2 Assessment Approach

22. The assessment draws on the views of ONR assessors in the reactor chemistry, fault studies and Probabilistic Safety Analysis (PSA) disciplines, the technical areas most relevant to this issue. These assessors were specifically invited to provide their views on the evidence that Westinghouse submitted for its closure. Where appropriate, this evidence was assessed against the expectations and requirements of the Safety Assessment Principles (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 other relevant technical areas (where appropriate);
- raising and issuing of RQs as appropriate, followed by assessment of Westinghouse's responses; and
- holding technical (level 4) meetings to progress the identified lines of enquiry.

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

2.2.1 Regulatory Queries

24. One RQ was raised with Westinghouse specifically in relation to this issue, and the response provided further evidence to support its resolution. Westinghouse's responses to other RQs raised in the technical areas mentioned above also provided input to the closure of this issue and this is discussed, where relevant, in Section 3.

2.2.2 Technical Meetings

25. Very few technical meetings with Westinghouse were held solely to consider the closure of this issue. However, other meetings in the fault studies, PSA and reactor chemistry technical areas considered aspects which are relevant to this issue, and the output from those meetings is taken into account, as appropriate, in the advice from ONR GDA assessors on closure of this issue.

2.3 Standards and Criteria

26. ONR undertook assessments relevant to this issue in line with the requirements of NS-PER-GD-014 (Ref. 10). The standards and criteria adopted within this assessment are principally the SAPs (Ref. 11), internal Technical Assessment Guides (TAGs; Ref. 12), relevant national and international standards and relevant good practice informed from existing practices adopted on UK nuclear licensed sites. Further details are provided below.

2.3.1 Safety Assessment Principles

27. Due to the range of technical areas covered by GDA Issue GI-AP1000-CC-01, the relevant SAPs are detailed in the individual assessment reports and, where necessary, are cited in the subsections of this report.

28. As the SAPs (Ref. 11) constitute the regulatory principles against which dutyholders' safety cases are judged, they are therefore the basis for ONR's nuclear safety assessment. It is worth noting that the 2014 Edition (Revision 0) of the SAPs was used when performing the assessment described in this report, whereas the original Step 4 assessment used the 2006 Edition.

2.3.2 Technical Assessment Guides

29. The following TAGs (Ref. 12) were used as part of this assessment:

- NS-TAST-GD-035 Revision 4, Limits and Conditions for Nuclear Safety (Operating Rules) – see Ref. 9
- NS-TAST-GD-051 Revision 4, The Purpose, Scope and Content of Nuclear Safety Cases

2.3.3 Other ONR Guidance

30. ONR's Guidance to Requesting Parties ONR-GDA-GD-001 Revision 3 (Ref. 13) contains guidance on ONR's expectations of the contents of a generic PCSR and has been consulted in preparing this assessment.

2.3.4 National and International Standards and Guidance

31. There are both International Atomic Energy Agency (IAEA) standards (Ref. 14) and Western European Nuclear Regulators Association (WENRA) reference levels (Ref. 15) of relevance. It should be noted that the latest version of the SAPs has been benchmarked against both IAEA and WENRA guidance.

2.4 Use of Technical Support Contractors

32. No technical support work was undertaken to support the assessment of the submissions made in response to GI-AP1000-CC-01.

2.5 Integration with Other Assessment Topics

33. 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-01, I sought input from the following technical disciplines, which had self-identified as having particular interest in the issue:

- fault studies
- reactor chemistry
- PSA

2.6 Out of Scope Items

34. I identified no out of scope items.

3 WESTINGHOUSE RESPONSE TO THE ISSUE

35. As set out in the GI-AP1000-CC-01 resolution plan, Westinghouse identified the following deliverables.

Deliverable 1: Methodology plan

"This plan will identify how Westinghouse will develop limits and conditions and EMIT [Examination, Maintenance, Inspection and Testing] *and what will be the content of documentation for the final deliverable provided to ONR. This plan will also provide details on the programme schedule."*

36. This deliverable was submitted in accordance with the resolution plan schedule in December 2015, as a UK plant-specific report: UKP-GW-GL-500 – 'UK Limits and Condition Process Description' (Ref. 16). ONR reviewed the report and provided comments in the form of RQ-AP1000-1487, with Westinghouse providing a full response on 10 March 2016 (Ref. 17).

Deliverable 2: Consolidated list of Operating Rules including EMIT considerations

"This will be a report that identifies the going forward limits and conditions and EMITs. The report will also provide the origin of the limits and conditions. Additional information may be included as requested by utility."

37. This deliverable was submitted in accordance with the resolution plan schedule in January 2016, as a UK plant-specific report: UKP-GW-GL-501 – 'UK Generic Technical Specifications' (Ref. 18).

Deliverable 3: Process for inclusion of limits and conditions and EMIT into plant operating documents

"This will either be a report or take the form of actual plant procedures. It will include identification of inputs to plant procedures, TSs [Technical Specifications]*, surveillance requirements and EMIT schedules from a consolidated list of limits and conditions. Also included is a review of arrangements for including identified limits and conditions in plant operating documents and for maintaining them in the future."*

38. This deliverable was submitted in accordance with the resolution plan schedule in February 2016, as a UK plant-specific report: UKP-GW-GL-502 – 'Recommendation for Development of the AP1000 Technical Requirements Manual' (Ref. 19).

Deliverable 4: Update PCSR chapters as appropriate

"The PCSR will be reviewed for impact of implementation of this plan. The PCSR will be updated after all resolution plans have been implemented."

39. In the 2009 PCSR, the discussion of limits and conditions was largely confined to two paragraphs forming sub-chapter 3 in Chapter 11 (Operational Management) (Ref. 3), which referred back to the EDCD for details of the Technical Specifications. The 2011 PCSR (which was submitted too late for ONR to assess in Step 4) had a similarly brief discussion in Chapter 5 (Engineering Principles) as sub-chapter 5.6. In response to this issue, Westinghouse significantly expanded sub-chapter 5.6, which was submitted to ONR as Revision 0A in April 2016 (Ref. 20). A revised version of Chapter 5, including changes to sub-chapter 5.6, was submitted as Revision 0B in September 2016 (Ref. 21). The final version of Chapter 5 was included with Revision 1 to the consolidated PCSR in February 2016 (Ref. 22).

40. Westinghouse also introduced additional text on limits and conditions, Technical Specifications and ORs into other chapters of the revised PCSR, and these were considered as appropriate during level 4 discussions in the relevant technical assessment areas. The adequacy of the treatment of limits and conditions in the revised PCSR is considered in Section 4.

4 ONR ASSESSMENT OF GDA ISSUE GI-AP1000-CC-01

41. In the following subsections, I have summarised the overall ONR assessment of Westinghouse's submissions for this GDA issue. The following subsections summarise the contents of the three Westinghouse reports submitted as deliverables 1 to 3 (see Section 3). I have considered the views of key ONR subject matter experts and drawn conclusions on the case for closure of GDA Issue GI-AP1000-CC-01.

4.1 Background to the Issue

42. The key objective of setting plant operation limits is to prevent situations arising that might lead to accident conditions, and to mitigate the consequences of such accident conditions should they arise. This means there is a need to consider operational limits and safe boundary conditions beyond those affecting Class 1 Systems, Structures and Components (SSCs); and limits and conditions must apply to the whole plant for all operating modes, not just to the reactor. Operational limits are set within the safety assumptions contained in the safety case.

43. ONR's Step 4 report on cross-cutting topics (ONR-GDA-AR-11-016; Ref. 1) provides the detailed background to the issue. That report notes that the arrangements described in Westinghouse's Step 4 submissions for defining limits and conditions did not meet ONR's expectations. Those submissions principally described how US regulatory requirements could be met, while ONR had expected Westinghouse to derive the limits and conditions through design basis analysis, together with those necessary from all parts of the safety case analysis, and in particular engineering analysis, PSA and severe accident analysis.

44. RO-AP1000-094 (Ref. 6) was issued during Step 4 and reflected the position set out in the 2009 PCSR. The RO stated that ONR required:

- to have clearer visibility of the key limits and conditions (for example, operating envelope, set-points on protection systems, and equipment availability) embedded within the safety case, which are required to be translated into the operating and maintenance documentation and practice for the UK **AP1000** plant; and
- to understand how plant ORs or Operating Technical Specifications (OTSs) and maintenance schedules may be derived from the design basis limits and claims made in the PCSR, and what processes can be followed to ensure that the ORs, OTSs and/or maintenance schedules ultimately adopted are consistent with the design basis limits.

45. However, ONR found that Westinghouse's response to the RO (Ref. 6) did not meet its expectations, and that it was driven by US regulatory criteria and standards, rather than being derived from the safety analysis (such as the PCSR and Westinghouse's assessments of the **AP1000** plant, including those produced in response to ROs raised in other technical areas).

4.2 Westinghouse Deliverables

4.2.1 UKP-GW-GL-500 – UK Limits and Condition Process Description (Ref. 16)

46. In this document Westinghouse sets out its approach for defining the required limits and conditions for safe operation of the **AP1000** reactor, which is broken down into a three-stage process as follows:

Demonstration of Safety Case

⇩

Evaluation of Plant Characteristics

⇩

Development of **AP1000** Operating Rules

47. Westinghouse's **Demonstration of Safety Case** stage is mainly comprised of the claims from the **AP1000** fault and accident analysis as documented in PCSR Volume 3 (Volume 3 is comprised of Chapters 8 to 14), which include Design Basis Accident and PSA insights. The output of this stage of the process is the identification of design requirements necessary to satisfy safety and functional performance goals.

48. The **Evaluation of Plant Characteristics** stage reviews many different characteristics identified as design requirements – that is, safety and functional requirements. This ultimately results in the identification of plant parameters that are included in the **AP1000** ORs. Characteristics reviewed for incorporation into the ORs include:

- plant geometry – for example, critical dimensions
- initial conditions
- fuel design and performance parameters
- Control and Instrumentation functions and set-points
- system performance characteristics

49. The limits and conditions that arise from the safety case are attributed to four distinct groups:

- initial or boundary conditions for transient or accident analyses
- consequences of abnormal events
- SSC performance
- SSC availability or integrity

50. The **Development of the AP1000 ORs** stage is grouped into six categories that represent design phase products and ultimately facilitate transition to the operating phase. The ORs categories are:

- Operating Technical Specifications (OTSs)
- design transients (loading conditions)
- fuel design requirements
- chemical and radiochemical specifications
- In-Service Inspection
- periodic testing

51. The document presented a useful flowchart showing the process for the development of UK **AP1000** ORs and this is reproduced in Annex 2.

52. Assessors from ONR's fault studies, fuel and core, chemistry and PSA topic streams reviewed the document. They made some observations (mostly positive) and requests for clarification, via RQ-AP1000-1487, to which Westinghouse submitted a full and satisfactory response (Ref. 17).

53. Overall, ONR's assessors considered that UKP-GW-GL-500 sets out a logical, well-structured and comprehensive process. The report is understandably heavy on the Technical Specifications and is, as a result, a little less clear on other ORs and precisely how they will be derived. The inclusion of chemistry and radiochemistry within the identified ORs was seen as a positive step.

54. However, while the scope of chemistry ORs considered seems broad and consistent with ONR expectations, we would expect ORs to be organised into a hierarchy such that the level of control, etc is highest on those of greatest safety significance (that is, consistent with the three-tier approach being adopted for OTSs). This is important for chemistry where not all parameters carry the same significance (and some are not safety significant but commercial).

55. ONR considered that the declared GDA–licensee interface seemed broadly appropriate.

4.2.2 UKP-GW-GL-501 – UK Generic Technical Specifications (Ref. 18)

56. The process document discussed in the previous section anticipates that to reflect the distinction between primary SSCs (Class 1) and supporting SSCs (Class 2 and Class 3), the **AP1000** OTSs will be maintained by the licensee in tiers:

- Tier 1 Technical Specifications
- Tier 2 Technical Requirements Manual (TRM)
- Tier 3 General Availability Controls (GAC)

57. While Technical Specifications are typical of other Pressurised Water Reactors, to reflect the application of passive and active technologies consistent with the UK **AP1000** plant, the TRM and GAC will be characterised by less restrictive action completion times and fewer surveillance requirements consistent with the role of these SSCs in the **AP1000** plant safety case.

58. ONR anticipated that UKP-GW-GL-501 (UK Generic Technical Specifications) would largely address Action 2 of GI-AP1000-CC-01 – which required Westinghouse to provide evidence of the application of the process document. In particular:

- a tabulated list of the key limits and conditions for those SSCs that provide the delivery of important safety functions; and
- a list of the key EMIT requirements assumed within the safety case.

59. ONR's general view of the submission was that, although the introductory sections set out clearly the basis for deriving generic Technical Specifications from the UK **AP1000** plant safety case, the attached list (~800 pages) of key generic Technical Specifications appeared to be the same, or almost the same, as those listed in Chapter 16 of the EDCD document that had been submitted to ONR at the start of GDA in 2008. In particular, from the reactor chemistry perspective, ONR found that the list of generic Technical Specifications submitted in UKP-GW-GL-501 added nothing new to the list available in Step 4, which had contained a disappointingly small number of chemistry-related Technical Specifications. This is discussed further in Subsection 4.2.4.1.

4.2.3 UKP-GW-GL-502 – Recommendation for Development of the AP1000 Technical Requirements Manual (Ref. 19)

60. This short document is intended by Westinghouse to provide an outline of plant functions for consideration in the development of the site-specific TRM – the Tier 2 OTS described in Subsection 4.4.2. The TRM, when completed by the licensee, will comprise a set of availability controls whose implementation will provide reasonable assurance that risk-important SSCs and other SSCs important for operation are available consistent with governing plant analyses. Westinghouse emphasises that development of the TRM is ultimately the responsibility of the licensee during site licensing.

61. Criteria for the licensee's TRM will reflect a combination of deterministic and probabilistic methods and will include considerations for defence-in-depth functions,

post-72 hour operations, and severe accident conditions. A table in UKP-GW-GL-502 lists key instrumentation, plant and electrical systems that Westinghouse has identified for consideration by the licensee in developing the TRM.

62. The document notes that criteria for the GAC (the Tier 3 OTS) will reflect deterministic, probabilistic, programmatic and operating experience-based methods and will include considerations for normal plant operational conditions and the operation of Class 3 SSCs.

63. ONR reviewed the document and concluded that the approach described was consistent with the general process for developing Tier 1 and Tier 2 OTSs set out in the process document UKP-GW-GL-500; as such it provides a useful illustration of Westinghouse's views on an approach to developing ORs that could be followed by a future licensee.

64. ONR concurs with Westinghouse's view that the development of the TRM is ultimately the responsibility of a future licensee. ONR recognises the need to engage with the licensee to ensure that its arrangements for compliance with Licence Conditions 23 & 28 provide the necessary EMIT coverage particularly for the Class 2 active systems.

4.2.4 Update of UK AP1000 Generic PCSR: UKP-GW-GL793

65. As noted in Section 3, the revised PCSR includes a significantly expanded sub-chapter 5.6 on limits and conditions for safety. Additional references to limits and conditions, Technical Specifications and ORs have also been introduced into other chapters of the revised PCSR, and these were considered necessary in level 4 discussions in the relevant technical assessment areas. The outcomes of such discussions are considered appropriate in the individual issue close-out reports and assessment notes. Conclusions from the reactor chemistry and fault studies topic areas are considered below.

4.2.4.1 PCSR: Reactor Chemistry

66. The lack of a definition in the PCSR of chemistry-related ORs and the absence of consideration of radiochemistry aspects were discussed with Westinghouse at level 4 reactor chemistry meetings (see, for example, Ref. 23). Such concerns had also been raised in RQ-AP1000-1499 (Ref. 24) and RQ-AP1000-1729 (Ref. 25).

67. Westinghouse's approach was to include, in Chapter 21 Revision 0D (Ref. 26), Table 21-5 (primary circuit water chemistry safety limits) and Table 21-6 (secondary circuit water chemistry safety limits), and also to make reference to the **AP1000** chemistry manual (Ref. 27) and the summary report of **AP1000** plant chemistry characterisations (Ref. 28). The former two tables deal exclusively with the primary and secondary coolant, and contain a list of parameters and their limits. All of the other SSCs where chemistry controls are required are referenced to tables contained in the latter two documents.

68. The ONR chemistry assessor welcomed these tables as a useful and important addition to the PCSR, but had a number of reservations about the approach adopted by Westinghouse:

- The values only consider power operations, not any other modes where chemistry limits will differ.
- There is no link between the values quoted and the evidence which supports these.
- No radiochemistry parameters are identified (nor are any identified within the Radiation Protection chapter of the PCSR (Chapter 24).
- Some values are given as a range, but ONR would not expect zero to be a limit for some values given (for example, dissolved hydrogen).

- No expected values are presented (although some can be inferred from the text).

69. Nevertheless, ONR's reactor chemistry assessor was able to conclude (Ref. 29) that, collectively, there is sufficient information contained within the safety case for the **AP1000** plant for a competent licensee to be able to fully define the chemistry-related ORs. Refs 27 and 28 are an important start for this process, as are the generic Technical Specifications (Ref. 18). ONR's reactor chemistry assessor was not content that the generic PCSR currently provides adequate coverage of reactor chemistry ORs but was satisfied that this was a matter that can be rectified by a future licensee.

4.2.4.2 PCSR: Fault Studies

70. Identifying and demonstrating limits and conditions are fundamental to fault studies, and are therefore key requirements for Chapter 8 (Fault and Accident Analysis) and Chapter 9 (Internally Initiated Faults) of the PCSR.

71. In Chapter 8 the fault schedule identifies the SSCs claimed for design basis faults in all operation modes. It therefore takes into account and shows at a glance the reduced availability of SSCs permitted by the Technical Specifications. Chapter 9 presents transient analysis for design basis faults in all operating modes. This substantiates the Technical Specifications. The transient analysis also assumes set-points for Control and Instrumentation, performance requirements for pumps, pressure losses for pipes, etc.

72. Chapters 8 and 9 do not explicitly highlight every limit and condition or Technical Specification that they influence or substantiate. ONR's fault studies assessor considered this to be acceptable, because generating these data sources for future derivations of limits and conditions by a licensee is so clearly fundamental to the objectives of its fault analyses.

73. As part of GI-AP1000-FS-02 Action 2 (Ref. 30), Westinghouse has produced a new UK-specific document that captures key limits and conditions from the fault studies analysis which need to be considered in core designs (Ref. 31). This has been assessed and judged to be adequate. GI-AP1000-FS-01 Action 3 has resulted in some changes to short-term availability controls (Tier 2 Technical Specifications). The ONR fault studies assessor judged the treatment of limits and conditions in the revised PCSR to be appropriate (Ref. 32).

4.3 Assessment Findings

74. Assessment findings are matters that do not undermine the generic safety submission and are primarily 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.

75. Residual matters are recorded as assessment findings if one or more of the following apply:

- Site-specific information is required to resolve this matter.
- The way to resolve this matter depends on licensee design choices.
- The matter raised is related to operator-specific features, aspects or choices.
- The resolution of this matter requires licensee choices on organisational matters.
- To resolve this matter the plant needs to be at some stage of construction or commissioning.

76. In my assessment I found no examples which met these criteria.

4.4 Minor Shortfalls

77. Residual matters are recorded as a 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; or
- require further substantiation to be undertaken.

78. During my assessment of this issue, I have identified no minor shortfalls.

5 CONCLUSIONS

79. This report presents the findings of the assessment of GDA Issue GI-AP1000-CC-01 relating to the **AP1000** reactor GDA closure phase.

80. With regard to the documents submitted by Westinghouse in response to this issue, my conclusions were as follows:

- **UKP-GW-GL-500:** ONR considers that this sets out a logical, well-structured and comprehensive process for the development of ORs for the UK **AP1000** by a future licensee.

- **UKP-GW-GL-501:** Although ONR considered that the list of key generic Technical Specifications fell short of what was anticipated, ONR acknowledged that, overall, the generic safety case provides sufficient information for a competent future licensee to be able to fully define the complete set of ORs for the UK **AP1000** reactor.

- **UKP-GW-GL-502:** ONR considered this to be a useful supplement to UKP-GW-GL-500.

- **Revised PCSR (UKP-GW-GL-793):** With regard to its treatment of Technical Specifications and ORs, Westinghouse had made a number of amendments and additions to the 2009 PCSR, and these changes were considered broadly adequate to address the requirements for PCSR update set out in this GDA issue. Some deficiencies were considered to remain in the treatment of limits and conditions in generic PCSR, however, and future licensees will need to address these in developing site-specific OTS and ORs.

81. Overall, on the basis of the findings set out in this report, I am satisfied that GDA Issue GI-AP1000-CC-01 can be closed.

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ANNEX 1. REGULATORY ISSUE GI-AP1000-CC-01: LIMITS & CONDITIONS

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.
Action A1*	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. ONR expect Westinghouse to: • 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 affect 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.
Action A2*	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: • 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. The GDA AP1000 reactor fault schedule could be used to identify the SSCs for each operating state.
Action A3*	Produce PCSR sub-chapter on Limits and Conditions as appropriate to capture the outcome of Actions 1 and 2 within this GDA Issue..

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

ANNEX 2 – AP1000 REACTOR LIMITS AND CONDITIONS METHODOLOGY FLOWCHART