Office for Nuclear Regulation

An agency of HSE

Generic Design Assessment – New Civil Reactor Build

GDA Close-out for the EDF and AREVA UK EPR™ Reactor

GDA Issue GI-UKEPR-CC-01 Revision 1 – Categorisation and Classification of Systems, Structures and Components

Assessment Report: ONR-GDA-AR-12-023
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EXECUTIVE SUMMARY

This report presents the close-out of part of the Office for Nuclear Regulation’s (an agency of HSE) Generic Design Assessment (GDA) for the cross-cutting GDA Issue **GI-UKEPR-CC-01.** This issue included eight actions associated with the development of methodologies for categorising Safety Function and classifying Structures, Systems and Components and the application of these methodologies within the UK EPR™ design. Our assessment has considered whether these are in line with UK and international standards and relevant good practice.

The assessment has focused on the deliverables identified within the EDF and AREVA Resolution Plan published in response to the GDA Issue and on further assessment undertaken of those deliverables.

EDF and AREVA chose to adopt two different approaches for the application of classification depending on the type of EPR™ system. The approach taken by EDF and AREVA was to develop their methodologies for Safety Function (SF) categorisation and Structures, Systems and Components (SSC) classification within their technical report NEPS-F DC 557 and, where applicable, provide evidence of the application of these through examples within the UK EPR™ design.

For civil structures, electrical, C&I and discrete parts of the HVAC system a system wide approach is applied, while for the remaining UK EPR™ mechanical systems EDF and AREVA chose to classify at the Safety Feature Group (SFG) level, which is at sub system rather than at system level. EDF and AREVA provided evidence of the application of the SFG approach, but this was limited to two examples within the UK EPR™ design. In addition, EDF and AREVA proposed a number of design changes to increase the safety classification of key SSCs above the level originally proposed.

We have assessed the deliverables detailed within the Resolution Plan, and supporting information provided by EDF and AREVA, including updates to GDA submission documentation and a number of design change proposals related to classification. As a result ONR is satisfied that the development of methodologies for categorising Safety Function and classifying Structures, Systems and Components, and the application of these methodologies within the UK EPR™ design, are sufficient and are in line with UK and international standards and relevant good practice.

Our judgement is based upon the following factors:

- The methodology for categorising plant safety functions is now clear and well documented within the GDA submission and this approach aligns with UK and international standards and relevant good practice.
- EDF and AREVA opted to adopt two SSC classification approaches within the GDA. They have applied a system wide classification approach for electrical, C&I and civil structures and the DVLnew, DELnew, DVL and DEL HVAC systems. For all other systems, including mechanical systems they have applied a SFG approach where the SFG is comprised of safety features (SFs) which collectively, contribute to the delivery of a safety function(s), however the SFs may be located in different systems. Nevertheless, the requirement to first establish the required safety function prior to SSC classification is documented for both classification approaches within the GDA submission and aligns with UK and international standards and relevant good practice.

- The methodologies for categorising SFs and classifying SSCs associated with civil structures, electrical and C&I systems have been developed in GDA and now align with UK and international standards and relevant good practice.
- The rules used by EDF and AREVA to assign the mechanical design requirements applied to pressure retaining components differ from previous approaches used for PWR reactors. The rules were implemented on the two examples provided for GDA and showed a logical progression and consistency with previous approaches. In some instances, the rules can lead to lower mechanical design requirements compared with previous reactor designs. While the examples given in GDA are acceptable we will require a future licensee to confirm that a consistent and logical progression, from previous approaches, extends to all mechanical systems when the design requirements are defined during the site-specific phase.
- The use of nuclear and non-nuclear pressure vessel design codes associated with these mechanical design requirements has been clarified in the SSC classification methodology to meet our expectations.
- Multiple design changes have been agreed in GDA to increase the classification of key SSCs above the level originally proposed for the UK EPR™ and implementation of these changes will significantly improve the robustness of the UK EPR™ design in areas such as Spent Fuel Pool cooling, the make-up water plant and the ultimate diesel generators.
- The supporting technical documentation, including the specification for update of System Design Manuals (SDM), provides sufficient guidance to allow a future licensee to apply these methodologies during the Site-specific phase.
- Although the application of agreed SF and SSC methodologies is limited within the GDA design, the application examples provided together with the supporting technical documentation, including report NEPS-F DC 57 and the specification for update of SDMs, are considered sufficient to allow a future licensee to fully apply these methodologies within a site-specific UK EPR™ design.

On the basis of ONR’s assessment of the information provided by EDF and AREVA I am satisfied that the requirements of GDA Issue, **GI-UKEPR-CC-01** have been addressed.

Ten assessment findings were raised in relation to this GDA Issue and these are identified in Annex 1.

LIST OF ABBREVIATIONS (add)

ALARP	As Low As is Reasonably Practicable
AREVA	AREVA NP SAS
C&I	Control & Instrumentation
CDRM	Control Rod Drive Mechanisms
CMF	Change Management Form
CVCS	Chemical and Volume Control System
DAC	Design Acceptance Confirmation
EBS	Extra Boration System
EDF	Electricité de France SA
EFWS	Emergency Feed Water System
EHS	European Harmonised Standards
EMIT	Examination, Inspection, Maintenance and Testing
GDA	Generic Design Assessment
HIC	High Integrity Component
HSE	Health and Safety Executive
HVAC	Heating, Ventilation, and Air Conditioning
IAEA	International Atomic Energy Agency
LHSI	Low Head Safety Injection
LLSF	Low Level Safety Function
LOCA	Loss of Coolant Accident
MHSI	Medium Head Safety Injection
ONR	Office for Nuclear Regulation (an agency of HSE)
PCC	Plant Control Condition
PCSR	Pre-construction Safety Report
PDS	Primary Depressurisation System
PLSF	Plant Level Safety Function
PMC	Pressurised Mechanical Components
PSA	Probabilistic Safety Analysis
RCPB	Reactor Coolant Pressure Boundary
SAP	Safety Assessment Principle(s) (HSE)
SDM	System Design Manual
SF	Safety Function
SFG	Safety Feature Group

LIST OF ABBREVIATIONS (add)

SFP	Spent Fuel Pool
SIS	Safety Injection System
SSC	Structure, System, Component
TAG	Technical Assessment Guide(s) (ONR)
TO	Technical Observations
TQ	Technical Query
TSC	Technical Support Contractor
UDG	Ultimate Diesel Generator
WENRA	Western European Nuclear Regulators' Association

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Scope 1
1.3 Methodology 2
1.4 Structure 2
2 ONR'S ASSESSMENT STRATEGY FOR CROSS CUTTING 3
2.1 The Approach to Assessment for GDA Close-out 3
2.2 Standards and Criteria 3
2.3 Safety Assessment Principles 3
2.3.1 Technical Assessment Guides 3
2.3.2 National and International Standards and Guidance 4
2.4 Use of Technical Support Contractors 4
2.5 Out-of-scope Items 4
3 EDF AND AREVA DELIVERABLES IN RESPONSE TO THE GDA ISSUE 5
3.1 1st Deliverable – Update of NEPS-F DC 557 7
3.2 2nd Deliverable – UK EPR™ PCSR sub-chapter 3.2 7
4 ONR ASSESSMENT 8
4.1 Scope of Assessment Undertaken 9
4.2 Assessment 9
4.2.1 GI-UKEPR-CC-01 Action 1: Classification of duty systems 9
4.2.2 GI-UKEPR-CC-01 Action 2: Classification of Civil Engineering Structures 16
4.2.3 GI-UKEPR-CC-01 Action 3: Provision of an internal and external hazard fault schedule 21
4.2.4 GI UKEPR-CC-01 Action 4: Requirements for Pressurised Mechanical Components 24
4.2.5 GI UKEPR-CC-01 Action 5 - Classification of diverse lines of protection 32
4.2.6 GI UKEPR-CC-01 Action 6 Classification of C&I 34
4.2.7 GI-UKEPR-CC-01 Action 7: Classification of spent fuel pool cooling system 36
4.2.8 GI-UKEPR-CC-01 Action 8: Classification of electrical SSCs 38
4.2.9 GI-UKEPR-CC-01 Assessment Generic Aspects 39
4.3 Comparison with Standards, Guidance and Relevant Good Practice 41
5 ASSESSMENT CONCLUSIONS 42
5.1 Overall Conclusions 42
5.2 Review of the Update to the PCSR 43
6 ASSESSMENT FINDINGS 44
6.1 Impacted Step 4 Assessment Findings 45
7 REFERENCES 46

Tables

Table 1: Relevant Safety Assessment Principles Considered for Close-out of **GI-UKEPR-CC-01** Revision 1

Annexes

Annex 1: GDA Assessment Findings Arising from GDA Close-out for *Cross Cutting* GDA Issue, **GI-UKEPR-CC-01**

Annex 2: GDA Issue, **GI-UKEPR-CC-01** Revision 1 – *Cross Cutting* – UK EPR™

1 INTRODUCTION

1.1 BACKGROUND

1 This report presents the close-out of the Health and Safety Executive's (HSE) Generic Design Assessment (GDA) within the Cross-Cutting area. The report specifically addresses the GDA Issue **GI-UKEPR-CC-01** Revision 1 and associated GDA Issue Actions (Ref. 6) generated as a result of the GDA Step 4 Cross Cutting Assessment of the UK EPR™ (Ref. 7). The assessment has focused on the deliverables identified within the EDF and AREVA Resolution Plans (Ref. 8) published in response to the GDA Issue and on further assessment undertaken of those deliverables.

2 GDA followed a step-wise-approach in a claims-argument-evidence hierarchy. In Step 2 the claims made by EDF and AREVA were examined and in Step 3 the arguments that underpin those claims were examined. The Step 4 assessment reviewed the safety aspects of the UK EPR™ reactor in greater detail, by examining the evidence, supporting the claims and arguments made in the safety documentation.

3 The Step 4 Cross Cutting Assessment identified three GDA Issues and seven Assessment Findings as part of the assessment of the evidence associated with the UK EPR™ reactor design. A GDA Issue is an observation of particular significance that requires resolution before the Office for Nuclear Regulation (ONR), would agree to the commencement of nuclear safety related construction of the UK EPR™ within the UK. An Assessment Finding results from a lack of detailed information which has limited the extent of assessment and as a result the information is required to underpin the assessment. However, they are to be carried forward as part of normal regulatory business.

4 The Step 4 Assessment concluded that the UK EPR™ reactor was suitable for construction in the UK subject to resolution of 31 GDA Issues.

5 The purpose of this report is to provide the assessment which underpins the judgement made in closing GDA Issue **GI-UKEPR-CC-01** and its eight actions covering several technical topic areas which required EDF and AREVA to develop and apply SF categorisation and SSC classification methodologies to the UK EPR™ design.

1.2 SCOPE

6 This report presents only the assessment undertaken as part of the resolution of this GDA Issue and it is recommended that this report be read in conjunction with the Step 4 Cross Cutting Assessment (Ref. 7) of the EDF and AREVA UK EPR™ in order to appreciate the totality of the assessment of the evidence undertaken as part of the GDA process.

7 This assessment report is not intended to revisit aspects of assessment already undertaken and confirmed as being adequate during previous stages of GDA. However, should evidence from the assessment of EDF and AREVA's responses to GDA Issues highlight shortfalls not previously identified during Step 4, there will be a need for these aspects of the assessment to be highlighted and addressed as part of the close-out phase or be identified as Assessment Findings to be taken forward to site licensing.

1.3 METHODOLOGY

8 The methodology applied to this assessment is identical to the approach taken during Step 4 which followed the HOW 2 Process (Ref. 1), in relation to mechanics of assessment within ONR.

9 This assessment has been focused primarily on the submissions relating to resolution of the GDA Issue as well as any further requests for information or justification derived from assessment of those specific deliverables.

10 The aim of this assessment is to provide a comprehensive assessment of the submissions provided in response to the GDA Issues to enable ONR to gain confidence that the concerns raised have been resolved sufficiently so that they can either be closed or lesser safety significant aspects be carried forward as Assessment Findings.

1.4 STRUCTURE

11 This Assessment Report structure differs slightly from the structure adopted for the previous reports produced within GDA, most notably the Step 4 Cross Cutting Assessment. The report has been structured to reflect the assessment of the individual GDA Issue rather than a report detailing close-out of all GDA Issues associated with this technical area.

12 The reasoning behind adopting this report structure is to allow closure of GDA Issues as the work is completed rather than having to wait for the completion of all the GDA work in this technical area.

2 ONR'S ASSESSMENT STRATEGY FOR CROSS CUTTING

13 The intended assessment strategy for GDA Close-out for the three Cross Cutting Issues was set out in an assessment plan that identified the intended scope of the assessment and the standards and criteria that would be applied.

14 The overall bases for the assessment of the GDA Issues are the Cross Cutting elements of:

- Submissions made to ONR in accordance with the resolution plan (Ref. 8).
- Update to the Submission / Pre-construction Safety Report (PCSR) / Supporting Documentation (Ref.12).
- Design Change Submissions – proposed by EDF and AREVA and submitted in accordance with UK EPR Project Instruction UKEPR-I-003 (Ref. 10).

15 In completing my assessment of this cross cutting topic I have sought advice from ONR specialists and this advice was provided through assessment notes which are referenced from this report.

2.1 The Approach to Assessment for GDA Close-out

16 The approach to the closure of GDA Issues for the UK EPR™ Project involved the assessment of submissions made by EDF and AREVA in response to the GDA Issue. These submissions are detailed within the EDF and AREVA Resolution Plan for the GDA Issue.

17 Where further supporting evidence was required as part of our assessment, Technical Queries (TQ) were generated and these are referred to in section 4.2 of this report.

18 When requests for further information through production of the aforementioned TQs did not adequately resolve the GDA Issue, formal notification in the form of a letter detailing the shortfall(s) in ONR expectations was sent to EDF and AREVA.

19 The objective of the Cross Cutting assessment has been to assess submissions made by EDF and AREVA in response to the GDA Issue identified through the GDA process and the design changes requested by EDF and AREVA and, if judged acceptable to clear the GDA Issue.

2.2 Standards and Criteria

20 The relevant standards and criteria adopted within this assessment are principally the Safety Assessment Principles (SAP), internal ONR Technical Assessment Guides (TAG), relevant national and international standards and relevant good practice informed from existing practices adopted on UK nuclear licensed sites. The key SAPs and relevant TAGs have been detailed within this section. National and international standards and guidance have been referenced where appropriate within the assessment report. Relevant good practice, where applicable, has also been cited within the body of the assessment.

2.3 Safety Assessment Principles

21 The key SAPs (Ref. 2) applied within the Cross Cutting assessment of the EDF and AREVA UK EPR™ are included within Table 1 of this report.

2.3.1 Technical Assessment Guides

22 The following Technical Assessment Guides have been used as part of this assessment and these can be found on the HSE web site via the link provided at Ref. 3:

- T/AST/017 Structural Integrity Civil Engineering Aspects. Issue 2. March 2005
- T/AST/013 External Hazards. Issue 3. April 2009
- T/AST/009 – Examination, Inspection, Maintenance and Testing (EMIT) of SSCs
- T/AST/003 – Safety Systems, issue 5 , September 2009
- T/AST/051 –Purpose, Scope and Content of Nuclear Safety Cases

2.3.2 National and International Standards and Guidance

23 The following international standards and guidance have been used as part of this assessment:

- Safety of Nuclear Power Plants: Design. Safety Requirements. International Atomic Energy Agency (IAEA). Safety Standards Series No. NS-R-1. IAEA. Vienna. 2000 (Ref. 5).
- IEC standards (e.g.) IEC61226 (Ref. 21).

2.4 Use of Technical Support Contractors

24 No Technical Support Contractors

2.5 Out-of-scope Items

25 This GDA Issue applies across the UK EPR™ GDA design and there are no defined out-of-scope items. However, application of the SF and SSC methodologies agreed in GDA have been limited in application to examples within the design.

3 EDF AND AREVA DELIVERABLES IN RESPONSE TO THE GDA ISSUE

26 The information provided by EDF and AREVA in response to this GDA Issue, as detailed within their Resolution Plan (Ref. 8), was broken down into the eight component GDA Issue Actions and then further broken down into specific deliverables for detailed assessment.

27 The key deliverables associated with this GDA Issue are listed in the table below for each GDA Issue action for the key tasks identified in the Resolution Plan (Ref. 8). During progress of this GDA issue some changes where made to task deliverables and these changes are shown in the table below.

28 Within these key deliverables are two principal deliverables that apply to all the GDA Issue actions with the exception of action 3 which is related to the development of the UK EPR™ hazard schedule. The two principal deliverables are;

- Update to report NEPS-F DC 557 (Ref. 18) and
- Update PCSR sub-chapter 3.2 (Ref. 46)

29 These two principal deliverables are described briefly in Sections 3.1 and 3.2 below and are considered further in detail in Section 4 of this report.

30 The table below lists all the key deliverables provided by EDF and AREVA in response to this GDA Issue through their Resolution Plan (Ref. 8). The table also includes references to the relevant part of Section 4 of this report where assessment of the remaining deliverables is addressed.

GI-UKEPR-CC-01 Issue Action	Resolution Plan Deliverable	Ref
Action 1: Classification of duty systems	Task 1 – Develop overall methodology	See report Section 4.2.1.1
Action 1: Classification of duty systems	Task 2 - Examples of Methodology Application CVCS + EFWS	18
Action 1: Classification of duty systems	Task 3 - Update of NEPS-F DC 557	18
Action 1: Classification of duty systems	Task 4 - PCSR Update - Sub-chapter 3.2	46
Action 2: Classification of internal civil structures	Task 1 - Update of NEPS-F DC 557 Supporting Documents : • ECEIG112228 • ENGSGC110254 • ENSN110130	18 38 40 39
Action 2: Classification of internal civil structures	Task 2 - PCSR Update - Sub-chapter 3.2	46
Action 3: Provision of an internal and external hazard fault schedule	Task 1 - Methodology and Identification of Representative Cases	23 & 24
Action 3: Provision of an internal and external hazard fault schedule	Task 2 - Development of Representative Hazards Fault Schedule Examples	31
Action 3: Provision of an internal and external	Task 3 - PCSR Update - Sub-chapters 13.1 and 13.2	19 & 32

GI-UKEPR-CC-01 Issue Action	Resolution Plan Deliverable	Ref
hazard fault schedule		
Action 4: Classification of mechanical pressure systems	Task 1 - Class 1 Components - Application of M3 Requirements - PEPS-F DC 99 (Document Withdrawn replaced by ENSNDR120069 Rev A October 2012	50 & 51
Action 4: Classification of mechanical pressure systems	Task 2 - Class 2 Components - Comparison between RCC-M3 and EHS+ Design Change (withdrawn by EDF/AREVA and replaced by commitment through stage 1 & 2 CMF 30 to apply nuclear codes only to class 2 PMCs as referred to in GDA design reference.)	9 & 57
Action 4: Classification of mechanical pressure systems	Task 3 - Update of NEPS-F DC 557	18
Action 4: Classification of mechanical pressure systems	Task 4 - PCSR Update - Sub-chapter 3.2	46
Action 4: Classification of mechanical pressure systems	Task 5 (new) - Mechanical Classification and Site Licensing Overview Document ENSNDR120069	52
Action 5: Classification of diverse lines of protection	Task 1 - Diverse Line of Protection - Upgrading to Class 2 via stage 1 & 2 CMF36 & CMF37 as referred to in GDA design reference.	9
Action 5: Classification of diverse lines of protection	Task 2 - Update of NEPS-F DC 557	18
Action 5: Classification of diverse lines of protection	Task 3 - PCSR Update – Sub-chapter 3.2	46
Action 5: Classification of diverse lines of protection	Task 4 - PCSR Update – Sub-chapter 14.7	12
Action 6: Categorisation and classification of C&I systems	Task 1 - UK EPR C&I Architecture Safety Principles (GI-UKEPR-CI06.A9)	60
Action 6: Categorisation and classification of C&I systems	Task 2 - Update of NEPS-F DC 557	18
Action 6: Categorisation and classification of C&I systems	Task 3 - PCSR Update - Sub-chapter 3.2	46
Action 7: Classification of the spent fuel pool cooling system	Task 1 - Classification Analysis of the Spent Fuel Cooling System + stage 1 & 2 CMF38 as referred to in GDA design reference.	9
Action 7: Classification of the spent fuel pool cooling system	Task 2 - Update of NEPS-F DC 557	18
Action 7: Classification of the spent fuel pool cooling system	Task 3 - PCSR Update - Sub-chapter 3.2 SFP sub chapter update	46
Action 8: Classification of electrical systems	Task 1 - Update of NEPS-F DC 557	18
Action 8: Classification of electrical systems	Task 2 - PCSR Update - Sub-chapter 3.2	46

31 It is important to note that this information above is supplementary to that provided within the March 2011 PCSR (Ref. 11) which has already been subject to assessment during earlier stages of GDA. In addition, it is important to note that the deliverables are not intended to provide the complete safety case for this Cross Cutting topic. Rather they form further detailed arguments and evidence to supplement those already provided during earlier Steps within the GDA Process.

3.1 1st Deliverable – Update of NEPS-F DC 557

32 This report provides a description of the Safety Function Categorisation and SSC classification methodologies developed by EDF and AREVA for the UK EPR™ design. It includes examples of the application of these methodologies to EPR™ systems. The development of this report and my assessment of it are addressed in Section 4 of this report.

3.2 2nd Deliverable – UK EPR™ PCSR sub-chapter 3.2

33 This PCSR sub-chapter provides a summary of the Safety Function Categorisation and SSC classification methodologies provided in report NEPS-F DC 557 and includes tabular summaries of the application of these methodologies to SSCs within the UK EPR™ design.

4 ONR ASSESSMENT

34 Further to the assessment work undertaken during Step 4 (Ref. 7), GDA Issue **GI-UKEPR-CC-01** (Ref. 6), with its eight actions, was raised to require EDF and AREVA to provide further evidence to demonstrate the development, and where required, the application of SF and SSC methodologies to the UK EPR™ . EDF and AREVA were also required to identify design changes arising from the application of these methodologies.

35 GDA issue **GI-UKEPR-CC-01** has eight actions related to the following aspects of the methodologies for categorising SF's and classifying SSCs:

- Action 1: Classification of duty systems;
- Action 2: Classification of internal civil structures;
- Action 3: Provision of an internal and external hazard fault schedule;
- Action 4: Classification of mechanical pressure systems;
- Action 5: Classification of diverse lines of protection;
- Action 6: Categorisation and classification of C&I systems;
- Action 7: Classification of the spent fuel pool cooling system;
- Action 8: Classification of electrical systems.

36 This assessment of the deliverables provided by EDF and AREVA in response to this GDA Issue (Ref. 8) was focused and structured as illustrated below:

- Methodologies for categorisation of SFs and classification of SSCs – This covers the development and capturing of methodologies for SF categorisation and SSC classification application within the UK EPR™ PCSR and key supporting references, and includes consideration of associated supporting design requirements rules.
- Application of Methodologies for categorisation of SFs and classification of SSCs – This covers the examples of application of SF categorisation and SSC classification methodologies to the UK EPR™ design for GDA issue Actions 1, 3 and 4.
- Design changes – This covers modifications arising from application of the SF categorisation and SSC classification methodologies in the UK EPR™ design (Ref: 9).
- Update to GDA documentation – This covers the principal GDA submission documents impacted by the SF categorisation and SSC classification methodologies including the PCSR (Ref 12).

37 This assessment has been carried out in accordance with the HOW 2 ONR Assessment Process (Ref. 1).

38 In completing my assessment of this cross cutting topic I have sought and considered advice from ONR specialists. With the exception of Action 6 this advice has been provided through assessment notes which are referenced from this report (Refs: 70-74).

39 For GDA Issue Action 6 which concerns the classification for C&I systems I have presented in Section 4.2.6 of this report a summary of the ONR assessment. The more detailed assessment of this is included within the ONR C&I topic area GDA close-out report (Ref. 61).

4.1 Scope of Assessment Undertaken

40 The scope of the assessment has been to consider the expectations set-out in the GDA Issue, **GI-UKEPR-CC-01**, and the associated GDA Issue Actions summarised above and detailed within Annex 2 of this report. For each of the following themes associated with each GDA Issue action further evidence was sought on:

- Development and compilation of SF categorisation and SSC classification methodologies;
- Application of SF categorisation and SSC classification methodologies through examples within the UK EPR™ design;
- UK EPR™ design changes arising from application of the methodologies
- Impact on GDA submission documentation including the PCSR (Ref. 11)

41 Additionally, the assessment included consideration of the SF and SSC requirements that are included as an Annex to the specification for System Design Manual (SDM) update post GDA (Ref. 68). The SDM specification was a deliverable for GDA Issue **GI-UKEPR-CC02** and further details can be found in the close-out report for that issue (Ref. 65)

4.2 Assessment

42 As stated above in section 4.1 this assessment has focused on the following themes:

- Development of SF categorisation and SSC classification Methodologies
- Examples of application of SF categorisation and SSC classification Methodologies within the UK EPR™ design;
- UK EPR™ design changes related to SF categorisation and SSC classification methodologies;
- Update to GDA documentation.

43 The assessment of each theme and how it has been addressed in the responses provided for each GDA Issue action is described and discussed further in Sections 4.2.1-4.2.9.

44 In developing its SSC classification methodology EDF and AREVA have applied a system wide classification approach for electrical, C&I and civil structures and the DVLnew, DELnew, DVL and DEL HVAC systems. For all other systems, including mechanical systems they have applied a Safety Feature Group (SFG) approach where the SFG is comprised of safety features (SFs) which collectively, contribute to the delivery of a safety function(s), however the SFs may be located in different systems. Nevertheless, both approaches are documented in the methodologies report (Ref. 18) and PCSR (Ref. 12). The overall approach to SF categorisation and SFG approach to classification is considered in detail in Section 4.2.1 of this assessment report.

45 The system wide classification approach is considered primarily in Sections 4.2.2, 4.2.6 and 4.2.8 of this report and overall comments on both classification approaches are summarised in Section 4.2.9 of this report.

4.2.1 GI-UKEPR-CC-01 Action 1: Classification of duty systems

46 During the GDA Step 4 cross cutting assessment (Ref. 7) it was noted that although EDF and AREVA had started to assign appropriate SSC Classification 1, 2 and 3 to major items of mechanical equipment (non pressurised items), such as the Polar Crane and Control Rod Drive Mechanisms (CRDM), and that this aligns well with our SAPs (ECS.1

and ECS.2), the application of this process needed to be extended in the design to include other major mechanical items, specifically "duty systems" whose failure could result in a demand on a safety system. This led to GDA Issue Action **GI-UKEPR-CC-01.A1** which required EDF and AREVA to review all the Plant Control Condition (PCC) events in the range PCC-2 to PCC-4 and identify any duty systems that require safety Classification, or an alternative safety Classification to that identified in their classification report NEPS-F DC 557 Rev C (Ref. 58) which was presented in GDA Step 4.

47 It was agreed with EDF and AREVA that the resolution plan for this GDA Issue action would include the application of the SSC and SC methodologies to two UK EPR™ mechanical systems, the Chemical and Volume Control System (CVCS) and the Emergency Feed Water System (EFWS) duty and safety systems.

4.2.1.1 SF Categorisation and SSC Categorisation Methodologies and Rules

48 In response to GDA Issue **GI-UKEPR-CC-01.A1**, EDF and AREVA outlined a methodology for the categorisation and classification of duty systems and after feedback from ONR, this was developed and incorporated into the final version of report NEPS-F DC 557 (Ref. 18). That report is summarised in and referenced from the GDA final consolidated PCSR (Ref. 46).

49 ONR made an assessment of EDF and AREVA's methodologies for classification of structures, systems, and components (SSCs) and SFGs and a summary of my conclusions is presented below.

50 The document describing EDF and AREVA's methodologies (Ref.18) commences with a definition of terms, a review of relevant international standards on SF categorisation and SSC classification and an overview of the classification methodology. It explains that the methodology can be broken down into five general areas;

- Identification of inputs into the classification process through the identification of safety functions (SF) using the results of the fault analysis;
- Categorising safety functions;
- Classification of structures, systems and components (SSC);
- Assignment of engineering requirements for SSCs such as system architecture requirements for:
  - single failure,
  - emergency power supplies
  - engineering standards,
  - seismic and
  - testing and maintenance
- Verification of the SF categorisation and SSC classification using the safety analysis and the PSA.

51 The methodology document (Ref. 18) then explains how the plant level (PLSF) and lower level safety functions (LLSF) are defined on the UK EPR™. The LLSFs are aligned with the IAEA defence in depth principles (Ref. 5) into:

- operational functions (Level 1),

- preventative safety functions (Level 2),
- design basis safety functions (Level 3) comprising a main line of protection and a diverse line of protection in the case of frequent initiating faults, and
- risk reduction functions identified through the Probabilistic Safety Analysis (PSA) (Level 4) including severe accident situations.

52 These functions are then categorised in accordance with international standard IEC61226 (Ref. 21) into the three categories:

- Category A – any function that plays a principal role in ensuring nuclear safety;
- Category B – any function that makes a significant contribution to nuclear safety;
- Category C – any other safety function;

53 In the ONR's opinion this approach completely aligns with **SAP ECS.1.**

54 The classification methodology document (Ref. 18) then defines the classification process and starts with a definition of the safety feature and safety feature group concepts.

55 A safety feature is really a sub-system of a main system that contributes towards a lower level safety function. An example of this is the charging system which is part of the CVCS duty system.

56 A SFG is a group of **all** the safety features that are needed to perform a lower level safety function and generally consist of a frontline safety feature such as the CVCS charging system and its supporting safety features including C&I, electrics and Heating, Ventilation, and Air Conditioning (HVAC).

57 Once a SFG has been identified it is then classified. Generally, the safety class of the SFG corresponds to the safety category of the function it performs (i.e. Category A corresponds to Safety Class 1, etc). The safety class assigned to a SFG reflects the categorisation of the most important safety function to which it contributes. The precise definitions are:

- Safety Class 1 – any SFG that forms a principal means of fulfilling a Category A safety function;
- Safety Class 2 – any SFG that:
  - makes a significant contribution to fulfilling a Category A safety function, or
  - provides a diverse means of fulfilling a category A safety function (in addition to the principal means, safety class 1 safety feature group that fulfils the function) or
  - provides the principal means of ensuring a Category B safety function.
- Safety Class 3 – any SFG that:
  - contributes to a category B safety function in addition to a safety class 2 safety feature group, or
  - provides a principal means of ensuring a Category C safety function.

58 In the ONR assessor's opinion these definitions meet the guidance in **SAP ECS.2**.

59 However, a potential concern is that the classification methodology report (Ref. 18) makes it clear that there may be circumstances when it is acceptable for a limited number of

safety features to be one safety class lower than the SFG to which they contribute. In such cases, the methodology report states that an adequate justification must be provided to demonstrate that the lower class is suitable through an ALARP analysis that takes into account (amongst other factors):

- The importance of the safety feature (e.g. whether it is required to reach the non-hazardous stable state or is required after the initiating event);
- Whether or not a malfunction would affect the safety function that the safety feature contributes to or;
- Whether or not a malfunction of the equipment would be revealed during normal operation.

60 A further concern with the SFG approach is that the sub-division of systems into sub-systems can be overdone resulting in a potential “salami slicing” approach to classification. The overriding aim of classification is to ensure that the engineering requirements of the system and or sub-system are proportionate to the importance of the safety function to which it contributes. This is to ensure that the system is robustly engineered to minimise the likelihood of a potential common mode failure, recognising that many systems are very complex and perform multiple functions.

61 The report (Ref. 18) does state that when redundancy is required between two components they should be classified identically to avoid such problems, but it nevertheless highlights the concern.

62 After identifying the safety classification of a safety feature, the classification methodology report (Ref. 18) then presents the implications of the classification process on system architecture of the SFGs including the requirements for:

- redundancy (single failure),
- physical separation,
- loss of off-site power,
- seismic withstand capability,
- qualification for accident conditions and
- examination, maintenance, inspection and testing (EMIT) requirements.

63 In the ONR assessor’s opinion, these requirements are generally appropriate. In particular, I welcome the fact, confirmed in Table 4 of report (Ref. 18) that class 3 duty systems will be subject to EMIT requirements and included within the maintenance schedule.

64 One slight concern is that the report states that redundancy is not required on the diverse line of protection. While ONR accept that in accordance with **SAP EDR.4**, the single failure criterion only applies at the functional level and therefore does not apply to a diverse line of protection, there is a case for the worst plant maintenance state to be considered as this can have quite a high conditional probability.

65 In ONR’s opinion, there is a need for a case by case justification for discounting the worst plant maintenance state when determining the redundancy requirements of a system, and this needs to be supported by a probabilistic assessment. However, ONR notes that proposed maintenance activities on the UK EPR™ will only be allowed on any one out of the four-train system when the reactor is at power.

66 EMIT details are matters that can be resolved during the site-specific development phase along with work to develop the operational technical specifications (OTS) as details of these activities are outside the scope of GDA.

67 The classification methodology report (Ref. 18) presents the implications of the classification process with regard to the engineering requirements for systems, structures and components. These areas have been assessed by ONR specialist engineers in Fault Studies, C&I, structural integrity and civil engineering and are discussed further, as appropriate in Sections 4.2.1.2, 4 2.2, 4.2.4 and 4.2.6 of this report.

68 The fault study aspects of the engineering requirements focused on the management of the interfaces between mechanical systems of different class, which is summarised in Table 5 of the classification methodology report (Ref. 18), and which aims to ensure that the failure of a lower safety class system cannot result in the failure of an interfacing system associated with a higher safety class.

69 This requirement is generally achieved through the use of one or more isolation valves. These inherit the classification of the interfacing system with the highest safety class. Additional redundancy is required for those cases where failure of an single active isolation valve to close, together with failure of the system with the lower safety class, could result in the failure of the safety function of the system with the higher safety class (as opposed to just a single redundant train of the system).

70 The final stage of the classification process (Ref. 18) is to verify the allocated safety classifications against the results of the PSA. The ONR assessor's opinion is that this approach is consistent with the requirement that although the classification process should primarily be based upon deterministic methods, this should be complemented by probabilistic methods.

71 However, as the PSA will need to be repeatedly updated during the site-specific development phase, the results of the initial classification process should only be regarded as preliminary.

72 This leads to the following Assessment Finding for a future licensee to review the results of the classification process against future revisions of the PSA to ensure the preliminary classifications remain appropriate.

> ***AF-UKEPR-CC-19:*** *A future licensee shall review the results of the classification process against future revisions of the PSA to confirm that the preliminary classifications that will be identified during the site-specific design development phase remain appropriate*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*

73 ONR's assessment of the SFG methodology approach and principles included in the classification methodology report (Ref. 18) for the UK EPR™ mechanical systems confirms that this aligns with the SAPs and international good practice.

74 ONR's assessment of the application of the SFG classification approach for the UK EPR™ example duty systems is presented in the section below.

4.2.1.2 Examples of application of SF categorisation and SSC classification Methodologies and Rules

75 The appendix of the classification methodology report (Ref. 18) provides two examples of application of the SFG classification approach for the UK EPR™ and these were the EFWS and the CVCS safety and duty system.

76 The EFWS is relatively straight forward since the main safety feature group of the system to which most of the systems components contribute is clearly Class 1 to deliver the category A cooling safety function.

77 The CVCS is more complex system which includes 24 safety feature groups (SFG) and these are listed in the appendix to report (Ref. 18). Those mechanical safety features associated with isolations due to the interface of the CVCS with either the containment building or the primary pressure circuit are allocated Class 1. Isolations to protect against boron dilution faults are also classified as Class 1 and all remaining safety features are classified as Class 3 apart from the control function on the letdown flow which is Class 2.

78 This appears to contrast markedly with the classification of the CVCS on Sizewell B which is mostly classified at the equivalent of Class 1 although it should be recognised that the equivalent of a Class 2 designation does not exist on Sizewell and so anything that would be the equivalent of a Class 2 has of necessity been classified as Class 1. It should also be noted that the design intent for the CVCS on the UK EPR™ is different from that of the CVCS on Sizewell. This issue has been explored through TQ-EPR-1615 and TQ EPR 1630.

79 On Sizewell B the CVCS is designed as a safety system to perform a diverse safety injection role. Following common mode failure of the Medium Head Safety Injection (MHSI) and the Low Head Safety Injection (LHSI) in response to a frequent small break Loss of Coolant Accident (LOCA) the operator is expected to depressurise the primary circuit and re-instate CVCS make-up. The lower primary circuit pressure increases the make-up capacity of the CVCS and reduces the rate of coolant loss through the break such that the CVCS has sufficient capacity to ensure adequate cooling of the fuel.

80 In the case of the UK EPR™ it is claimed that the MHSI and LHSI are diverse systems. The CVCS is therefore designed to perform a prevention function rather than a protection function for which classification at Class 3 is appropriate although still recognising it has a significant risk reduction role. This aspect is discussed in more detail in the close-out report for **GI-UKEPR-FS-02** (Ref. 20) which considers functional diversity for frequent faults. However, I accept the arguments of EDF and AREVA presented in their responses to TQ EPR 1615 and TQ-EPR-1630 that the MHSI and LHSI are more diverse than the equivalent systems on Sizewell and that the design intent of the CVCS is to be a preventative system with the result that it would be disproportionate to upgrade the system to Class 2. Nevertheless, it should be recognised that the reliability requirements on the CVCS put it on the margins of the classification boundary between Class 2 and Class 3.

81 This illustrates a difficulty, not so much with the classification methodology of EDF and AREVA, but with the IEC standard (Ref. 21) on which it is based as the boundary between a diverse function (associated with Category A but system Class 2) and a risk reduction function (associated with Category C and system Class 3) is open to interpretation. This difficulty can only be overcome in practice by gaining confidence in how a future licensee applies the methodology to the UK EPR™. This matter is addressed by the generic Assessment Finding described in section 4.2.9.1 of this report

that requires a future licensee to apply SF categorisation and SSC classification methodologies throughout the site-specific design.

4.2.1.3 Design Changes

82 There are no design changes relating specifically to this GDA Issue action.

4.2.1.4 Update to GDA documentation

83 The SF categorisation and SSC classification methodologies described above are documented in the EDF and AREVA methodology report (Ref. 18) which is referenced from and summarised in the GDA PCSR sub chapter 3.2 (Ref. 46) on classification. However, the application of these methodologies has not been included in the SDMs describing the UK EPR™ design as these methodologies were finalised and agreed late in GDA and their application was limited to two examples to demonstrate the process.

84 The generic requirement to update UK EPR™ site-specific design documentation to include application of the SF categorisation and SSC classification methodologies is discussed in Section 4.2.9.2 of this report

4.2.1.5 Assessment summary of GI-UKEPR-CC-01 Action 1

85 In response to this GDA Issue action EDF and AREVA developed SF categorisation and SSC classification methodologies for application to the UK EPR™ design and introduced the SFG approach for the UK EPR™ mechanical systems. An SFG is comprised of safety features which collectively, contribute to the delivery of a safety function(s), However, the SFs may be located in different systems.

86 Although the application of the SFG approach was limited to the two examples presented in GDA for the CVCS and EFWS mechanical systems in my judgement the methodologies and the examples of their application meet the SAPs and align with international good practice.

87 For ONR to gain confidence that the SFG methodology approach and principles described above will be applied appropriately there is a need for the process to be tested by repeated application Therefore ONR may wish to assess a further selection of system classifications during the early phase of site-specific design development. Given there is a practical need on the part of a future licensee to apply the classification process to all systems and structures during the site-specific development this generic requirement is discussed further in section 4.2.9 of this report.

88 The methodology developed by EDF and AREVA includes, at the final stage of the classification process (Ref. 18), the requirement to verify the allocated safety classifications against the results of the PSA. ONR consider that the approach is consistent with the requirement for the classification process to primarily be based upon deterministic methods and complemented by probabilistic methods. However, this leads to the assessment finding **AF-UKEPR-CC-19** for a future UK EPR™ licensee to review the results of the classification process against future revisions of the PSA to ensure the preliminary classifications remain appropriate; this Assessment Finding is included in Annex 1 of this report.

89 Overall I am satisfied that sufficient progress has been made in the development of the SF categorisation and SSC classification methodologies to justify closure of this GDA Issue action subject to the Assessment Finding presented in Annex 1 which requires a future licensee to:

AF-UKEPR-CC-19: *A future licensee shall review the results of the classification process against future revisions of the PSA to confirm that the preliminary classifications that will be identified during the site-specific design development phase remain appropriate*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

4.2.2 GI-UKEPR-CC-01 Action 2: Classification of Civil Engineering Structures

90 During GDA Step 4 cross-cutting assessment (Ref. 7) it was noted that in the civil engineering topic for classification that further responses and clarification was required from EDF and AREVA to ONR queries on the classification of internal structures and to detail dedicated rules for the design of C2 structures. To address these requirements Action 2 was raised (Ref. 6).

91 In response to this issue action the Resolution Plan (Ref. 8) produced by EDF and AREVA separated the response into two discrete tasks:

- Task 1: Methodology
  - development and update of the following supporting references to report NEPS-F DC 557:
    - ECEIG112228 Rev. A, “UK EPR – GDA – Identification of C1 ‘Other Structures’ (Removal Parts)” (Ref. 38).
    - ENSN110130 Rev. A, “UK EPR – Safety Class 2 Structures – Definition of C2 Safety Requirements” (Ref. 39).
    - ENGSGC110254 Rev. A, “Civil Works Dedicated Rules for Buildings Classified C2 ‘Main Structures’ ” (Ref. 40) and
  - update of NEPS-F DC 557.
- Task 2: PCSR update of sub-chapter 3.2.

92 My assessment of these is summarised under the themes below.

4.2.2.1 SF Categorisation and SSC Classification Methodologies and Rules

93 The main deliverable for this GDA Issue is “Classification of Structures Systems and Components”, Document NEPS-F DC 557 Rev D (Ref. 18). Rev C of this document (Ref. 58) had been reviewed during GDA Step 4 and found to fall short of regulatory expectations.

94 ONR’s assessment of the three supporting references to report NEPS-F DC 557 is summarised below.

4.2.2.1.1 C1 Other Structures - ECEIG112228 Rev. A, “UK EPR – GDA – Identification of C1 ‘Other Structures’ (Removal Parts)”.

95 Document ECEIG112228 Rev. A (Ref. 38) includes a replacement of Table 5 in the 2011 PCSR chapter 3.2 (Ref. 46) by extending it to include C1 “other structures” (removable parts) in the rest of the Nuclear Island buildings, i.e. reactor building (HR), fuel building (HK) and safeguard buildings 1 to 4 (HL).

96 The document (Ref. 38) gives the definition of main structures and other structures as follows:

- "Main structures" - that are fundamental to the structural behaviour of the building and therefore contribute directly to its main safety functions of protecting Class 1 and Class 2 SSCs and/or providing a barrier function. Such structures must conform with the design and construction rules in the ETC-C code and be seismically designed against SC1 requirements.
- "Other structures" - that do not contribute directly to the structural behaviour of the main structure but play an important safety role. Examples are structures that provide shielding protection inside the Reactor Building. Such structures comply with dedicated design and construction rules and are seismically designed to SC2 (if required).

97 Within Ref 38 the definition of design rules and assumptions for C1 other structures is very brief and is limited to identifying whether each item in the table has a safety function for fire, air tightness, shielding thickness etc and it does not give the exact design codes and standards to be used to design for that safety functional requirement. This is judged to be acceptable as the argument given by EDF and AREVA is that *"due to their specific role, these "other structures" may consist of steel plates, polyethylene plates etc. for which the ETC-C is not a suitable design code".*

98 The items listed also vary in whether they are seismic Class 1 or 2 (SC1 or SC2) and the document does not give a definition of the actual SC1 or SC2 requirements or the methodology for classifying these C1 other structures.

99 The document also introduces the designation of SC2(*) to indicate that the holding down bolts or fixings for non-concrete C1 other structures would be designed as SC2 to ETC-C. For example if a partition or removable part was SC2 its fixings would also be SC2. This raises a question about whether it is possible to have SC2 fixings on an SC1 other structure.

100 Overall ONR judges that the document provides an adequate register of the C1 "other structures" within the nuclear island buildings and their safety functional requirements. It also provides confirmation that the ETC-C code is not an applicable design code for the "other structures" which are not made from reinforced concrete or structural steel. However, the actual "dedicated rules" are not included in this report but are to be included in NEPS-F DC 557 Rev D.

4.2.2.1.2 C2 Safety Requirements ENSN110130 Rev A

101 Document ENSN110130 Rev. A (Ref. 39) aims to define the safety requirements for C2 civil structures. It states that the intention is to apply "as much as possible requirements which are very similar to ETC-C code used for Safety Class1 structures with C1 requirements." It also states that the safety requirements for C1 structures are defined in the PCSR sub-chapter 3.3 (Ref. 12)

102 Table 1 of the document shows the civil structure safety class versus the design requirements. This is an update of the table in Sub-chapter 3.2 of the March 2011 PCSR (Ref. 11). It shows that both classifications C1 and C2 are sub-divided into "main structures" and "other structures". However, the table just refers to "dedicated rules" for the codes and standards quoted for C1 other structures and C2 main and other structures, with no indication of what these may be.

103 Section 4.1 of the document is titled design rules. It gives an adequate description of the methodology to be used to define the design requirements. It also includes Table 2 which lists the potential load combinations from the ETC-C code which are applicable to C2 civil structures. This is derived from Table 3 of Sub-chapter 3.3 of the March 2011

PCSR (Ref. 11), Design of Safety Classified Civil Structures, which gives the load combinations for C1 civil structures.

104 Greater clarity would be achieved if the reference number for each combination was the same in both tables, such that it would be obvious which combinations were not applied to C2 structures. Also it was unclear why external explosion had not been included as a load case.

105 C2 civil structures are normally designed to SC2. However, there is no distinct definition of what SC2 requirements are, other than a reference to Section 2.1.7 of Sub-chapter 13.1, Issue 05 (Ref. 45) which states that the criteria and methods defined in Section 2.1.5 and 2.1.6 for SC1 buildings are also applied to SC2 buildings. Therefore, the analysis, design and detailing for SC2 structures is the same as for SC1. The only difference is the performance of an SC2 structure following the design basis earthquake, which can exceed the design code requirements, provided the post-event condition of the structure does not endanger a C1 structure, system or component.

106 This document then refers to document ENGSGC110254 (Ref. 40) for the rules for the design of C2 main structures and this is considered below.

4.2.2.1.3 C2 Main Structures ENGSGC110254 Rev A

107 This document defines the dedicated design rules for civil works that are applicable for C2 “main structures”. The document comprises design rules for C2 “main structures” by providing eight exceptions against ETC-C AFCEN 2010 Part 1 – design, and no exceptions were given against Part 0 or Part 2 of the code and this implies that C2 “main structures” will comply completely with these parts.

108 Design rules for C2 “other structures” are excluded from the document as these do not form part of the GDA scope and so ONR assessment of these rules will need to be carried out during the site-specific phase.

109 The design code Eurocode 2, BS EN 1992-1-1 (Ref. 34) is for the design of concrete structures. Part 1-1 introduces a term, α_{cc} to modify the design strength of concrete in Clause 3.1.6. The ETC-C AFCEN 2010 specifies a different value for α_{cc} than the UK National Annex to Eurocode 2, and so under the resolution of **GI-UKEPR-CE-02**, clause 1.4.3.1.1 of the UK Companion Document (Ref. 36) amends α_{cc} to match the UK National Annex. ENGSGC110254 Rev. A has reverted to the ETC-C value of α_{cc}.

110 This document, subject to the amendment of α_{cc} provides a satisfactory definition of the design rules for C2 “main structures”.

4.2.2.2 Examples of application of SF Categorisation and SSC Classification Methodologies and Rules

111 Application of the methodologies has been included in table 8 of the report NEPS-F DC 557 (Ref. 18) and a summary of this is provided in section 8 of the update to PCSR sub-chapter 3.2 (Ref. 46). Further details are provided in section 4.2.2.4 below.

4.2.2.3 Design changes

112 There are no specific design changes associated with this GDA Issue action.

4.2.2.4 Impact on GDA documentation

113 EDF and AREVA revised the methodology report NEPS-F DC 557 (Ref. 18) and PCSR chapter 3.2 (Ref. 46) in response to this GDA Issue action.

4.2.2.4.1 Report NEPS-F DC 557

114 Report NEPS-F DC 557 (Ref. 18) was revised to include a new section 8,“Classification and requirements Applied to Structures”. This section details the classification of civil structures and introduces the concept of “main structures” and “other structures”. Table 8 in section 8 shows that there are four main classification (excluding non-safety classified) as follows:

- C1 Main Structures
- C1 Other Structures
- C2 Main Structures
- C2 Other Structures

115 The design requirements and codes and standards to be used for C1 main structures are clear and the ETC-C and the UK Companion Document are to be used.

116 The dedicated rules shown for C2 main structures are the two supporting documents reviewed above, namely “Definition of C2 safety requirements”, ENSN110130 Rev A (Ref. 39) and “Dedicated rules for buildings classified C2 “main structures”, ENGSGC110254 Rev A. (Ref. 40) As reviewed above, these are not substantially different from C1 main structure requirements and so are acceptable.

117 The table of safety classified structures (Table 8) has been greatly expanded to show the sub-categories of C1 “other structures” and to show more definition of design rules. This results in a higher number of C1 “other structures” now having defined rules. Only structures made from unusual materials require dedicated rules to be defined at the site-specific phase. This leads to the following assessment finding to cover these structures:

> **AF-UKEPR-CC-20:** *A future licensee shall provide the dedicated rules for each of the “C1 other structures – other than concrete/steel” for the analysis, detailed design, detailing, construction and EMIT of those structures. The licensee shall justify that these dedicated rules ensure each such structure fulfils its safety functional requirements.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*

118 Table 8 of Ref 18 now provides a definition of the requirements for each classification for robustness against earthquake, EMIT (Examination, Inspection, Maintenance and Testing) and seismic detailing rules. The requirements for EMIT are limited to specifying if additional requirements above the ETC-C or Eurocodes are necessary, but the actual detail of these extra requirements will not be provided until the site-specific design development phase. This aligns with the agreed scope of GDA.

119 The final version of the methodology report (Ref. 18) has also clarified that the only difference between seismic classes SC1 and SC2 is the required performance of the structure during and after the design basis earthquake. The methodology for considering stability, local stability, integrity of component supports, containment and avoidance of interaction is given in Section 8.3.7 of that report. The exact design criteria will be specified for each civil structure in its associated hypothesis note at the site-specific detail development phase. Since this applies to both main structures and other structures, but their timescales will be different, the following two assessment findings are raised for a future licensee to address these matters.

AF-UKEPR-CC-21: *A future licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 "main structures" and justify that they will provide the structural performance required for the safety classified component or system that is supported or protected by that structure.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

AF-UKEPR-CC-22: *A future licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 "other structures", including fixings or holding down bolts to the main structures, and justify that they will provide the structural performance required for the safety functional requirement of that structure.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

4.2.2.4.2 PCSR sub-chapter 3.2

120 PCSR sub-chapter 3.2 (Ref. 46) has been updated to include in Section 8 a summary of the information on classification of structures provided in the final version of report NEPS-F DC 557 (Ref. 18).

4.2.2.5 Assessment summary of GI-UKEPR-CC-01 Action 2

121 EDF and AREVA provided an updated SSC classification methodologies report NEPS-F DC 557 (Ref. 18) including supporting references and updated the PCSR chapter 3.2 (Ref. 46) in response to this GDA Issue action. ONR is satisfied that this updated methodologies report provides adequate definition of the classification of civil structures and the rules to be applied to each classification. In particular, as required by this GDA Issue action the classification of C1 "other structures" or internal structures for all Nuclear Island buildings has been provided together with the dedicated rules for C2 structures..

122 PCSR sub-chapter 3.2 (Ref. 46) has been updated to align with the methodologies report (Ref. 18).

123 Overall I am satisfied that sufficient progress has been made in the development of the SF categorisation and SSC classification methodologies to justify closure of this GDA Issue action subject to the Assessment Findings presented in Annex 1:

AF-UKEPR-CC-20: *A future licensee shall provide the dedicated rules for each of the "C1 other structures – other than concrete/steel" for the analysis, detailed design, detailing, construction and EMIT of those structures. The licensee shall justify that these dedicated rules ensure each such structure fulfils its safety functional requirements.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

AF-UKEPR-CC-21: *A future licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 "main structures" and justify that they will provide the structural performance required for the safety classified component or system that is supported or protected by that structure.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

AF-UKEPR-CC-22: *A future licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 "other structures", including fixings or holding down bolts to the main structures, and justify that they will provide the structural performance required for the safety functional requirement of that structure.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

4.2.3 GI-UKEPR-CC-01 Action 3: Provision of an internal and external hazard fault schedule

124 During GDA Step 4 fault studies assessment (Ref. 22) it was noted that the fault schedule did not include a list of internal and external design basis hazards. To address our expectation that such a list should be provided to meet the requirements of **SAP FA.2** GDA Issue **GI UKEPR-CC-01.A3** was raised requiring EDF and AREVA to add a list of design basis faults to the fault schedule.

125 In response to this issue action the Resolution Plan produced by EDF and AREVA separated the response into three discrete tasks:

- Task 1: Methodology and identification of representative cases.
- Task 2: Development of representative hazards fault schedule examples.
- Task 3: PCSR update of sub-chapters 13.1 and 13.2.

126 My assessment of these is considered under the themes below

4.2.3.1 SF Categorisation and SSC Classification Methodologies and Rules

127 Task 1 of the Resolution Plan (Ref. 8) to the GDA Issue, **GI-UKEPR-CC-01** stated that the methodology would be that for a credible hazard, a fault analysis would be carried out in order to determine the following:

- The initiating faults caused by the hazard (where the initiating faults are the same as those on the "plant" fault schedule),
- The consequential effects of the hazard on the protection and safeguards systems, including those involved in the management of the above initiating faults,
- The specific hazard safety functions, the implementation of which is necessary to make sure that the fault sequence is bounded by those of the "plant" fault schedule (e.g. for internal flooding: water detection in a sump, isolation of a hydraulic circuit, etc.).

128 EDF and AREVA letter EPR00976R (Ref. 47) dated 10 October 2011 provided the methodology proposal for Task 1 which included an outline format for the hazard schedule and I provided comments on this in my letters EPR70386R dated 8 December 2011 and EPR70393R dated 9 January 2012 (Refs: 48 and 49).

129 Subsequently it was agreed that, as the supporting analyses are ongoing for the reference design plant of the UK EPR™, the scope of this analysis for GDA was limited to two representative cases where there was sufficient design information to perform the analysis. The two examples agreed were:

- Internal hazard – internal flooding, and
- External Hazard – external explosion.

130 ONR is satisfied that the methodology identified in Task 1 is adequate. The approach to the identification of the initiating faults, consequential effects and hazard safety functions for particular systems is in line with the expectations detailed within the SAPs, specifically **EHA.1**, "Identification" which calls for external and internal hazards that could affect safety to be identified and treated as events that could give rise to possible initiating faults. Included within the supporting paragraphs to this SAP is the expectation that consequential events and combinations of consequential events from a common initiating event should be considered. In addition, **FA.2,** "Identification of initiation faults" and the associated text commentary within paragraph 504 states that internal and external hazards should be included as part of the fault identification process.

131 ONR is satisfied that the identification of the representative cases appears reasonable given that one internal and one external hazard has been selected. From an internal hazards perspective, the selection of internal flooding is the most logical internal hazard to select. This is due to the large amount of analyses that have been undertaken within this area in relation to potential flooding scenarios together with the identification of their associated consequences.

4.2.3.2 Examples of application of SF Categorisation and SSC Classification Methodologies and Rules

4.2.3.2.1 Internal Hazard – Internal Flooding

132 A representative hazard fault schedule for internal flooding was provided with letter EPR01066R (Ref. 23). This gave a detailed description of the internal hazards fault schedule and its considerations. It also superseded the outlined proposal in EPR00976R (Ref. 47) on which I had commented.

133 The fault schedule does identify the potential effects of internal flooding on civil engineering structures, and what safety functional requirements the civil structures must provide. I therefore find this acceptable as an example of the schedule for internal flooding.

134 ONR noted that the possible safety functions required from civil structures from internal flooding are as follows:

- Water tight structures are required in certain locations
- Water tight barriers (doors and penetrations) are required in certain locations
- Certain drainage paths must be isolated, e.g. between divisions.
- Water level detection must be provided in sumps.
- Certain drainage paths must be provided, e.g. drainage down to the basement for storage.
- Isolation of flooding source. This could mean provision of bunded structures.
- Drainage paths may be required to outside the building.

135 All the above safety functional requirements for civil structures are reasonable. The exact design criteria for each structure or building area will need to be specified and EDF and AREVA have confirmed under resolution of **GI-UKEPR-CE-01** that this will be done using the "design hypothesis notes".

136 ONR concludes that although the example of the fault schedule for internal flooding with respect to civil structures is sufficient further regulatory assessment of the actual fault

schedule and the resulting design criteria for civil structures may need to be carried out during the site-specific phase.

4.2.3.2.2 External Hazard - Explosion

137 The representative hazard fault schedule for external explosion was provided under letter EPR01103N (Ref. 24). This gave a detailed review of the possible effects from an external explosion on civil structures. From my assessment of the schedule I concluded the following:

- The schedule presented for the example external explosion is reasonable
- The claim made on the majority of buildings is that the external walls and doors are designed for the design basis pressure wave and this has been confirmed for the buildings sampled by ONR within GDA. However, for those buildings not included in GDA scope such as the diesel buildings a future licensee will have to demonstrate the adequacy of the site-specific design for this hazard.
- With respect to doors/openings/louvres etc. in the Nuclear Island external walls, a detailed ONR assessment of their capability was not carried out under Step 4, but the design methodology was sampled and found to be acceptable. An Assessment Finding was raised in GDA Step 4 for a future licensee to provide justification of the detailed design of doors/louvres in the Aircraft Protection Crash shell (**AF-UKEPR-CE-67**).
- Claims are made on some internal civil structures to resist the pressure wave but these need to be cross referenced to where the detailed design loads are to be specified, which I presume is the site-specific hazard schedule which would detail what each wall and floor needs to resist, not just for external explosion but for all hazards.

138 ONR is satisfied that the two example fault schedules have demonstrated an adequate methodology for identifying the loading effects of these hazards on civil structures. However, the actual hazards fault schedules and the resulting specification for civil structures will need to be assessed at the site-specific design development phase.

4.2.3.3 Design Changes

139 There are no design changes associated with this GDA Issue action.

4.2.3.4 Update to GDA documentation

140 The key documents impacted by this GDA Issue action were PCSR subchapters 13.1 (external hazards) and 13.2 (internal hazards) (Refs: 45 & 19).

141 The Hazards schedule examples derived from the deliverables ((Ref. 23 and 24) were incorporated into the sample hazard schedule ECESN120418. EDF. July 2012. (Ref. 31) and this has been summarised in and referenced from the updated PCSR sub chapters(Refs 19 and 32).

142 ONR judge the PCSR updates to be acceptable.

4.2.3.5 Assessment Summary of GI UKEPR-CC-01 Action 3

143 ONR is satisfied that the two example fault schedules have demonstrated an adequate method of indentifying the loading effects of these hazards on civil structures. Additionally, ONR is satisfied with the methodology, but the actual hazards fault

schedules and the resulting specification for civil structures will need to be assessed at the site-specific phase.

144 ONR has assessed the proposed format for the two example hazard schedules and judge they provide an appropriate framework for inclusion in the fault schedule.

145 In my opinion sufficient progress has been made to justify closure of **GI UKEPR-CC-01.A3** subject to the following Assessment Finding:

> **AF-UKEPR-CC-23:** *A future licensee shall develop and complete a hazard fault schedule based upon the format defined in the sample hazard schedule ECESN120418 for all remaining site-specific internal and external hazards.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*

4.2.4 GI UKEPR-CC-01 Action 4: Requirements for Pressurised Mechanical Components

146 The UK EPR™ approach for the classification of pressure retaining components was reviewed during the GDA Step 4 structural integrity assessment to ensure that the classification approach would be consistent with ONR's SAPs, in particular **ECS.3** and the supporting paragraphs 157-161. This is reported in the Step 4 report on Structural Integrity (Ref. 53). For pressure retaining components a mechanical requirement level (M1, M2, M3 and NR (No mechanical Requirement)) is used to determine the nuclear pressure vessel design class and pressure vessel design code, where appropriate, to ensure that the component quality is appropriate to fulfil the safety function it provides.

147 The approach for pressure retaining components is part of the overall UK EPR™ classification system and therefore ONR's assessment is also reported in the Step 4 report on Cross Cutting issues (Ref. 7) as the overall topic of categorisation and classification is treated as a multi-disciplinary cross-cutting matter in GDA.

148 During GDA Step 4 EDF and AREVA made changes to the criteria used to define the mechanical requirement levels and they made commitments in a letter dated 6 May 2011 (Ref. 56) to address specific concerns identified by ONR's assessment of the classification process. ONR requested EDF and AREVA to use nuclear pressure vessel design codes for Safety Class 1 components with an M3 mechanical requirement instead of non-nuclear codes with supplements, and to re-classify the Safety Injection System (SIS) accumulators and connected lines as M2 rather than M3.

149 Although progress had been made on the approach for determining the classification of pressure retaining components, further work was still required to show that the pressure vessel classification approach would be consistent with ONR's SAPs. In particular evidence would need to be provided to justify that:

- the M3 mechanical requirement is adequate for a Safety Class 1 pressure retaining component; and
- the design and construction to non-nuclear pressure vessel codes with supplements is adequate for a Safety Class 2 pressure retaining component.

150 Action 4 of **GI-UKEPR-CC-01** was raised to address these residual concerns remaining at the end of Step 4 of GDA.

151 In response to this issue action the Resolution Plan produced by EDF and AREVA (Ref. 8) separated the response into four discrete tasks:

- Task 1: Class1 components – application of M3 requirements (report PEPS-F DC 99)
- Task 2: Class 2 components
  - Comparison between RCC-M3 and European Harmonised Standards (EHS)
  - Justification for application of EHS and supplements .
- Task 3 : Update of report NEPS-F DC 557
- Task 3: Update of PCSR sub-chapters 3.2.

152 Prior to the start of our assessment of this issue action EDF and AREVA wrote to ONR on the 22 September 2011 (Ref. 57) stating they had reviewed their position on Safety Class 2 components. Rather than justify the use of non-nuclear codes with supplements (EHS+) for Safety Class 2 pressure retaining components they made a commitment to use nuclear codes.

153 This change meets the expectation on **SAP ECS.3** and the supporting paragraphs 157 to 161 of utilising nuclear codes for Safety Class 1 and 2 components. ONR was satisfied that this commitment would satisfactorily address the concern regarding the use of non-nuclear codes for Safety Class 2 pressure components and was therefore also content with their suggestion that the two deliverables proposed against Task 2 of Action 4 would no longer be required. This was recorded in the revised delivery plan for **GI-UKEPR-CC-01** (Ref. 8) and is formalised in the design change proposal CMF-30 which is discussed in section 4.2.4.3 below.

4.2.4.1 SF Categorisation and SSC Classification Methodologies and Rules

154 EDF and AREVA report PEPS-F DC 99 Rev A (Ref. 50) sought to demonstrate the adequacy of claiming M3 requirements as sufficient for components identified as Safety Class 1, at a system level, based on the system description associated with the components, the safety functions/features of the system and a review of the hazard analysis.

155 From my review of this report and technical discussions with EDF and AREVA two technical queries, TQ-EPR-1525 and TQ-EPR-1553, (Ref. 16) were raised to detail my concerns. The key points being:

- There was no linkage between the criteria for downgrading a Safety Class 1 to M3 (i.e. failure of a component would not lead to unacceptable consequences) to the arguments demonstrating the adequacy of claiming M3 in Ref. 50
- The analysis of the mechanical requirements at a system level rather than a component level was insufficient to show why some components in a system could be downgraded to M3 whereas others were not downgraded to M3;
- The descriptive reasoning behind the downgrade criteria was not clear in the functional review;
- The application of the barrier role and upgrade criteria were not clear for the RCV (CVCS).
- A general question on whether the design codes to be used for the RCV (CVCS) would differ from those applied on previous generations of French PWR.

156 In response to these questions EDF and AREVA reviewed their position and concluded that this deliverable (Ref; 50) was unlikely to provide the necessary confidence to allow

ONR to close the GDA Issue Action. Consequently EDF and AREVA withdrew this deliverable and issued ENSNDR120069 Rev A. (Ref. 51), in order to address the GDA Issue Action.

157 The new deliverable provides a historical context to the evolution of the approach to the classification of pressure equipment on the UK EPR™ and shows the application of the approach on the two mechanical systems examples described in section 4.2.1 of this report using the overall UK EPR™ classification methodology described within report NEPS-F D 557 (Ref. 18).

158 ONR judged this deliverable as providing suitable supporting guidance to future EPR licensees to apply the methodology and rules for classification of PMCs included in section 7.3.4 of the methodologies report (Ref. 18) and PCSR sub-chapter 3.2 (Ref. 46) which are summarised below.

159 The wording of these rules was revised and clarified in Revision D of the methodologies report (Ref. 18) and this is now more consistent with the equivalent rules applied in the Flamanville 3 classification process. The revised rules described in Section 7.4.3.1. of Ref. 18 can be summarised as:

- The safety class drives the minimum requirements to be applied:
  - Safety Class 1 and Safety Class 2 components must meet M3 requirements at least,
  - Safety Class 3 components do not need to meet M1, M2 or M3 requirements (i.e. ‘M’ requirements not needed, NR).
- Secondly, the operating conditions and barrier role give the following requirements:
  - M1 requirements:
    - The component forms the Reactor Coolant Pressure Boundary (RCPB),
    - The component is a High Integrity Component (HIC).
  - M2 requirements:
    - The component performs a barrier role. The component is required to maintain its pressure boundary integrity during conditions where the component is not isolated from the primary coolant circuit under PCC or RRC conditions where cladding damage may have occurred.
    - The component forms part of a Reactor Building penetration, unless already identified as HIC (M1).
  - M3 requirements:
    - The component performs a barrier role that its failure could potentially, under normal or accident conditions (PCC-1 to PCC-4 and RRC conditions), lead to a discharge of radioactivity.

160 The rules to set the pressure vessel design codes and pressure vessel classes within those codes to meet these mechanical requirement levels are then defined in Section 7.4.3.3. of Ref. 18 as follows:

- M1 requires Class 1 nuclear pressure equipment to the rules of the RCC-M code (RCC-M1);

- M2 requires Class 2 nuclear pressure equipment to rules of RCC-M code (RCC-M2) or equivalent rules from ASME or KTA with supplements as necessary;
- M3 for Safety Class 1 and 2 components requires Class 3 nuclear pressure equipment to the rules of RCC-M (RCC-M3) or equivalent rules from another nuclear code
- M3 for Safety Class 3 components may also use European Harmonised Standards with supplements or any code compliant with PED, with supplements, to give equivalence with the Class 3 rules of RCC-M.
- NR (No mechanical Requirement) simply requires normal industrial pressure vessel standards for example European Harmonised Standards.

161 These rules for setting pressure vessel design code and pressure vessel class have been updated from the Step 4 requirements defined in NEPS-F DC 557 Rev C to reflect the commitments to use nuclear standards for Safety Class 1 and 2 pressure equipment. These are summarised in table 7 in PCSR chapter 3.2 (Ref. 46) as below:

Component Safety Class	Mechanical Component requirement	Design Code
1	M1	RCC-M1
	M2	RCC-M2 or ASME III or KTA with supplements
	M3	RCC-M3
2	M2	RCC-M2 or ASME III or KTA with supplements
	M3	RCC-M3
3	M2	RCC-M2 or ASME III or KTA with supplements
	M3	RCC-M3 or Harmonised European standards with supplements (or any code compliant with PED, with supplements)
	NR	Harmonised European standards (or any code compliant with PED)

162 The rules for control of interfaces between PMCs were also reviewed.

163 The interfaces are based on French reactor deign experience, and Appendix 2 of (Ref. 50) shows the interface table for the 1450 MWe N4 design, the Flamanville 3 design and the UK EPR™ the interface definitions are generally compatible.

164 However, one difference of note was the interface between an M2 system and an M3 or NR system using remote control operated valves. The N4 definition was written in terms of requiring two of these valves with a possibility of dropping to a single valve if the criteria based on the consequences of failure noted in the footnote of the table were met. The Flamanville 3 and UK EPR™ definition was written in terms of requiring a single valve, with the footnote of the table stating that redundancy could be required depending on the safety class of the of the Safety Function Group it belongs to.

165 I did not believe this footnote was sufficiently clear in comparison to the N4 definition, and EDF and AREVA agreed to change the definition to make in clearer. Table 5 of Revision D of the methodologies report (Ref. 18) includes the improved footnote:

‘Utilisation of a single component may be appropriate provided that the failure to close this component cumulated with the failure of the lower classified system of the interface does not impair the safety function(s) of the interfacing higher classified system and does

not enable an uncontrolled release of radioactive material, stored to decay, to occur. If this is not ensured, then two isolation components will be necessary".

166 I judged this revised footnote was sufficiently clear and consistent with the intent of the N4 footnote.

167 The methodology for the classification of PMCs described in report NEPS-F DC 557 (Ref. 18) and updated PCSR sub-chapter 3.2 (Ref. 46) is a development of the approach applied for Flamanville 3 (FA3). It differs from the more prescriptive rules applied to previous designs and the background to this approach is described in (Ref. 51).

168 There has been agreement in principle to the use of this approach in France, but it can lead to lower classifications compared with previous designs, for example the SIS accumulators and related pipework.

169 This aspect has been addressed for the GDA UK EPR™ through the EDF and AREVA commitment to allocate M2 design requirements to the accumulators through design change proposal CMF 50, but it will be important for future Licensees to be aware of the outcome of the discussions that are to take place in France between ASN and EDF on classification in case there are significant implications for the classification of pressure equipment on the UK EPR™. This leads to the following Assessment Finding for a Licensee to address this aspect.

> ***AF-UKEPR-CC-24:*** *A future Licensee shall review the approach used to assign the mechanical requirements for pressure retaining components on the UK* EPR™ *in the light of discussions being held with the French nuclear regulator ASN on the application of the classification methodology for Flamanville 3 and any outcome from the French Groupe Permanent Reacteurs (GPR) meeting planned for 2013 to discuss the topic of classification.*
>
> ***Required timescale:*** *Prior to Install RPV*

4.2.4.2 Examples of application of SF and SSC Methodologies and Rules

170 Full classification using the UK EPR™ classification methodology will only take pace during the site-specific phase for EPR mechanical systems. The decision by EDF and AREVA to adopt a classification methodology based on the SFGs approach for mechanical systems on UK EPR™ as documented in Revision D of the methodologies report, (Ref. 18) has meant application of the methodology has been limited in GDA to two mechanical systems, the EFWS and CVCS which have been discussed in detail in section 4.2.1 of this report.

171 ONR reviewed the examples provided by EDF and AREVA from a PMC perspective.

172 The ASG (EFWS) system shown in Appendix 3 (Ref. 18) is a relatively straightforward system. The system outside of containment is designed and constructed to a Class 3 nuclear pressure vessel class whereas the containment penetration and lines inside containment are designed and constructed to a Class 2 nuclear pressure vessel class. The only exception to this is on the N4 design, where the upgrade requirements from the prescriptive French rules, based on temperature, pressure and cyclic loading require an upgrade of the feedwater pumps and lines downstream of these due to the pressure of the lines. The pressure, temperature and cyclic loading are fundamental inputs to the design of the component and I am not unnecessarily concerned that these upgrade rules are not carried forward. In addition there is a small difference in boundary between the Class 2 and Class 3 equipment for Sizewell B – Class 2 extends one valve further

outwards from containment, but this is due to an additional claim on the isolation function of that additional valve which is not made on the UK EPR™ design.

173 ONR is satisfied that the comparison back to previous reactor designs on the ASG (EFWS) system shows that the outputs from the new approach to pressure vessel classification for the UK EPR™ are in good agreement with the previous prescriptive approaches.

174 The RCV (CVCS) system shown in Appendix 4 (Ref. 18) is a more complex system. In this particular example there are significant difference in the pressure vessel classification applied to the N4 plants and Sizewell B and the EPR plants. For example the Regenerative Heat Exchangers of Sizewell B and the N4 plants are designed to Class 2 nuclear pressure vessel standards whereas the equivalent heat exchangers on the EPR design are designed to M3 requirements which can be met by using European Harmonised standards with supplements in both the Flamanville 3 and UK EPR™ designs. This difference applies throughout the main part of the system. For the N4 and Sizewell B plant Class 2 nuclear pressure vessel standards are applied, whereas for the Flamanville 3 and UK EPR™ designs European harmonised standards with supplements to meet an M3 mechanical requirement will be sufficient, with only the containment penetrations and associated isolations being designed and constructed to Class 2 nuclear standards.

175 The difference is significant and is down to the differences in the safety function of the RCV (CVCS) system on the reactor designs. On the N4 plant and Sizewell B the RCV (CVCS) system is used to provide RCS make up and a borating function in situations where cladding damage may have occurred. The RCV (CVCS) system on the EPR design is not required to provide these safety functions and the Extra Boration System (EBS) provides these functions. As a consequence the main components in the RCV (CVCS) are Safety Class 3, and the pressure vessel classification is upgraded from NR to M3 as a result of the barrier function that the components maintain. Safety Class 3 components do not require the use of nuclear codes and standards, so the M3 requirement can be met by pressure equipment designed and manufactured to European harmonised standards with supplements instead of the requirements of the RCC-M3 code.

176 Therefore the safety function and safety classes of the RCV (CVCS) system have been appropriately defined and ONR is satisfied that the new approach to pressure vessel classification for the EPR shows a logical progression in pressure vessel code classes compared with the previous prescriptive approaches. Note the subject of safety function and safety classification for the RCV (CVCS) system has been subject to detail review through Action 1 of GDA Issue **GI-UKEPR-CC-01**, and a design change is to be implemented to isolate the system in the event of fuel clad damage which underpins the allocation of Safety Class 3.

177 There are two further differences that need to be recognised:

- One is that there is an upgrade of a pump and the associated line on the N4 plant due to the upgrade requirements from the prescriptive French Rules. As I stated against the ASG (EFWS) system I am not unnecessarily concerned by this.
- The second is an upgrade of the volume control tank RCV (CVCS) system on Flamanville 3 due to the ESPN order, (Ref. 77) because of the volume of the radioactive contents. As a result of the upgrade it will be designed and constructed to RCC-M2 whereas the equivalent tank on the UK EPR™ could be designed and

manufactured to European Harmonised standards with supplements due to the M3 mechanical requirement on a Safety Class 3 system.

178 The ESPN order does not apply in the UK, but it is a national practice which, taken together with the nuclear pressure vessel design code, is considered in France to lead to a suitable quality of nuclear pressure equipment. A Licensee will therefore need to review the ESPN Order to see whether additional requirements need to be applied to the UK EPR™ as a result of this French national practice. This leads to the following Assessment Finding to ensure that a future licensee addresses this aspect:

> ***AF-UKEPR-CC-25:*** *The Licensee shall review their procedures for the design and manufacture of pressure retaining components to take account of relevant good practice, including the French Order dated 12 December 2005 concerning Nuclear Pressure Equipment (the 'ESPN Order'), to determine whether additional requirements should be applied for UK EPR™.*
>
> ***Required timescale:*** *Prior to Install RPV*

179 Overall, ONR is satisfied that the examples provided of the application of the classification approach for the UK EPR™ CVCS and EFWS mechanical systems give confidence in the robustness of this approach.

180 ONR also undertook a simplified review across a wider range of systems and gained confidence that the approach should give results that show consistency and logical progression compared with previous prescriptive approaches. However, there is the potential for lower classes to be applied in the situation where the safety function does not appear to have changed, such as the RIS (SIS) (already addressed in GDA Step 4) and the EBS. Such situations will have to be systematically identified and either upgraded or justified by a Licensee during the site-specific phase as part of the classification process, to ensure that the results show consistency and logical progression in all mechanical systems. This leads to the following Assessment Finding for a future licensee to address this aspect:

> ***AF-UKEPR-CC-26:*** *The Licensee shall review the UK EPR™ approach to the mechanical classification of pressure retaining components to compare the nuclear pressure equipment design classes assigned by this approach to the nuclear pressure equipment design classes that would have been assigned by one of the more prescriptive approaches used on previous reactor designs. If the UK EPR™ approach would lead to the use of a lower nuclear pressure equipment design class than in the previous approach, the Licensee shall either upgrade the nuclear pressure equipment design class to make it comparable with previous classification practices or provide a robust technically based justification for the lower design class. The mechanical requirements to be assigned to the Extra Boration System (EBS) should be reviewed early in this process.*
>
> ***Required timescale:*** *Prior to Install RPV*

4.2.4.3 Design changes

181 The GDA design reference (Ref. 9) was updated to reflect the three commitments made by EDF and AREVA in respect of the classification of pressure retaining components. The following Change Management Forms (CMFs) have been raised to address these commitments:

182 CMF-24. This commits to implementing the overall methodology for the classification of components, structures and systems, (Ref. 18), which includes the use of nuclear codes for Safety Class 1 pressure equipment.

183 CMF-30. Commits to use nuclear codes for Safety Class 2 pressure equipment (this aspect would also be covered by CMF-24 as the use of nuclear codes for safety class 2 pressure equipment is included with Ref. 18. However, a separate CMF was created for this aspect as it was resolved as part of the GDA Issue Action)

184 CMF-33. Implementation of an automatic class 1 signal "isolation of CVCS letdown line in case of high activity in the primary coolant"

185 CMF-52. Commits to upgrade the SIS accumulators and associated pipework to the M2 mechanical requirement.

186 I am satisfied that these CMFs adequately capture the commitments to update the design reference with respect to the classification of pressure retaining components.

4.2.4.4 Update to GDA documentation

187 ONR has reviewed the updates to the sub-chapter 3.2 of the PCSR (Ref. 46) on the classification of structures, equipment and systems and ONR is satisfied that the sub-chapter reflects the current approach to the classification of pressure retaining equipment as described in the methodologies report (Ref. 18) on the classification of structures, systems and components.

188 Additionally, ONR is satisfied that the supporting document on the classification of mechanical pressure retaining components (Ref. 52), referenced from the methodologies document (Ref; 18), provides sufficient information to underpin the basis for the mechanical design requirements presented in the methodologies report.

4.2.4.5 Assessment Summary of GI UKEPR-CC-01 Action 4

189 The UK EPR™ approach to classifying pressure retaining components differs from the approaches used in previous designs of PWR reactor. The approach was applied to the two mechanical systems classified using the overall UK EPR™ classification system within GDA as examples, and generally shows a logical progression and consistency with previous approaches. However, the approach can lead to lower pressure equipment design requirements compared with the previous reactor designs. While this may be acceptable for the UK EPR™ design we expect a future Licensee will need to confirm that the consistency and logical progression from previous approaches extends to all mechanical systems when they are classified, but this can be taken forward through Assessment Findings.

190 Importantly, the pressure vessel design codes associated with the mechanical requirements have been upgraded to meet our expectations

191 In my opinion sufficient progress has been made to justify closure of **GI UKEPR-CC-01.A4.** However, a future licensee will have to ensure that during application of the methodology to the Site-specific design cognisance is taken of the following Assessment Findings:

> **AF-UKEPR-CC-24:** *A future Licensee shall review the approach used to assign the mechanical requirements for pressure retaining components on the UK* EPR™ *in the light of discussions being held with the French nuclear regulator ASN on the application of the classification methodology for Flamanville 3 and any outcome from the French Groupe Permanent*

Reacteurs (GPR) meeting planned for 2013 to discuss the topic of classification.

Required timescale: *Prior to Install RPV*

AF-UKEPR-CC-25: *The Licensee shall review their procedures for the design and manufacture of pressure retaining components to take account of relevant good practice, including the French Order dated 12 December 2005 concerning Nuclear Pressure Equipment (the 'ESPN Order'), to determine whether additional requirements should be applied for UK EPR™.*

Required timescale: *Prior to Install RPV*

AF-UKEPR-CC-26: *The Licensee shall review the UK EPR™ approach to the mechanical classification of pressure retaining components to compare the nuclear pressure equipment design classes assigned by this approach to the nuclear pressure equipment design classes that would have been assigned by one of the more prescriptive approaches used on previous reactor designs. If the UK EPR™ approach would lead to the use of a lower nuclear pressure equipment design class than in the previous approach, the Licensee shall either upgrade the nuclear pressure equipment design class to make it comparable with previous classification practices or provide a robust technically based justification for the lower design class. The mechanical requirements to be assigned to the Extra Boration System (EBS) should be reviewed early in this process.*

Required timescale: *Prior to Install RPV*

4.2.5 GI UKEPR-CC-01 Action 5 - Classification of diverse lines of protection

192 During GDA Step 4 fault studies assessment (Ref. 22) it was noted that the fault schedule identified a number of diverse systems that were safety classified as Class 3. My expectation is that such systems would be Class 2 to meet the requirements of SAP ECS.2. For this reason, GDA Issue **GI UKEPR-CC-01.A5** was raised requiring EDF and AREVA to review the classification of these systems.

193 In response to GDA Issue **GI-UKEPR-CC-01.A5**, EDF and AREVA have confirmed by letter (Ref. 26) that the classification of all safety systems claimed as diverse lines of protection will be at least Class 2. This has necessitated EDF and AREVA raising a design change proposal through CMF 36 to upgrade from Class 3 to Class 2 the following safety system functions:

- The automatic actuation of the emergency boration system following receipt of an anticipated transient without scram (ATWS) signal;
- The automatic actuation to close the full load main feedwater isolation valves;
- The manual actuation signal to open the Primary Depressurisation System (PDS);
- The automatic switchover of the CVCS charging pump suction to the IRWST;
- The automatic isolation of the CVCS letdown line following receipt of the boron anti-dilution signal;
- The manual start-up of the 3rd train of the spent fuel pool cooling system;
- The automatic trip of the spent fuel pool purification pumps following receipt of a low pool level signal.

194 For similar reasons, EDF and AREVA have also raised CMF-37 to upgrade the ultimate diesel generators from Class 3 to Class 2.

4.2.5.1 Methodologies and Rules

195 The key aspect of SF categorisation and SSC classification applicable for this GDA Issue action is the requirement that the SFG providing the diverse line of protection required for frequent faults for a category A safety Function will be at least class 2 and this is documented in section 4.3.4 of sub-chapter 3.2 of the PCSR (Ref. 46).

196 Further discussion on overall SF categorisation and SSC classification methodologies agreed in GDA and applied through examples in the GDA design is presented in sections 4.2.1 and 4.2.9 sections of this report.

4.2.5.2 Examples of application of SF and SSC Methodologies and Rules

197 The application of the methodology for classification of diverse lines of protection for the UK EPR™ is provided through design change proposals CMFs 36 and 37 which are described in the section below.

4.2.5.3 Design Changes

198 In response to GDA Issue **GI-UKEPR-CC-01.A5**, EDF and AREVA have confirmed by letter (Ref. 26) that the classification of all safety systems claimed as diverse lines of protection will be at least Class 2. This has necessitated EDF and AREVA raising CMF 36 to upgrade from Class 3 to Class 2 the following safety system functions:

- The automatic actuation of the emergency boration system following receipt of an anticipated transient without scram (ATWS) signal;
- The automatic actuation to close the full load main feedwater isolation valves;
- The manual actuation signal to open the primary depressurisation system (PDS);
- The automatic switchover of the CVCS charging pump suction to the IRWST;
- The automatic isolation of the CVCS letdown line following receipt of the boron anti-dilution signal;
- The manual start-up of the 3rd train of the spent fuel pool cooling system;
- The automatic trip of the spent fuel pool purification pumps following receipt of a low pool level signal.

199 This design change is judged to improve the robustness of the UK EPR™ design and meets the expectation of SAP **ECS.2** that such systems would be at least Class 2.

200 For similar reasons, EDF and AREVA have also raised CMF-37 to upgrade the classification of Ultimate Diesel Generator (UDG) Safety Features. This design change involves upgrading the safety class of the Ultimate Diesel Generator safety features from Class 3 to Class 2. It will reduce the risk of severe accidents by increasing the reliability that may be claimed from the UDGs in events involving failure of off-site and on-site AC power supplies.

201 This design change is judged to improve the robustness of the UK EPR™ against extreme events and is referred to in the Fukushima **GI-UKEPR-CC-03** close out report (Ref. 66).

4.2.5.4 Update to GDA documentation

202 Design changes CMFs 36 and 37 are included in the GDA design reference (Ref. 9)

4.2.5.5 Assessment Summary of GI UKEPR-CC-01 Action 5

203 In response to this GDA Issue action EDF and AREVA provided commitments to upgrade the UK EPR™ diverse lines of protection and the ultimate diesel generators from class 3 to class 2 and these commitments are captured in GDA through design change proposals CMFs 36 and 37 which have been agreed for inclusion in the GDA design reference. Both these modifications are judged to improve the safety of the UK EPR™ design and meet the expectation of SAP **ECS.2** that such systems would be Class 2.

204 In my opinion sufficient progress has been made to justify closure of **GI UKEPR-CC-01.A5.**

4.2.6 GI UKEPR-CC-01 Action 6 Classification of C&I

205 During GDA Step 4 cross-cutting and C&I assessments (Ref. 7) it was noted that in the C&I topic area for classification, that further responses and clarification were required from EDF and AREVA to ONR queries on the classification approach. In particular this issue action requires the production of evidence to demonstrate that the categorisation of C&I systems is consistent with current good practice as provided by IEC 61226:2009 (Ref. 21) and that the categorisation of the C&I systems is consistent with the probabilistic claims given in ONR TAG 46 (Ref. 3).

206 There is another GDA Issue action associated with C&I systems categorisation and classification and that is issue **GI-UKEPR-CI-06** . This issue action required EDF and AREVA to provide evidence to demonstrate, in the wider context, that the architectural requirements for the UK EPR™ C&I systems meet our SAPs and current good practice.

207 The fuller assessment of GDA Issue action **GI-UKEPR-CI-06** is provided in the C&I GDA close-out Assessment Report ONR-GDA-AR-11-022 (Ref. 61).

208 For the C&I topic area a Technical Support Contractor (TSC) provided support during the close-out phase and a description of the scope of work performed by the TSC and the Technical Observations (TO) arising from the work are contained in a TSC report (Ref. 59). A summary of the TSCs' report, including details of the TOs raised, is given in Annex 17 of the C&I GDA close-out Assessment Report, ONR-GDA-AR-11-022 (Ref. 61).

209 In response to this issue action EDF and AREVA submitted documents covering:

- safety principles and design rules for the UK EPR™ C&I Architecture (Ref. 60)
- design processes for categorisation of functions; (Ref. 62) and
- classification of C&I systems (Ref. 18)

210 ONR's assessment of these is summarised under the themes below.

4.2.6.1 SF Categorisation and SSC Classification Methodology and Rules

211 The submissions provided by EDF and AREVA were reviewed and requests for clarification were raised through five TQs (Ref. 16) related to this topic, including one raised in the fault studies technical area.

212 In response to these TQs EDF and AREVA revised their submissions to address the queries raised.

213 Following submission of the final revision of the safety principles document that defines the categorisation and classification requirements (Ref. 60), it was confirmed through assessment, and summarised in the C&I close-out report (Ref. 61), that the probabilistic claim limits met ONR expectations for computer based systems performing a nuclear safety function in a nuclear power plant (Ref. 2) (i.e. Class 1 at $1x10^{-3}$ to $1x10^{-4}$ pfd / pdfy, Class 2 at $1x10^{-2}$ pfd / pdfy and Class 3 at $1x10^{-1}$ pfd / pdfy).

214 The C&I close-out report (Ref. 61) also confirms that the categorisation process follows the international standard (Ref. 21), that is functions are categorised as Category A, B, or C, according to the definitions in the standard and a top down application is adopted that is Category A functions are assigned first to see if they meet the criteria in the standard with Category C functions being allocated to those that are not otherwise assigned to Categories A or B.

215 The document ‘Engineering and Projects Organisation EPR overall C&I design process’ (Ref. 62) outlines the UK EPR™ C&I design process including functional categorisation.

216 The ONR review of this document, as summarised in the C&I close-out report (Ref. 61), found the C&I design process to be consistent with the relevant clauses described in Table 1 of the standard BS IEC 61513:2001 (Ref. 63).

217 The ONR review of the final revision of the classification methodology document NEPS-F DC 557 Rev D (Ref. 18) identified that C&I components are assigned a safety class at the system level, based on the highest safety class of the safety features/safety feature groups they are supporting.

218 ONR noted that the reliability limits for Class 2 and 3 computer based C&I systems in Section 9 do not agree with Ref. 64 Section 4, being one decade too low (e.g. the Class 2 pfd limit is $1x10^{-3}$ when it should be $1x10^{-2}$).

219 Subsequently an Assessment Finding was raised in the C&I close out report (Ref; 61) **(AF-UKEPR-CI-049** see below). EDF and AREVA decided that the main focus of the classification methodology document (Ref. 18) would be on classification of non C&I systems, and that C&I classification would be addressed in detail in the submission ‘UK EPR GDA - Classification of C&I system features - ECEF091489’ (Ref. 76).

220 Document ‘UK EPR Generic Design Assessment – Classification of C&I safety features - ECEF091489 Rev D’ (Ref. 76) was submitted to complement PELL-F DC 90 Rev. C (Ref. 60). The ONR review concluded that this provides sufficient evidence that the categorisation and classification conforms to BS IEC 61226 (e.g. Class 1 systems are assigned to Category A functions). ONR noted there are some categorisation and classification assignments that need to be reviewed during the site-specific design development phase (this is recorded in Assessment Finding **AF-UKEPR-CI-048** in Ref. 61).

221 EDF and AREVA note in Section 2.1 of (Ref. 65) that the electrical and C&I design of the UK EPR™ has not been completed, and therefore the system classifications are not finalised. However the information provided to support the GDA Issue is adequate to demonstrate that the approach to categorisation and classification aligns with standard BS IEC 61226 (Ref. 21), and the probabilistic claims meet ONR expectations. This is sufficient to close this GDA Issue action.

222 ONR raised an Assessment Finding in the C&I GDA close-out report (Ref. 61) to capture additional matters arising from the assessment that need to be addressed during the site –specific development phase.

223 This Assessment Finding **AF-UKEPR-CI-049** requires a future UK EPR™ licensee to update NEPS-F 557 (Ref. 18) to align this with the probabilistic claim limits for Class 2 and 3 computer based systems given within other safety documentation such as PEPS-F DC 90 (Ref. 60) and ECECC111134 (Ref. 64) (e.g. the Class 2 pfd claim limit should be $1x10^{-2)}$. Further guidance on this is provided in the Technical Observation GICC01.A6.TO2.01 in Annex 17 of the C&I close-out report (Ref. 61).

4.2.6.2 Application of methodology

224 The design requirements for C&I components are included in section 7.4.6 of PCSR sub-chapter 3.2 (Ref. 46) and in section 7.4.6 of the SF categorisation and SSC classification methodologies report (Ref. 18) and these are summarised below.

225 The design requirements applicable to C&I components depend on the safety class of the SFG they contribute to:

- C1: C&I components Safety class 1 (cat. A requirements of IEC61226:2009),
- C2: C&I components Safety class 2 (cat. B requirements of IEC61226:2009),
- C3: C&I component Safety class 3 (cat. C requirements of IEC61226:2009)

226 Additionally, the methodologies have been applied to the main C&I systems and the classification of these is included in table 3 of PCSR sub-chapter 3.2 (Ref. 46).

227 The update to Refs 18 and 46 aligns with ONR expectations.

4.2.6.3 Design changes

228 Several design changes were agreed in GDA associated with the classification of C&I systems and these are referred to in the C&I GDA close-out report (Ref. 61).

4.2.6.4 Impact on GDA documentation

229 This is addressed in section 4.2.6.2

4.2.6.5 Summary GI UKEPR-CC-01.A7 assessment

230 Although the electrical and C&I design of the UK EPR™ has not been completed, and therefore the system classifications are not finalised, sufficient information has been provided, provided in response to the GDA Issue, to demonstrate that the approach to categorisation and classification aligns with the standard BS IEC 61226 (Ref. 21), and the probabilistic claims meet ONR expectations and this is sufficient to close this GDA Issue action.

231 Several Assessment Findings have been raised in the GDA C&I close-out report (Ref. 61) which a future UK EPR licensee will have to address in the site-specific development phase.

4.2.7 GI-UKEPR-CC-01 Action 7: Classification of spent fuel pool cooling system

232 During GDA Step 4 fault studies assessment (Ref. 22) it was noted that the main spent fuel pool (SFP) cooling system was classified as Class 2. My expectation is that those systems providing the principal means of protection against design basis faults should be classified as Class 1 to meet the guidance in **SAP ECS.2**. For this reason, GDA Issue **GI-UKEPR-CC-01.A7** was raised requiring EDF and AREVA to review the classification of this system.

233 For this GDA Issue action the focus was obtaining a commitment from EDF and AREVA to upgrade the classification of the SFP main cooling system and to progress

development of the subsequent design change proposal related to this commitment and this is discussed further in sections 4.2.7.3 to 4.2.7.5.

234 It should be noted that a more detailed assessment of the SFP will be provided in the assessment (Ref. 30) of the spent fuel pool safety case which is provided for the close out of GDA Issue **GI-UKEPR-FS-03**.

4.2.7.1 Methodologies and Rules

235 No specific aspect of SF categorisation and SSC classification methodologies is applicable for this GDA issue action as the key applicable aspect is associated with the overall SF categorisation and SSC classification methodologies agreed in GDA and applied through examples in the GDA design, which is discussed in sections 4.2.1 and 4.2.9 (summary) sections of this report.

4.2.7.2 Examples of application of SF Categorisation and SSC Classification Methodologies and Rules

236 No specific example of the application of SF categorisation and SSC classification methodologies is applicable for this GDA Issue action.

4.2.7.3 Design Changes

237 In response to GDA Issue **GI-UKEPR-CC-01.A7**, EDF and AREVA have confirmed (Refs: 27, 28 & 29) that the classification of the main spent fuel pool train will be upgraded from Class 2 to Class 1. They have raised change management form CMF-.38 (Ref. 9) to cover this modification.

238 This design change involves upgrading the safety class of the main fuel pool cooling train safety features from Class 2 to Class 1. It will benefit nuclear safety by increasing the reliability that may be claimed from the fuel pool cooling system within, and beyond, design basis accidents.

239 This design change is judged to improve the robustness of the EPR™ against extreme events and is referred to in the Fukushima **GI-UKEPR-CC-03** close out report (Ref. 66).

240 This commitment is considered sufficient to justify the closure of this action although it should be noted that a more detailed assessment will be provided in the assessment (Ref. 30) of the spent fuel pool safety case to be provided for the close out of GDA Issue **GI-UKEPR-FS-03**. This will include an assessment of the response to TQ EPR 1616 (Ref. 16) clarifying the operation of the spent fuel pool cooling system.

241 The requirement for future licensees to implement in the site-specific phase design changes agreed in GDA including CMF-38 is identified in the generic Assessment Finding **AF-UKEPR-CC-11** raised in the close out report for GDA Issue **GI-UKEPR-CC-02**.

4.2.7.4 Update to GDA documentation

242 PCSR sub-chapter 9.1 (Ref. 12) for the spent fuel pool has been updated to include CMF-38 and this is discussed further in the close out report for **GI-UKEPR-FS-03** (Ref. 30)

243 CMF-38 is also included in the new PCSR sub-chapter on severe accidents 16.6 (Ref. 12) as an enhancement to the EPR™ design to improve robustness and this is agreed by ONR.

4.2.7.5 Summary GI UKEPR-CC-01.A7

244 In response to this GDA Issue action EDF and AREVA provided a commitment and CMF-38 to upgrade the classification of the SFP main cooling train. This modification is judged

to improve the safety of the EPR™ design and I am satisfied that this GDA Issue action can be closed.

4.2.8 GI-UKEPR-CC-01 Action 8: Classification of electrical SSCs

245 During Step 4 electrical assessment (Ref. 67) it was noted that EDF and AREVA had to provide clarification with regards to differentiation elements for Class 1, 2 and 3 electrical systems. This was required both in terms of systems architecture and electrical components design and to provide evidence that the difference between EE1 and EE2 systems is much broader than seismic requirements. For this reason, GDA Issue **GI-UKEPR-CC-01.A8** was raised requiring EDF and AREVA to define electrical Class 1, 2 and 3 SSCs.

246 In response to GDA Issue **GI-UKEPR-CC-01.A8** EDF and AREVA provided a Resolution Plan (Ref. 8) which identified the following task deliverables.

- Task 1 - update NEPS-F DC 557 (Ref. 18) which defines the methodology for classification of Structures, Systems, Safety features and Components and
- Task 2 – update PCSR Sub Chapter 3.2 (Ref. 46) which defines the classifications applied to individual components of the electrical system.

4.2.8.1 Methodologies and Rules

247 EDF and AREVA revised the SF categorisation and SSC classification methodologies report (Ref. 18) to include the requirements for electrical systems.

248 Section 6 of the report concerns the requirements applied to systems and states that the design requirements will be applied at system level considering the rules depicted at component level in section 7.

249 In section 7.4.5 of the report the rules for allocating design requirements for electrical components are defined as follows:

- C1- electrical components Safety Class 1
- C2 - electrical components Safety Class 2
- C3 - electrical components Safety Class 3

250 The design code RCC-E is stated to provide the basis for the requirements supplemented by a dedicated book of technical specifications and international standards.

251 The report also states that some SSCs will not be designated to the RCC-E code and where this is the case appropriate high standards will be adopted and justified by an ALARP analysis.

252 PCSR chapter 3.2 (Ref. 46) has been updated to include at table 2 the classification of the main electrical systems and this is in line with my expectations.

4.2.8.2 Examples of application of Methodologies and Rules

253 The methodologies have been applied to the main electrical systems and the classification of these is included in table 2 of PCSR chapter 3.2 (Ref. 46)

254 The application aligns with ONR’s expectations.

4.2.8.3 Design changes

255 The GDA design reference (Ref. 9) was updated to reflect the two design changes agreed within GDA associated with the classification of EPR™ electrical systems and these are:

- CMF-37 to upgrade the Ultimate Diesel Generators (UDG) from Class 3 to Class 2 associated with **GI-UKEPR-CC-01.A5** (see section 4.2.5.3 of this report).
- CMF-53 to upgrade the classification of parts of the earthing system to Class 1 on the UK EPR™.

256 These two design changes have been agreed for inclusion in the GDA design reference (Ref. 9) and I am satisfied that these CMFs adequately capture the commitments to update the design reference with respect to the classification of electrical SSCs.

4.2.8.4 Impact on GDA documentation

257 The impact on the methodologies report (Ref. 18) and PCSR sub-chapter 3.2 (Ref. 46) is as described in section 4.2.8.2 above.

4.2.8.5 Summary of GI-UKEPR-CC-01 Action 8 Assessment

258 Overall, I am content that the work presented is sufficient for the closure of **GDA Issue GI-UKEPR-CC-01 A.8** subject to the action detailed below related to GDA Issue **GI-UKEPR-EE-01** which is discussed in the close-out report (Ref. 75)

259 The classification of the earthing system was identified in PCSR Sub Chapter 3.2 as Class 1 and the submission by EDF and AREVA to close out electrical GDA Issue **GI-UKEPR-EE-01** applied different classifications to various parts of the earthing system. This was reviewed in GDA Issue **GI-UKEPR-EE-01** and is discussed in the close-out report (Ref. 75) which raised an Assessment Finding **AF-UKEPR-EE-23** requiring the Licensee to determine the detail design requirements to comply with the earthing system classification.

4.2.9 GI-UKEPR-CC-01 Assessment Generic Aspects

260 In sections 4.2.1-8 of this report the assessment of SF categorisation and SSC classification methodologies and examples of the application of these to the UK EPR™ design has been described and has resulted in several technical topic specific Assessment Findings for a future UK EPR™ licensee to address.

261 The sections below focus on the requirements to capture the generic aspects arising from my assessment of this GDA Issue and these are summarised through the Assessment Findings described in the sections below to ensure a future UK EPR™ licensee:

- Applies the SF categorisation and SSC classification methodologies agreed in GDA throughout a UK EPR™ design
- Develops documentation to include the requirements for SFGs in UK EPR™ Site-specific design documentation to supplement the information provided in SDMs

4.2.9.1 SF Categorisation and SSC Classification Methodologies - Application to the Site-specific UK EPR™ Design

262 ONR have accepted the two classification approaches documented in report NEPS-F DC 557 (Ref. 18) for classification at the SSC and SFG level through assessment of the application examples agreed in GDA and described in sections 4.2.1 – 4.2.8 of this report. The difference between the two approaches is that as an SFG is comprised of safety features (SFs) which collectively, contribute to the delivery of a safety function(s), the SFs may be located in different systems. However, in order for ONR to gain confidence that these classification methodologies will be applied appropriately throughout the EPR™ design, there is a need for the process to be tested by repeated

application. Therefore, ONR may wish to assess further examples of the application of these methodologies in the Site-specific design phase.

263 Given that there is a practical need on the part of a future licensee to apply the classification methodologies to all structures systems and components during the site-specific design development this leads to the following generic Assessment Finding.

> **AF-UKEPR-CC-27:** *A future licensee shall fully apply to the site-specific UK* EPR™ *design, the classification approach delineated in NEPS-F DC 557 rev. D and summarised in PCSR Sub-chapter 3.2 of the GDA PCSR. The results of this application shall be reported in site-specific design documentation and the site PCSR, as appropriate.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*

4.2.9.2 Requirements for development of SF and SSC site-specific UK EPR™ design documentation

264 The UK EPR™ reference design as defined in the design reference document (Ref. 9) references the suite of FA3 SDMs as key supporting documents describing the UK EPR™ design. As discussed in the close-out report for GDA Issue **GI-UKEPR-CC-02** (Ref. 65) these require update post GDA to include agreed design changes and the application of agreed SF categorisation and SSC classification methodologies described in sections 4.2.1 to 4.2.8 of this report.

265 The requirement to update SDMs post GDA has been addressed through Assessment Finding **AF-UKEPR-CC-11** raised under **GI-UKEPR-CC-02** which requires a future UK EPR™ licensee to implement the design changes agreed in GDA including CMF-24 which relates to SF categorisation and SSC classification methodologies. Further details are given in the **GI-UKEPR-CC-02** close-out report (Ref. 65).

266 Although the high level design requirements for SFGs are included in the SF categorisation and SSC classification methodologies report (Ref. 18) the SFG approach, which was agreed late in GDA, was not applied to or documented in the GDA EPR™ supporting design reference (Ref. 9) documentation including SDMs which are based on the Flamanville 3 (FA3) EPR project design at the end of December 2008.

267 The SDM update specification (Ref. 68) that was required through **GI-UKEPR-CC-02** included an annex (Ref. 69) which provided guidance on how the SF categorisation and SSC classification methodologies, agreed in GDA, can be applied to SSCs and SFGs within a site-specific UK EPR™ design.

268 I reviewed the Annex (Ref. 69) to the SDM update specification and judged it provided sufficient guidance to enable a future licensee to apply SF categorisation and SSC classification methodologies to the Site-specific EPR™ SDMs.

269 However, as the design requirements for SFGs are not included in the GDA (Ref. 9) SDMs, or in other GDA supporting design documentation, there is a requirement for a future licensee to include these within site-specific UK EPR™ design documentation. This leads to the following Assessment Finding.

> **AF-UKEPR-CC-28:** *A future UK EPR™ licensee shall develop site-specific design detail documentation specifying the functional, design, manufacturing, commissioning and operational requirements, for Safety Features and Safety Feature Groups required to deliver safety functions identified in the PCSR and supporting design documents including SDMs.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

4.2.9.3 Summary of generic assessment requirements for GDA Issue GI-UKEPR-CC-01

270 The SF categorisation and SSC classification methodologies agreed for inclusion in GDA and the application of these to the Site-specific UK EPR™ design for specific requirements have been identified in the Assessment Findings summarised in sections 4.2.1-4.2.8 of this report. In addition to these specific requirements, two generic Assessment Findings were introduced in section 4.2.9 of this report. These require a future licensee to apply the SF categorisation and SSC classification methodologies agreed in GDA to a site-specific UK EPR™ design, and to document the requirements for SFGs in the SDMs that define UK EPR™ mechanical systems:

AF-UKEPR-CC-27: *A future licensee shall fully apply to the site-specific UK* EPR™ *design, the classification approach delineated in NEPS-F DC 557 rev. D and summarised in PCSR Sub-chapter 3.2 of the GDA PCSR. The results of this application shall be reported in site-specific design documentation and the site PCSR, as appropriate.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

AF-UKEPR-CC-28: *A future UK EPR™ licensee shall develop site-specific design detail documentation specifying the functional, design, manufacturing, commissioning and operational requirements, for Safety Features and Safety Feature Groups required to deliver safety functions identified in the PCSR and supporting design documents including SDMs.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

271 Overall, in my opinion sufficient progress by EDF and AREVA has been made in developing and applying SF categorisation and SSC classification methodologies to justify closure of GDA Issue **GI UKEPR-CC-01** subject to a future UK EPR™ licensee addressing the Assessment Findings indentified in this report.

4.3 Comparison with Standards, Guidance and Relevant Good Practice

272 I am satisfied that the development of methodologies for categorising Safety Function and classifying Structures, Systems and Components and the application of these methodologies within the UK EPR™ design is sufficient and that these are in line with UK and international standards and relevant good practice.

5 ASSESSMENT CONCLUSIONS

273 A summary of the assessments completed for the eight actions related to this GDA Issue is provided in sections 4.2.1 - 4.2.8 of this report. These concluded that sufficient information had been provided by EDF and AREVA for these actions to be closed, subject to a future UK EPR™ licensee addressing the identified Assessment Findings. In addition to the technical topic-specific requirements, the requirements for a future UK EPR™ licensee to address generic aspects through two generic Assessment Findings is identified in section 4.2.9 of this report. This leads to the overall assessment summary conclusions presented below for this cross-cutting topic.

5.1 Overall Conclusions

274 I have assessed the principal deliverables and supporting information provided by EDF and AREVA. These included, updates to report NEPS-F DC 557 and relevant chapters of the PCSR to include agreed SF and SSC methodologies, examples of application of these within the UK EPR™ design, and several design change proposals, together with a specification for update of SDMs to address the SF and SSC methodologies (which was required for associated GDA Issue **GI-UKEPR-CC02** on the EPR™ design reference). I am satisfied that the development of methodologies for categorising Safety Function and classifying Structures, Systems and Components and the application of these methodologies within the UK EPR™ design is sufficient and that these are in line with UK and international standards and relevant good practice.

275 My judgement is based upon the following factors:

- The methodology for categorising plant safety functions is now clear and well documented within the GDA submission and this approach aligns with UK and international standards and relevant good practice.
- EDF and AREVA chose to adopt two SSC classification approaches within the GDA. They have applied a system wide classification approach for electrical, C&I and civil structures and the DVLnew, DELnew, DVL and DEL HVAC systems. For all other systems, including mechanical systems they have applied a safety feature group (SFG) sub system approach. Nevertheless, the requirement to first establish the required safety function prior to SSC classification is documented for both classification approaches within the GDA submission and aligns with UK and international standards and relevant good practice.
- The methodologies for categorising SFs and classifying SSCs associated with civil structures, electrical and C&I systems have been developed in GDA and now align with UK and international standards and relevant good practice.
- The rules used to assign the mechanical design requirements applied to pressure retaining components differ from previous approaches used for PWR reactors. The rules were implemented on the two examples provided for GDA and showed a logical progression and consistency with previous approaches. In some instances, the rules can lead to lower mechanical design requirements compared with previous reactor designs. While the examples given in GDA are acceptable we will require a future licensee to confirm that a consistent and logical progression, from previous approaches, extends to all mechanical systems when the design requirements are defined during the site-specific phase.

- The use of nuclear and non-nuclear pressure vessel design codes associated with these mechanical design requirements has been clarified in the SSC classification methodology to meet our expectations.
- Multiple design changes have been agreed in GDA to increase the classification of key SSCs above the level originally proposed for the UK EPR™. Implementation of these changes will significantly improve the robustness of the UK EPR™ design in areas such as Spent Fuel Pool cooling, the make-up water plant and the ultimate diesel generators.
- The supporting technical documentation, including the specification for update of System Design Manuals (SDM), provides sufficient guidance to allow a future licensee to apply these methodologies during the site-specific phase.
- Although the application of agreed SF categorisation and SSC classification methodologies is limited within the GDA design, the application examples provided together with the supporting technical documentation including, report NEPS-F DC 57 and the specification for update of SDMs are considered sufficient to allow a future licensee to fully apply these methodologies within a site-specific UK EPR™ design.

276 On the basis of the assessment of the information provided by EDF and AREVA I am satisfied that the requirements of GDA Issue, **GI-UKEPR-CC-01** have been addressed.

277 Ten Assessment Findings have been raised in relation to this GDA Issue and these are identified in Annex 1 of this report for a future UK EPR™ licensee to address for the a site-specific design.

5.2 Review of the Update to the PCSR

278 The update of the UK EPR™ PCSR to address this GDA Issue action is described in section 4.2 of this report and it is concluded that sufficient information has been provided by EDF and AREVA for closure of this GDA Issue. In addition the requirement to apply the SF categorisation and SSC classification methodologies to a UK EPR™ design and safety documentation has been captured through the following Assessment Finding;

> **AF-UKEPR-CC-28:** *A future UK EPR™ licensee shall develop site-specific design detail documentation specifying the functional, design, manufacturing, commissioning and operational requirements, for Safety Features and Safety Feature Groups required to deliver safety functions identified in the PCSR and supporting design documents including SDMs*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*

6 ASSESSMENT FINDINGS

279 The following Assessment Finding has been raised that are required to be resolved during the Site-specific phase:

> ***AF-UKEPR-CC-19:*** *A future licensee shall review the results of the classification process against future revisions of the PSA to confirm that the preliminary classifications that will be identified during the site-specific design development phase remain appropriate*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*
>
> **AF-UKEPR-CC-20:** *A future licensee shall provide the dedicated rules for each of the "C1 other structures – other than concrete/steel" for the analysis, detailed design, detailing, construction and EMIT of those structures. The licensee shall justify that these dedicated rules ensure each such structure fulfils its safety functional requirements.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*
>
> **AF-UKEPR-CC-21:** *A future licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 "main structures" and justify that they will provide the structural performance required for the safety classified component or system that is supported or protected by that structure.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*
>
> **AF-UKEPR-CC-22:** *A future licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 "other structures", including fixings or holding down bolts to the main structures, and justify that they will provide the structural performance required for the safety functional requirement of that structure.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*
>
> **AF-UKEPR-CC-23:** *A future licensee shall develop and complete a hazard fault schedule based upon the format defined in the sample hazard schedule ECESN120418 for all remaining site-specific internal and external hazards.*
>
> **Required timescale:** *Prior to long lead items and SSC procurement specifications.*
>
> ***AF-UKEPR-CC-24:*** *A future Licensee shall review the approach used to assign the mechanical requirements for pressure retaining components on the UK* EPR™ *in the light of discussions being held with the French nuclear regulator ASN on the application of the classification methodology for Flamanville 3 and any outcome from the French Groupe Permanent Reacteurs (GPR) meeting planned for 2013 to discuss the topic of classification.*
>
> ***Required timescale:*** *Prior to Install RPV*
>
> ***AF-UKEPR-CC-25:*** *The Licensee shall review their procedures for the design and manufacture of pressure retaining components to take account*

of relevant good practice, including the French Order dated 12 December 2005 concerning Nuclear Pressure Equipment (the 'ESPN Order'), to determine whether additional requirements should be applied for UK EPR™.

Required timescale: *Prior to Install RPV*

AF-UKEPR-CC-26: *The Licensee shall review the UK EPR™ approach to the mechanical classification of pressure retaining components to compare the nuclear pressure equipment design classes assigned by this approach to the nuclear pressure equipment design classes that would have been assigned by one of the more prescriptive approaches used on previous reactor designs. If the UK EPR™ approach would lead to the use of a lower nuclear pressure equipment design class than in the previous approach, the Licensee shall either upgrade the nuclear pressure equipment design class to make it comparable with previous classification practices or provide a robust technically based justification for the lower design class. The mechanical requirements to be assigned to the Extra Boration System (EBS) should be reviewed early in this process.*

Required timescale: *Prior to Install RPV*

AF-UKEPR-CC-27: *A future licensee shall fully apply to the site-specific UK* EPR™ *design, the classification approach delineated in NEPS-F DC 557 rev. D and summarised in PCSR Sub-chapter 3.2 of the GDA PCSR. The results of this application shall be reported in site-specific design documentation and the site PCSR, as appropriate.*

Required timescale: *Prior to long lead items and SSC procurement specifications.*

AF-UKEPR-CC-28: *A future UK EPR™ licensee shall develop site-specific design detail documentation specifying the functional, design, manufacturing, commissioning and operational requirements, for Safety Features and Safety Feature Groups required to deliver safety functions identified in the PCSR and supporting design documents including SDMs*

Required timescale: Prior to long lead items and SSC procurement specifications.

6.1 Impacted Step 4 Assessment Findings

280 **AF-UKEPR-CC-05** superseded by **AF-UKEPR-CC-27.**

7 REFERENCES

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7 *Step 4 Cross-cutting Topics Assessment of the EDF and AREVA UK* EPR™ *Reactor.* ONR Assessment Report ONR-GDA-AR-11-032 Revision 0. December 2011. TRIM Ref. 2010/581499.

8 *Resolution Plan for GI-UKEPR-CC01.* **GI-UKEPR-CC-01**-RP Draft C. EDF and AREVA. June 2011. TRIM Ref. 2011/345429.

9 *Reference Design Configuration*. UKEPR-I-002 Revision 15. AREVA NP/EDF. December 2012. TRIM Ref. 2012/478281.

10 *Design Change Procedure*. UKEPR-I-003 Revision 11. EDF and AREVA. December 2012. TRIM Ref. 2012/478287.

11 *UK EPR GDA Step 4 Consolidated Pre-construction Safety Report – March 2011.* EDF and AREVA. Detailed in EDF and AREVA letter UN REG EPR00997N. 18 November 2011. TRIM Ref. 2011/552663.

12 *Final Consolidated UK EPR™ GDA Pre-construction Safety Report.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01470N. 30 November 2012. TRIM Ref. 2012/470151.

13 *Not Used*

14 *EDF and AREVA UK EPR™ - Schedule of Regulatory Observations Raised during GDA Step 1 to Step 4.* HSE-ND. TRIM Ref. 2010/600727.

15 *Design Change Procedure.* UKEPR-I-003 Revision 8. EDF and AREVA. February 2011. TRIM Ref. 2011/204076.

16 *EDF and AREVA UK EPR™ - Schedule of Technical Queries Raised during GDA Close-out.* Office for Nuclear Regulation. TRIM Ref. 2011/389411.

17 *Classification of Structures Systems and Components.* NEPS-F DC 557 Revision D. AREVA. November 2011. TRIM Ref. 2011/595982.

18 *GI-UKEPR-CC01 - Transmittal of Final Version of NEPS-F DC 557*. Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01450N. 31 October 2012. TRIM Ref. 2012/424288.

19 *Advance PCSR Sub-Chapter 13.2 – Classification of Structures, Equipment and Systems.* UKEPR-0002-032 Issue 4. Areva NP and EDF. November 2012. TRIM Ref. 2012/437599.

20 *GDA Close-out for EDF and AREVA UK EPR™ Reactor – GDA Issue GI-UKEPR-FS-02 Revision 0.* ONR Assessment Report ONR-GDA-AR-12-011 Revision 0. TRIM Ref. 2012/11.

21 *Nuclear Power Plants – instrumentation and control important to safety – classification of instrumentation and control functions.* IEC61226. International Electrotechnical Commission (IEC). 2009.

22 *Step 4 Fault Studies – Design Basis Assessment of the EDF and AREVA UK EPR™ Reactor*. ONR Assessment Report ONR GDA AR 11-020a Revision 0. November 2011. TRIM Ref. 2010/581404.

23 *GI-UKEPR-CC01 Action 3 – Task 2 – Development of Representative Hazards Fault Schedule Examples – Partial Response.* Letter from UK EPR™ Front Office to ONR. Unique Number EPR01066R. 23rd January 2012. TRIM Ref. 2012/40105.

24 *GI-UKEPR-CC01 Action 3 – Task 2 – Development of Representative Hazards Fault Schedule Examples – Full Response.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR-01103N. 2 March 2012. TRIM Ref. 2012/99863.

25 *GI-UKEPR-CC01 Action 3 – Provision of Updated PCSR Sub-Chapter 13.1*. Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01256R. 9 July 2012. TRIM Ref. 2012/273525.

26 *GI-UKEPR-CC01 Action 5 – Diverse Lines of Protection for Frequent Faults.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR-01104N. 19 March 2012. TRIM Ref. 2012/122004.

27 *GI-UKEPR-CC01 Action 7 – Spent Fuel Pool Cooling System*. Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01105N. 8 March 2012. TRIM Ref. 2012/107484.

28 *GI-UKEPR-CC01 Action 7 – Spent Fuel Pool Cooling System – ALARP justification.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01169R. 22 May 2012. TRIM Ref. 2012/211364.

29 *Analysis of a Class 1 requirement for the PTR (FPPS/FPCS) start-up feature of the main cooling trains*. ECECS120406 Revision A. EDF. May 2012. TRIM Ref. 2012/211370.

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32 *PCSR Sub-Chapter 13.2 Update – Internal Hazards Protection.* UKEPR-0002-132 Issue 05. EDF and AREVA. 31 October 2012. TRIM Ref. 2012/450702.

33 *Step 4 Civil Engineering and External Hazards Assessment of the EDF and AREVA UK EPR™ Reactor*. ONR Assessment Report ONR-GDA-AR-11-018 Revision 0. December 2011. TRIM Ref. 2010/581513.

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35 *EPR Technical Code for Civil Works*. ETC-C. AFCEN. December 2010.

36 *UK EPR™ - GDA- UK Companion Document to AFCEN ETC-C*. ENGSGC110015 Revision E. EDF. August 2012. TRIM Ref. 2012/350151.

37 *GI-UKEPR-CC01 Action 2 – Civil Works Building Classifications and Requirements.* EPR01087R. Letter from UK EPR™ Project Front Office to ONR. 15 February 2012. TRIM Ref. 2012/77430.

38 *UK EPR™ – GDA – Identification of C1 'Other Structures' (Removal Parts).* ECEIG112228 Revision A. EDF. October 2012. TRIM Ref. 2012/77483.

39 *UK EPR™ – Safety Class 2 Structures – Definition of C2 Safety Requirements*. ENSN110130 Revision A. EDF. December 2012. TRIM Ref. 2012/77496.

40 *Civil Works Dedicated Rules for Buildings Classified C2 'Main Structures'*. ENGSGC110254 Revision A. EDF. November 2011. TRIM Ref. 2012/77489.

41 *EPR™ FA3 – Neutron Protection of the Reactor Building Fuel Transfer Compartment – Equipment Specification.* NEEM-F DC 109 Revision B. EDF. July 2011. TRIM Ref. 2012/77497.

42 *GDA Issue GI-UKEPR-CC-01.A2 - ONR Comments on EPR01087R documents.* ONR. 16 May 2012. TRIM Ref. 2012/203298.

43 *Classification of Structures Systems and Components.* NEPS-F DC 557 Revision D Advanced draft. AREVA. May 2012. TRIM Ref. 2012/204717.

44 *Classification of Structures Systems and Components.* NEPS-F DC 557 Revision D Final advanced version. AREVA. 10 October 2012. TRIM Ref. 2012/397307.

45 *PCSR Sub-chapter 13.1 – External Hazards Protection.* UKEPR-0002-131 Issue 05. EDF and AREVA. September 2012. TRIM Ref. 2012/391598.

46 *PCSR Sub-Chapter 3.2 - Classification of structures, equipment and systems.* UKEPR0002-032 Issue 04. EDF and AREVA. November 2012. TRIM Ref. 2012/450462.

47 *GI-UKEPR-CC01 Action 3 – Development of Hazard Fault Schedule Methodology – Partial Response.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR00976R. 10 October 2011. TRIM Ref. 2011/519233.

48 *GI-UKEPR-CC01 Action 3 – Development of Hazard Fault Schedule Methodology – Partial Response.* EPR70386R. Letter from ONR to UK EPR™ Project Front Office. 8 December 2011. TRIM Ref. 2011/626960.

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50 *Safety Justification for the Classification of Class 1 Components with M3 Mechanical Design Requirements.* PEPS-F DC 99 Revision A. AREVA NP. September 2011. TRIM Ref. 2011/505616.

51 *UK EPR™ – GDA EPR™ design and mechanical requirements – Classification and requirements applied to mechanical pressure retaining components.* ENSNDR120069 Revision A. EDF. October 2012. TRIM 2012/408873.

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55 *ASME Boiler and Pressure Vessel Code - Section III Rules for Construction of Nuclear Facility Components*. American Society of Mechanical Engineers (ASME). 2007.

56 *SSCs Classification – RO-UKEPR-43 – A2 – March 28th Meeting's Main Commitments.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR00863N. 6 May 2011. TRIM Ref. 2011/256812.

57 *GI-UKEPR-CC01 Action 4: Use of Nuclear Codes for Class 2 Components*. Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR00956N. 22 September 2011. TRIM 2011/493249.

58 *Classification of Structures Systems and Components*. NEPS-F DC 557 Revision C. EDF and AREVA. January 2011. TRIM Ref. 2011/85983.

59 *GDA Issues Resolution - C&I Review for EDF/Areva UK EPR™ Design - Review of Responses to GI-UKEPR-CC-01 – Action A6*. 39075/38102R Issue 1.2 (Definitive). Frazer-Nash and Altran-Praxis. TRIM Ref. 2013/23237.

60 *Safety Principles Applied to the UK EPR™ C&I Architecture in Terms of the Requirements for Diversity and Independence*. PEPS-F DC 90 Revision C. EDF and AREVA. August 2012. TRIM Ref. 2012/342262.

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62 *UK EPR™ GDA – TATS Action GI 4-C&I-1 – EPR™ overall C&I design process*. PELA-F 12.1004 Revision B. AREVA. August 2012. TRIM Ref. 2012/310148.

63 *Nuclear power plants - Instrumentation and control for systems important to safety – general requirements for systems.* BS IEC 61513:2001. International Electrotechnical Commission (IEC). 2001.

64 *UK EPR™ Guideline for Application of Production Excellence and Independent Confidence Building*. ECECC111134 Revision C. EDF. July 2012. TRIM Ref. 2012/298715.

65 *GDA Close-out for EDF and AREVA UK EPR™ Reactor – GDA Issue GI-UKEPR-CC-02 Revision 3. – Consolidated Final GDA Submission including agreed Design Changes for the UK EPR™.* ONR Assessment Report ONR-GDA-AR-12-024 Revision 2. January 2013. TRIM Ref. 2012/24.

66 *GDA Close-out for the EDF and AREVA UK EPR™ Reactor – GDA Issue GI-UKEPR-CC-03 Revision 3 – Fukushima Lessons Learnt for the UK EPR™.* ONR Assessment Report ONR-GDA-AR-12-025 Revision 0. March 2013. TRIM Ref. 2012/25.

67 *Step 4 Electrical Systems Assessment of the EDF and AREVA UK EPR™ Reactor.* ONR Assessment Report ONR-GDA-AR-11-023 Revision 0. November 2011. TRIM Ref. 2010/581509.

68 *Deliverable to GI-UKEPR-CC02 – Transmission of revised Specification for SDMs update document (UKEPR-0019-001 Issue 01).* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01510N. 6 December 2012. TRIM Ref. 2012/478362.

69 *GI-UKEPR-CC01 & GI-UKEPR-CC02 – Outline of Specification for System Design Manual Update.* Letter from UK EPR™ Project Front Office to ONR. Unique Number EPR01451N. 31 October 2012. TRIM Ref. 2012/424343.

70 *Fault Studies review of the case for GDA Issue GI-UKEPR-CC-01 (Lessons Learnt from the Fukushima Event).* ONR Assessment Note -. November 2012. TRIM Ref. 2012/470328.

71 *Civil Engineering review of the case for GDA Issue GI-UKEPR-CC-01A2 and A3 (Lessons Learnt from the Fukushima Event).* ONR Assessment Note. TRIM Ref. 2012/455299.

72 *Electrical Engineering review of the case for GDA Issue GI-UKEPR-CC-(Lessons Learnt from the Fukushima Event).* ONR Assessment Note. November 2012. TRIM Ref. 2013/2591.

73 *Structural Integrity review of the case for GDA Issue GI-UKEPR-CC-01 (Lessons Learnt from the Fukushima Event).* ONR Assessment Note. January 2013. TRIM Ref. 2012/460115.

74 *Internal Hazards review of the case for GDA Issue GI-UKEPR-CC-01 (Lessons Learnt from the Fukushima Event).* ONR Assessment Note. December 2012. TRIM Ref. 2012/450951.

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77 *Order related to Nuclear Pressure Equipment*. ESPN Order. The Director-General for Nuclear Safety and Radiation Protection. 12 December 2005. TRIM Ref. 2013/105628.

Table 1

Relevant Safety Assessment Principles Considered for Close-out of GI-UKEPR-CC-01 Revision 1

SAP No.	SAP Title	Description
EMC.1	Integrity of metal components and structures: highest reliability components and structures. Safety case and assessment	The safety case should be especially robust and the corresponding assessment suitably demanding, in order that an engineering judgement can be made for two key requirements: the metal component or structure should be as defect-free as possible; the metal component or structure should be tolerant of defects.
ECS.1	Engineering principles: safety classification and standards Safety categorisation	The safety functions to be delivered within the facility, both during normal operation and in the event of a fault or accident, should be categorised based on their significance with regard to safety.
ECS.2	Engineering principles: safety classification and standards Safety classification of structures, systems and components	Structures, systems and components that have to deliver safety functions should be identified and classified on the basis of those functions and their significance with regard to safety.
ECS.3	Engineering principles: safety classification and standards Standards	Structures, systems and components that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate standards.
ECS.4	Engineering principles: safety classification and standards Codes and standards	For structures, systems and components that are important to safety, for which there are no appropriate established codes or standards, an approach derived from existing codes or standards for similar equipment, in applications with similar safety significance, may be applied.
ECS.5	Engineering principles: safety classification and standards Use of experience, tests or analysis	In the absence of applicable or relevant codes and standards, the results of experience, tests, analysis, or a combination thereof, should be applied to demonstrate that the item will perform its safety function(s) to a level commensurate with its classification.

Table 1

Relevant Safety Assessment Principles Considered for Close-out of GI-UKEPR-CC-01 Revision 1

SAP No.	SAP Title	Description
EHA 1	Eternal and internal hazards	External and internal hazards that could affect the safety of the facility should be identified and treated as events that can give rise to possible initiating faults
FA.2	Fault analysis: Identification of initiation faults	. Fault analysis should identify all initiating faults having the potential to lead to any person receiving a significant dose of radiation, or to a significant quantity of radioactive material escaping from its designated place of residence or confinement.
FA.14	Fault analysis: PSA – Use of PSA	PSA should be used to inform the design process and help ensure the safe operation of the site and its facilities.

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Annex 1

GDA Assessment Findings Arising from GDA Close-out for Cross Cutting GDA Issue GI-UKEPR-CC-01

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-CC-19	A future licensee shall review the results of the classification process against future revisions of the PSA to confirm that the preliminary classifications that will be identified during the site-specific design development phase remain appropriate	Prior to Long lead Items and SSC procurement specifications
AF-UKEPR-CC-20	A future UK EPR licensee shall provide the dedicated rules for each kind of “C1 other structures – other than concrete/steel” for the analysis, detailed design, detailing, construction and EMIT of those structures. The licensee shall justify that these dedicated rules ensure each such structure fulfils its safety functional requirements.	Prior to Long lead Items and SSC procurement specifications
AF-UKEPR-CC-21	A future UK EPR licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 “main structures” and justify that they will provide the structural performance required for the safety classified component or system that is supported or protected by that structure.	Prior to Long lead Items and SSC procurement specifications
AF-UKEPR-CC-22	A future UK EPR licensee shall confirm the specific design and construction requirements for seismic Class 1 and seismic Class 2 “other structures”, including fixings or holding down bolts to the main structures, and justify that they will provide the structural performance required for the safety functional requirement of that structure	Prior to Long lead Items and SSC procurement specifications
AF-UKEPR-CC-23	AF-UKEPR-CC-23 A future licensee shall develop and complete a hazard fault schedule based upon the format defined in the sample hazard schedule ECESN120418 for all remaining site-specific internal and external hazards.	Prior to Long lead Items and SSC procurement specifications

Annex 1

GDA Assessment Findings Arising from GDA Close-out for Cross Cutting GDA Issue GI-UKEPR-CC-01

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-CC-24	The Licensee shall review the approach used to assign the mechanical requirements for pressure retaining components on the UK EPR™ in the light of discussions being held with the French nuclear regulator ASN on the application of the classification methodology for Flamanville 3 and any outcome from the French Groupe Permanent Reacteurs (GPR) meeting planned for 2013 to discuss the topic of classification	Prior to RPV installation
AF-UKEPR-CC-25	The Licensee shall review their procedures for the design and manufacture of pressure retaining components to take account of relevant good practice, including the French Order dated 12 December 2005 concerning Nuclear Pressure Equipment (the 'ESPN Order'), to determine whether additional requirements should be applied for UK EPR™.	Prior to RPV installation
AF-UKEPR-CC-26	The Licensee shall review the UK EPR™ approach to the mechanical classification of pressure retaining components to compare the nuclear pressure equipment design classes assigned by this approach to the nuclear pressure equipment design classes that would have been assigned by one of the more prescriptive approaches used on previous reactor designs. If the UK EPR™ approach would lead to the use of a lower nuclear pressure equipment design class than in the previous approach, the Licensee shall either upgrade the nuclear pressure equipment design class to make it comparable with previous classification practices or provide a robust technically based justification for the lower design class. The mechanical requirements to be assigned to the Extra Boration System (EBS) should be reviewed early in this process.	Prior to RPV installation
Extant Step 4 AF-UKEPR-CC-12 replaced by AF-UKEPR-CC-27	A future licensee shall fully apply to the site-specific UK EPR™ design, the classification approach delineated in NEPS-F DC 557 rev. D and recalled in PCSR Sub-chapter 3.2 of the GDA PCSR. The results of this application shall be reported in site-specific design documentation and site PCSR, as deemed appropriate.	Prior to Long lead Items and SSC procurement specifications

Annex 1

GDA Assessment Findings Arising from GDA Close-out for Cross Cutting GDA Issue GI-UKEPR-CC-01

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-CC-28	A future UK EPR™ licensee shall develop site-specific design detail documentation specifying the functional, design, manufacturing, commissioning and operational requirements, for Safety Features and Safety Feature Groups required to deliver safety functions identified in the PCSR and supporting design documents including SDMs	Prior to Long lead Items and SSC procurement specifications

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Note: It is the responsibility of the Licensees / Operators to have adequate arrangements to address the Assessment Findings. Future Licensees / Operators can adopt alternative means to those indicated in the findings which give an equivalent level of safety.

For Assessment Findings relevant to the operational phase of the reactor, the Licensees / Operators must adequately address the findings during the operational phase. For other Assessment Findings, it is the regulators' expectation that the findings are adequately addressed no later than the milestones indicated above.

Annex 2

GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

CATEGORISATION AND CLASSIFICATION OF SYSTEMS STRUCTURES & COMPONENTS

GI-UKEPR-CC-01 REVISION 1

<table>
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<tr><td colspan="2">Related Technical Areas</td><td colspan="2">All</td></tr>
<tr><td>GDA Issue Reference</td><td>GI-UKEPR-CC-01</td><td>GDA Issue Action Reference</td><td>GI-UKEPR-CC-01.A1</td></tr>
<tr><td>GDA Issue</td><td colspan="3">The RP to demonstrate that the methodology developed and applied for categorising Safety Function and classifying Structures, Systems and Components is in line with UK and international standards and relevant good practice.</td></tr>
<tr><td>GDA Issue Action</td><td colspan="3">EDF and AREVA to review all the PCC-2 to PCC-4 initiating events and identify any safety related systems (SRS) that require safety classification, or an alternative safety classification to that presented in report NEPS-F DC 557 C.
It is expected that SRSs whose failure results in a PCC-3 or PCC-4 event will already have a safety classification commensurate with the assumptions made in the initiating event frequency. Some PCC-2 events may be the result of failures in non-classified duty / operational systems. This may be appropriate but EDF and AREVA need to demonstrate that there are no implicit claims made on integrity or the design that need to be captured by an appropriate safety classification.
The evidence we expect to see to address this action includes:
A systematic identification of the SSCs whose failure can lead to a PCC event.
A clear identification of, or reference to, the current safety classification and design requirements applied to those SSCs.
Discussion on how this safety classification is commensurate with the PCC allocation and safety criteria applied.
A revision of report NEPS-F DC 557 C to expand or modify the list of safety classified SSCs.
With agreement from the Regulators this action may be completed by alternative means.</td></tr>
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Annex 2

GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

CATEGORISATION AND CLASSIFICATION OF SYSTEMS STRUCTURES & COMPONENTS

GI-UKEPR-CC-01 REVISION 1

Technical Area	**CROSS CUTTING**		
Related Technical Areas	**All**		
GDA Issue Reference	**GI-UKEPR-CC-01**	**GDA Issue Action Reference**	**GI-UKEPR-CC-01.A2**
GDA Issue Action	The responses to GDA TQ's on the classification of internal structures within buildings to be added into an update to the GDA PCSR. Further clarification is required from EDF and AREVA on what is meant by "dedicated rules" in report N°NEPS-F DC 557 Rev C and in the PCSR, for the design of C2 structures. The evidence we expect to see to address this action is: • To update GDA PCSR chapter 3.2 to include the responses to GDA TQ's on the classification of internal structures. • To update PCSR chapter 3.3 in order to detail "dedicated rules" for the design of C2 structures and their scope of application. With agreement from the Regulator this action may be completed by alternative means.		

Annex 2

GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

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<tr><td>GDA Issue Action</td><td colspan="3">EDF and AREVA to update fault schedule in report N°NEPS-F DC 557 Rev C to include credible external and internal hazards as initiating events and from that the safety functions and SSC classifications.

The evidence we expect to see to address this action is:
• Update fault schedule in report N°NEPS-F DC 557 CCI to include credible external and internal hazards as initiating events
• Derive from the updated fault schedule the safety functions and SSC classifications
• Update PCSR to align with update to report N°NEPS-F DC 557 CCI.

With agreement from the Regulator this action may be completed by alternative means.</td></tr>
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GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

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<tr><td>GDA Issue Action</td><td colspan="3">EDF and AREVA to provide evidence that demonstrates the applicability of the M1-M3 classification approach against ONR’s expectations as detailed within SAPs, particularly ECS.3 and supporting paragraphs 157-161. In particular EDF and AREVA need to fully justify each case where an M3 requirement is applied to a Class 1 system i.e. an expansion of the claims made in Table 14 of NEPS-F DC 557 Rev C to show the arguments and evidence to support use of M3 for each Class 1 system. The arguments and evidence should take account of; the safety significance of the SSC, the demands that are placed on the system in terms of loadings, fatigue, temperature etc. and the consequences of the failure of the pressure boundary in terms of both the loss of system function and on the Internal Hazards safety case.

Where non-nuclear pressure vessel codes e.g. European Harmonised Standards are intended to used in the design of Class 2 systems EDF and AREVA need to fully justify each case i.e. an expansion of the claims made in Table 14 of NEPS-F DC 557 Rev C to show the arguments and evidence to support use of non-nuclear pressure vessel codes for each Class 2 system. The arguments and evidence should take account of; the safety significance of the SSC, the demands that are placed on the system in terms of loadings, fatigue, temperature etc. and the consequences of the failure of the pressure boundary in terms of both the loss of system function and on the Internal Hazards safety case.

With agreement from the Regulator this action may be completed by alternative means.</td></tr>
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GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

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<tr><td>GDA Issue Action</td><td colspan="3">EDF and AREVA to provide evidence to justify the allocation of class 3 SSC as the diverse line of protection for frequent faults and a demonstration that such allocation is ALARP.
The evidence we expect to see to address this action is:
• Detailed analysis of the seismic behaviour and ALARP justifications for electrical components
• Details on C&I class allocation
With agreement from the Regulator this action may be completed by alternative means.</td></tr>
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GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

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<tr><td>GDA Issue Action</td><td colspan="3">Categorisation of C&I systems to be consistent with current good practice as provided by IEC61226:2009 Nuclear Power Plants – Instrumentation and Control Systems Important to Safety – Classification’.
The evidence we expect to see to address this action is:
• Evidence to demonstrate that the categorisation of C&I systems is consistent with current good practice provided by IEC61226:2009 Nuclear Power Plants – Instrumentation and Control Systems Important to Safety – Classification.
• Evidence to demonstrate that the categorisation of C&I systems is consistent with the probabilistic claims (derived fro HSE ND TAG 46) given below.
With agreement from the Regulator this action may be completed by alternative means.</td></tr>
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Annex 2

GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

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<tr><td>GDA Issue Reference</td><td>GI-UKEPR-CC-01</td><td>GDA Issue Action Reference</td><td>GI-UKEPR-CC-01.A7</td></tr>
<tr><td>GDA Issue Action</td><td colspan="3">EDF and AREVA to provide evidence to justify the allocation of Class 2 SSCs to cool the spent fuel pool and demonstrate that the current allocation is ALARP. EDF and AREVA have claimed that the spent fuel pool is in a controlled state at the start of a loss of cooling event because of the available grace times before significantly elevated temperatures are reached. As a result, it is argued that provision of cooling to remove decay heat from the spent fuel pool is a Category B function, only requiring the main cooling trains to be Class 2. However this allocation means that there are no Class 1 SSCs providing this vital safety function.

The references, Classification of Structures Systems and Components. NEPS-F DC 557 Revision C, and 2. Dossier de Système Élémentaire PTR, P2 – Fonctionnement du système [System Design Manual Spent Fuel Cooling and Purification System (PTR [FPPS/FPCS]), P2 – System operation], set out the design requirements for the spent fuel pool cooling system, including the safety classification. The piping and heat exchangers are built to class M2 (the highest standard that is applied to SSCs not part of the reactor coolant pressure boundary or in the “High Integrity Component” (HIC) envelope). The main cooling trains are also to be built to the highest seismic and electrical standards. Therefore, many aspects of the design would be unaltered by reclassification. One potential shortfall is C&I where there are identifiable differences in requirements between Class 1 and Class 2 SSCs. Another concern is that while the piping is not part of the HIC envelope, the UKEPR PCSR claims "break preclusion" for the M2 piping upstream of isolation valves. EDF and AREVA shall review the safety classification of SSCs claimed to deliver spent fuel pool cooling functions and demonstrate that the current allocation is ALARP. The evidence we expect to see to address this action includes:

• Detailed analysis of the seismic, mechanical, electrical and structural integrity requirements of spent fuel pool cooling systems.
• Detailed analysis of the C&I class allocation.

With agreement from the Regulator this action may be completed by alternative means.</td></tr>
</table>

Annex 2

GDA Issue, GI-UKEPR-CC-03 – *Cross Cutting* – UK EPR™

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

CATEGORISATION AND CLASSIFICATION OF SYSTEMS STRUCTURES & COMPONENTS

GI-UKEPR-CC-01 REVISION 1

<table>
<tr><td colspan="2">Technical Area</td><td colspan="2">CROSS CUTTING</td></tr>
<tr><td colspan="2">Related Technical Areas</td><td colspan="2">All</td></tr>
<tr><td>GDA Issue Reference</td><td>GI-UKEPR-CC-01</td><td>GDA Issue Action Reference</td><td>GI-UKEPR-CC-01.A8</td></tr>
<tr><td>GDA Issue Action</td><td colspan="3">EDF and AREVA to provide further clarification with regards to differentiation elements for Class 1, 2, and 3 electrical systems both in terms of systems architecture and electrical components design and to provide evidence that the difference between EE1 and EE2 systems is much broader than seismic requirements (system architecture, single failure criterion, component integrity, diversity, equipment qualification etc.) The evidence we expect to see to address this action is:
• Revision to report NEPS-F DC 557 Rev C to provide further clarification to define class 1, 2, and 3 electrical SSCS and differentiation elements for these systems both in terms of systems architecture and electrical components design.
With agreement from the Regulator this action may be completed by alternative means.</td></tr>
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