Office for Nuclear Regulation

An agency of HSE

Generic Design Assessment – New Civil Reactor Build

Step 4 Cross-cutting Topics Assessment of the EDF and AREVA UK EPR™ Reactor

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PREFACE

The Office for Nuclear Regulation (ONR) was created on 1st April 2011 as an Agency of the Health and Safety Executive (HSE). It was formed from HSE's Nuclear Directorate (ND) and has the same role. Any references in this document to Nuclear Directorate, ND, Nuclear Installations Inspectorate (NII), or NII should be taken as references to ONR.

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

EXECUTIVE SUMMARY

This report presents the summary of the findings of the assessment of the Cross-cutting topics for the UK EPR reactor undertaken as part of Step 4 of the Health and Safety Executive's Generic Design Assessment. The Cross-cutting topics include, Design changes, Safety Function Categorisation and Structures, Systems and Components Classification, Design Limits and Conditions and Examination Maintenance Inspection and Testing. These assessments have been carried out on the Pre-construction Safety Report and supporting documentation submitted by EDF and AREVA during Step 4.

The Generic Design Assessments have followed a step-wise-approach in a claims-argument-evidence hierarchy. In Step 2 the claims made by EDF and AREVA were examined, in Step 3 the arguments that underpin those claims were examined.

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

It is seldom possible, or necessary, to assess a safety case in its entirety, therefore sampling is used to limit the areas scrutinised, and to improve the overall efficiency of the assessment process. Sampling is done in a focused, targeted and structured manner with a view to revealing any topic-specific, or generic, weaknesses in the safety case. The sampling for the Cross-cutting topics was identified in the Step 4 assessment plans in the impacted technical topic areas.

My assessment of Design Change has focused on:

- EDF and AREVA's arrangements for the Categorisation and control of design changes – (linked to Management for Safety of Quality Assurance topic area (Ref. ONR-GDA-AR-11-029 Revision 0).
- Review of EDF and AREVA's arrangements to include agreed design changes in the Generic Design Assessment design reference configuration.
- Review of adequacy of safety submission information (including outcome from Independent Nuclear Safety Assessment) provided by EDF and AREVA to support proposed design changes within Generic Design Assessment.
- Review of EDF and AREVA's arrangements to progress design changes in Generic Design Assessment post Step 4.

Design changes not agreed for inclusion in Generic Design Assessment are outside the scope of the Generic Design Assessment process.

From my assessment of Design Change, I have concluded that:

- Generally, EDF and AREVA have submitted sufficient supporting documentation to underpin design changes agreed for inclusion in Generic Design Assessment. However, this is not the case for those design changes at an early stage of development and further work will be required by EDF and AREVA to progress these within Generic Design Assessment after Step 4. This requirement will be progressed through Generic Design Assessment Issue (**GI-UKEPR-CC-02**).

- EDF and AREVA have developed robust arrangements for managing agreed design changes within Generic Design Assessment and for including them in the UK EPR design reference configuration document.
- Although EDF and AREVA have applied an Independent Nuclear Safety Assessment process to some Generic Design Assessment design changes the output from this process has not yet been presented to the regulators for examination.
- The application of EDF and AREVA's design change categorisation process developed for Generic Design Assessment has not been tested in detail beyond the limited number of design changes agreed for inclusion in Generic Design Assessment.

My assessment of Safety Function Categorisation and Structures, Systems and Components Classification has focused on:

- Review of EDF and AREVA's methodologies and criteria for categorisation and classification for the UK EPR design; and review of the application of these methodologies and criteria.

No items have been agreed with EDF and AREVA as being outside the scope of the Generic Design Assessment process. However, it is recognised that the full application of Structures, Systems and Components methodology to the EPR design requires input from suppliers and manufacturers and this level of design detail is outside the scope of Generic Design Assessment.

From my assessment of Safety Function Categorisation and Structures, Systems and Components classification, I have concluded that:

- EDF and AREVA have made significant progress in Generic Design Assessment Step 4 in developing and applying their methodologies and criteria for categorisation and classification for the UK EPR to meet UK and international standards and relevant good practice.
- The graded approach adopted by EDF and AREVA for Structures, Systems and Components classification at a principle level is consistent with UK and international standards and relevant good practice.
- Additional work is required within Generic Design Assessment to further apply these methodologies and criteria for the categorisation and classification throughout the UK EPR design, including any areas impacted by design changes already agreed for inclusion in Generic Design Assessment or arising from Generic Design Assessment Issue Resolution Plans. This requirement is captured in Generic Design Assessment Issue **GI-UKER-CC-01.**

My assessment of Limits and Conditions and Examination Maintenance Inspection and Testing requirements focused on:

- EDF and AREVA principles, methodologies and criteria for identifying key design limits and conditions and Examination Maintenance Inspection and Testing requirements for the UK EPR.
- Review of the information provided by EDF and AREVA to enable potential operators to derive Operating Technical Specifications, operating constraints and maintenance and inspection programmes.

No items have been agreed with EDF and AREVA as being outside the scope of the Generic Design Assessment process. However, it is recognised that the full development of Operating Technical Specifications and Examination Maintenance Inspection and Testing shall be the responsibility of future plant operators.

From my assessment, I have concluded that:

- EDF and AREVA have developed and applied appropriate methodologies, criteria and principles for identifying key design limits and conditions and Examination Maintenance Inspection and Testing requirements for the UK EPR design.
- The information in the Generic Design Assessment Submissions provide a sound starting point for a live site specific safety case from which future operators can derive and develop Operating Technical Specifications, operating constraints and Examination Maintenance Inspection and Testing programmes for a UK EPR.

In some areas there has been a lack of detailed information which has limited the extent of my assessment. As a result Nuclear Directorate will need additional information to underpin my conclusions and these are identified as Assessment Findings to be carried forward as normal regulatory business. These are listed in Annex 1, examples of Assessment Findings are as follows:

> ***AF-UKEPR-CC-01:*** *A future UK EPR licensee shall ensure design changes included in GDA are implemented into the UK EPR safety case.*
>
> ***AF-UKEPR-CC-05:*** *A future licensee shall fully apply the SF and SSC methodologies identified in the GDA PCSR to the developing design for a UK EPR.*
>
> ***AF-UKEPR-CC-06:*** *A future licensee shall use the information provided in the GDA PCSR and supporting references to derive OTS / Operating Rules (OR) and EMIT for UK EPR operations (includes shutdowns, maintenance activities).*

Some of the observations identified within this report are of particular significance and will require resolution before the Health and Safety Executive would agree to the commencement of nuclear safety-related construction of a UK EPR reactor in the UK. These are identified in this report as Generic Design Assessment Issues.

In addition, consequent on the Fukushima accident in March 2011, a further GDA Issue has been raised on both Requesting Parties to address any lessons to be learnt for the generic design. We have raised GDA Issue **GI-UKEPR-CC-03** requesting EDF and AREVA to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including from EDF and AREVA's internal reviews and from those lessons and recommendations that are identified in the ONR Chief Inspector's interim and final reports through. The GDA Issues are listed in Annex 2.

> ***GI-UKEPR-CC-01:*** *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.*
>
> ***GI-UKEPR-CC-02:*** *EDF and AREVA to continue to control, maintain and develop the GDA submission documentation, including the SSER, SML and design reference document and deliver final consolidated versions of these as the key references to any DAC/SODA ONR or Environment Agency (the joint Regulators) may issue at the end of GDA. These should include the management and acceptance of changes to GDA submission documentation impacted by design changes agreed for inclusion in GDA. This GDA Issue is raised by both ONR and Environment Agency.*
>
> ***GI-UKEPR-CC-03:*** *EDF and AREVA are required to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including those lessons and recommendations that are identified in the HM Chief Inspector's interim and final reports. This GDA Issue is raised by both ONR and Environment Agency.*

Overall, I am of the opinion that the UK EPR reactor is suitable for construction in the UK, subject to the assessment of additional information that becomes available as the Generic Design Assessment Design Reference is supplemented with additional details on a site-by-site basis (see Annex 1 Assessment Findings) and subject to satisfactory progression and resolution of the Generic Design Assessment Issues (listed in Annex 2).

LIST OF ABBREVIATIONS

ACT	Average Coolant Temperature
AF	Assessment Finding
AIC	Silver-Indium-Cadmium
ALARP	As Low As Reasonably Practicable
ASN	Autorité de Sûreté Nucléaire (French nuclear safety authority)
BMS	(Nuclear Directorate) Business Management System
BSL	Basic Safety level (in SAP)
BSO	Basic Safety Objective (in SAP)
BTS	Book of Technical Specifications
C&I	Control and Instrumentation
CCWS	Component Cooling Water System
CDRM	Control Rod Drive Mechanisms
CMF	Change Management Form
CVCS	Chemical and Volume Control System
DAC	Design Acceptance Confirmation
DBAA	Design Basis Accident Analysis
DECC	Department of Energy and Climate Change
DfT	Department for Transport
DSRC	Design Safety Review Committee
EBS	Emergency Boronation System
EDF and AREVA	Electricité de France SA and AREVA
EFWS	Emergency Feed Water System
EHS	European Harmonised Standards
EMIT	Examination Maintenance Inspection and Testing
EPRWG	MDEP EPR Working Group
GDA	Generic Design Assessment
HIC	High Integrity Component
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
IB	Intermediate Break
IEC	International Electrotechnical Commission

LIST OF ABBREVIATIONS

INSA	Independent Nuclear Safety Assessment
ISI	In-service Inspection
ISO	International Standards Organisation
JPO	Joint Programme Office (HSE-ND)
LB	Large Break
LCO	Limiting Conditions of Operation
LHSI	Low Head Safety Injection
LOCA	Loss of Coolant Accident
LOOP	Loss of Off-site Power
LTOP	Low Temperature Over-pressure Protection
MCR	Main Control Room
MDEP	Multinational Design Evaluation Programme
MHSI	Medium Head Safety Injection
NCB	Non Classified Building
NCSS	Non Computerised Safety System
ND	The (HSE) Nuclear Directorate
NDA	Nuclear Decommissioning Authority
NII	Nuclear Installations Inspectorate
NPP	Nuclear Power Plant
OCNS	Office for Civil Nuclear Security
OEF	Operating Experience Feedback
OJEU	Official Journal of the European Union
ONR	Office for Nuclear Regulation (formerly the Nuclear Directorate of HSE)
OR	Operating Rule
OTS	Operating Technical Specification
PCC	Plant Condition Category
PCER	Pre-construction Environment Report
PCSR	Pre-construction Safety Report
PID	Project Initiation Document
PSA	Probabilistic Safety Analysis
PMS	Plant Maintenance Schedule
PSR	Preliminary Safety Report

LIST OF ABBREVIATIONS

PT	Periodic Testing
PWR	Pressurised Water Reactor
QA	Quality Assurance
QDS	Qualified Display System
RCCA	Rod Cluster Control Assembly
RCPB	Reactor Coolant Pressure Boundary
RCP	Reactor Coolant Pump
RCSS	Reactor Core Surveillance System
RGP	Relevant Good Practice
RHR	Residual Heat Removal
RI	Regulatory Issue
RIA	Risk Informed Approach
RIA	Regulatory Issue Action
RO	Regulatory Observation
ROA	Regulatory Observation Action
RPS	Reactor Protection System
RRC	Risk Reduction Category
RCSL	Reactor Core Surveillance System
RI	Regulatory Issue
RIA	Risk Informed Approach
RO	Regulatory Observation
RSS	Remote Shutdown Station
SAP	(HSE) Safety Assessment Principles
SAS	Safety Automation System
SDM	System Design Manual
SF	Safety Function
SFAIRP	So Far As Is Reasonably Practicable
SFG	Safety Functional Group
SG	Steam Generator
SGTR	Steam Generator Tube Rupture
SI	Structural Integrity
SIS	Systems Important for Safety

LIST OF ABBREVIATIONS

SLB	Steam Line Break
SML	Submission Master List
SOA	State Oriented Approach
SRS	Safety Related System
SS	Safety System
SSC	Structure, System and Component
SSER	Safety, Security and Environmental Report
STUK	Säteilyturvakeskus (The Finish Nuclear Safety Authority)
TAG	(Nuclear Directorate) Technical Assessment Guide
TQ	Technical Query
TSC	Technical Support Contractor
US NRC	Nuclear Regulatory Commission (United States of America)
WENRA	Western European Nuclear Regulators' Association

TABLE OF CONTENTS

Tables

Annexes

Figures

1 INTRODUCTION

1 This report presents the findings of the Step 4 Cross-cutting Topics assessment of the UK EPR, Pre-construction Safety Report (PCSR) (Refs 13 and 15) and supporting documentation provided by EDF and AREVA under the Health and Safety Executive's (HSE) Generic Design Assessment (GDA) process. Assessment was undertaken of the PCSR and the supporting evidentiary information derived from the Submission Master List (Ref. 14). The approach taken was to assess the principle submission, i.e. the PCSR, and then undertake assessment of the relevant documentation sourced from the Master Submission List on a sampling basis in accordance with the requirements of the Nuclear Directorate's (ND) Business Management System (BMS) procedure AST/001 (Ref. 2). The Safety Assessment Principles (SAPs) (Ref. 4) have been used as the basis for this assessment. Ultimately, the goal of assessment is to reach an independent and informed judgment on the adequacy of a nuclear safety case.

2 During the assessment a number of Regulatory Observations (RO) were issued and the responses made by EDF and AREVA assessed. Where relevant, detailed design information from specific projects for this reactor type has been assessed to build confidence and assist in forming a view as to whether the design intent proposed within the GDA process can be realised.

3 A number of items have been agreed with EDF and AREVA as being outside the scope of the GDA process and hence have not been included in this assessment.

2 NUCLEAR DIRECTORATE'S ASSESSMENT STRATEGY FOR CROSS-CUTTING TOPICS

4 Cross-cutting topics have emerged as Step 4 has progressed and the assessment strategy for these was not captured in a specific assessment plan. For Cross-cutting topics the assessment strategy was that the nominated topic lead would coordinate the overall ND assessment in that Cross-cutting area. The Cross-cutting topics identified for GDA are as follows:

Cross-cutting topic	Technical Topic Lead
1 Severe Accidents	Fault Studies
2 SSC Classification	Cross-cutting
3 Design Changes	Cross-cutting
4 Limits and Conditions	Cross-cutting
5 Boron Dilution	Fault Studies
6 Smart Instruments	C&I
7 Dropped loads	Internal Hazards
8 Source Terms	Radiological Protection
9 Qualification	Civil Engineering

5 Of these nine Cross-cutting topics the assessment of three, Design Changes, Safety Function Categorisation and SSC Classification and, Design Limits and Conditions and EMIT requirements are addressed in this report. For these three Cross-cutting topics reference will be made, as appropriate, to supporting technical topic area reports for further detail of the assessment undertaken within GDA.

6 The remaining Cross-cutting topics are addressed in the technical report of the Cross-cutting Topic lead.

2.1 Assessment Plan

7 There is no specific assessment plan for Cross-cutting topics. However, the need to consider these topics across the project was recognised during Step 4, and was identified in individual Step 4 assessment plans.

2.2 Standards and Criteria

8 Design Changes - IAEA Safety Standard, *The Management System for Facilities and Activities Safety Requirements*, GS-R-3 (Ref. 16).

9 Safety Function Categorisation and SSC Classification - HSE's Safety Assessment Principles (SAPs) (Ref. 4) ECS.1-ECS.5 and paragraphs 148-161.

10 Design limits and conditions + EMIT:

- ND's Safety Assessment Principles (SAPs) (Ref. 4) EMT.1 - EMT.8 and paragraphs 187-193 + SC.2, SC.6, paragraph 498.
- IAEA Safety Standard, *The Management System for Facilities and Activities Safety Requirements* GS-R-3 (Ref. 16).
- Classification IAEA Safety Standard NS-R-1 (Ref. 81).

11 In addition to ND SAPs (Ref. 4), elements of the following Technical Assessment and Inspection Guides have been used, where appropriate.

- T/INS/017 – LC20 – Modification to design of plant under construction (Ref. 18).
- T/INS/017 – LC23 – Operating Rules (Ref. 19).
- T/INS/017 – LC28 – Examination, Inspection, Maintenance and Testing (EMIT) (Ref. 20).
- T/AST/009 – Examination, Inspection, Maintenance and Testing (EMIT) of SSCs (Ref. 21).
- T/AST/057 – Design safety assurance (Ref. 22).
- T/AST/051 – Purpose, Scope and Content of Nuclear Safety Cases (Ref. 23).

12 In addition our expectations for Design Limits and Conditions and EMIT requirements are laid out in our published GDA guidance on requirements for Requesting Parties (Ref. 5).

13 This guidance states that the arrangements for moving the safety case to an operating regime, i.e. the arrangements to ensure that the requirements of, and assumptions in, the safety case be captured in:

a) Technical specifications;

b) Maintenance schedule;

c) Procedures (normal operation, emergency, accident management);

d) Training programmes;

e) Emergency preparedness;

f) Operating limits; and

g) Radiation protection arrangements for operators.

14 EDF and AREVA's arrangements for items a) b) and f) above are considered under the Limits and Conditions Cross-cutting topic area.

15 Our expectation for design limits and conditions is that EDF and AREVA will provide further information to that provided in PCSR Sub-Chapter 18.2 (Ref. 13) to demonstrate how plant Operating Rules (OR) or Operating Technical Specifications (OTS) and maintenance schedules can be derived from the design basis limits and claims made in the GDA PCSR and what processes will be followed to ensure that the ORs, OTSs and / or maintenance schedules ultimately adopted are consistent with the design basis limits.

16 It is our expectation also that the Examination, Maintenance, Inspection and Testing (EMIT) requirements associated with SSCs that provide the means of delivery of important safety functions will be clearly identified in the GDA submission. In the UK these EMIT requirements are identified in the Plant Maintenance Schedule (PMS).

However, we recognise that the final EMIT specifications will be dependant upon suppliers' and operator's requirements.

2.3 Assessment Scope

17 The Step 4 assessment scope for the three Cross-cutting topics covered in this report has been primarily developed from the preliminary work undertaken in during Step 3, and reviewed and expanded as appropriate through co-ordination with the impacted technical topic areas and as lines of inquiry have emerged as the assessment has developed in Step 4.

2.3.1 Findings from GDA Step 3

18 It was identified in our Step 3 summary report (Ref. 9) that further work would be required in GDA to address SF Categorisation and SSC Classification, and design changes. In Step 3 the GDA design reference was agreed fixed at a point in time (December 2008) and that any changes to this would then be subject to design change control arrangements. It was also recognised in Step 3 that some significant design changes would be required to address our regulatory concerns (for example in the area of Control & Instrumentation (C&I)) and that these would be progressed in Step 4.

2.3.2 Additional Areas for Step 4 Cross-Cutting Topics Assessment

19 None.

2.3.3 Use of Technical Support Contractors

20 None.

2.3.4 Integration with Other Assessment Topics

21 The Cross-cutting topics covered in this report impact on all other technical topic areas.

2.3.5 Out of Scope Items

22 The following items have been agreed with EDF and AREVA as being outside the scope of GDA.

- Design changes – any design changes not agreed for inclusion in the EPR GDA design reference document UKEPR-I-002 (Ref. 37).
- Limits and Conditions – frequencies/periodicities for periodic tests for items where no specific claim is made on reliability within the GDA PSA.
- Full site specific Operational Technical Specifications / Operating Rules and EMIT for the UK EPR design.

3 EDF AND AREVA'S SAFETY CASE

23 Design changes and control of GDA submission – EDF and AREVA's arrangements for the control of design changes agreed for inclusion in GDA are presented in PCSR Chapter 21.1 and are supported by project procedure UKEPR-I-003 (Ref. 39) and design reference document UKEPR-I-002 (Ref. 37). The supporting safety case justification for each agreed design change is presented in those PCSR Chapters and key supporting references impacted by the design change as identified in EDF and AREVA's design change submission programme (Ref. 64).

24 Some design changes are at the early proposal stage and await impact assessment to identify affected GDA documentation. This is required to substantiate the proposed change before assessment in GDA.

25 The RP's case for Safety Function Categorisation and SSC Classification is presented in Chapters 3.1, 3.2, 3.3, 7 and 14.7 of the PCSR (Ref. 13) and supporting references, for example report N° NEPS-F DC 557 rev A (Ref. 52).

26 The RP's case for Design Limits and Conditions and EMIT is presented in Sub-Chapter 18.2 of the PCSR (Ref. 13) and in supporting PCSR Chapters and documentation referenced from this.

27 A review of the March 2011 Consolidated PCSR Chapters has been conducted to confirm factual accuracy and completeness of the Chapters' technical content, ensuring that the relevant commitments in response to regulatory queries have been captured correctly. The output of this review will need to be addressed by EDF and AREVA during GDA in response to the GDA Issues.

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

4.1 Design Changes Including Update to GDA Submission

28 This section deals with the assessment of GDA design changes, including EDF and AREVA's processes for the categorisation, generation and progress of design changes (Ref. 39). The design changes are included in the UK EPR design reference configuration (Ref. 37) after the Regulators have agreed their inclusion in GDA.

29 Proposed design changes for inclusion in GDA can arise from either:

- Response to regulatory concern.
- Proposal from EDF and AREVA to improve the UK EPR design base.
- From construction/design development experience on EPR projects in France, Finland, US and China.

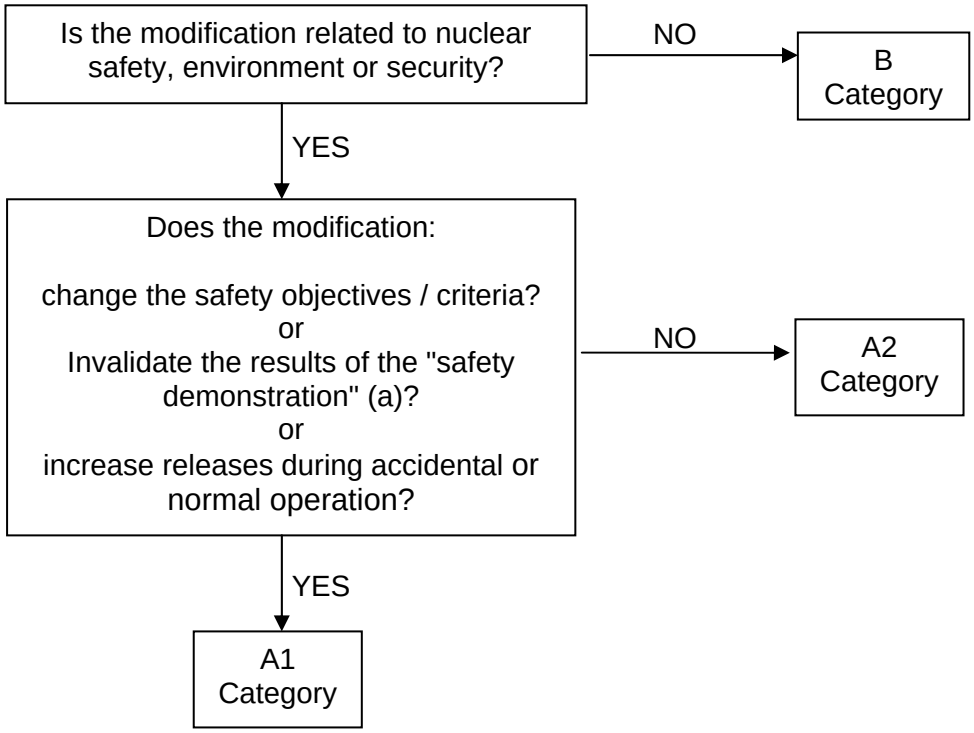
30 For GDA, all changes are categorised as described in EDF and AREVA's logic diagram given in Figure 1 below according to their impact on the GDA submission:

(A1): modifications related to nuclear safety, environment or security, which have (or potentially have) a significant impact on the GDA submission;

(A2): modifications related to nuclear safety, environment or security but having a minor impact with regards to the GDA submission; and

(B): modifications not related to nuclear safety, environment or security.

Figure 1: Logic Diagram for Categorisation of Changes



31 Prior to the December 2008 freeze date EDF and AREVA had initiated several design changes and these are identified as Change Management Form (CMF) numbers namely CMFs 004 to 009 and 011 to 012 (Ref. 78) in the EDF and AREVA design reference configuration document (Ref. 37). These design changes were initiated prior to the implementation of the Regulators' 6-step process for Agreement to Consider Changes in GDA, as shown in Table 1 of this report and as detailed in Ref. 27. The process is included in EDF and AREVA's design change control procedure (Ref. 39) and was considered in the Management for Safety and Quality Assurance (MSQA) GDA Step 4 Assessment Report (Ref. 8).

32 Although the regulators accept the inclusion of the pre December 2008 design freeze design change proposals in GDA, they have not been assessed during Step 4 as they were not significant changes. However, CMF-010 (Ref. 78) which concerns the Partial Cooldown Gradient Modification was categorised A1 and has a significant impact on the provisions in the UK EPR design to address intermediate and large break LOCAs. It has therefore been included in our Step 4 Fault Studies technical topic area (Ref. 8) partially in response to our Regulatory Observation RO-UKEPR-57 (Ref. 11) with respect to Intermediate Break (IB) and Large Break (LB) Loss of Coolant Accident (LOCA) faults. This is covered in more detail in Section 4.1.1.2 of this report.

33 Although the EDF and AREVA design change categorisation process (see Figure 1 logic diagram) was reviewed as part of our GDA assessment in the MSQA topic area (Ref. 8) the adequacy of the application of this process has not been fully tested as only a limited number of design changes were agreed for inclusion in GDA and these were assessed by the Regulators on an individual basis.

34 Where these design changes have been subject to assessment a summary is provided in this report and reference made to the relevant Step 4 technical topic assessment reports for supporting details.

35 The number of design changes agreed for inclusion in GDA to date is 16 with 10 of these being initiated to address regulatory concerns raised during our GDA assessment. Full details of these design changes are provided in EDF and AREVA's design change submission programme (Ref. 64). A summary of the assessment and status of each of the agreed design changes is given in Table 2 and in Sections 4.1.1.1-3 of this report.

36 The safety justification for each design change is identified in the impact assessment and where these have been completed the supporting safety documentation is presented in EDF and AREVA's design change programme summary (Ref. 64). It is for EDF and AREVA to demonstrate that risks arising from the design change proposals are As Low As Reasonably Practicable (ALARP). EDF and AREVA recognise this responsibility in their design change control procedure (Ref. 39).

37 The majority of the design changes agreed for inclusion in GDA have been incorporated into the Consolidated PCSR submitted March 2011 (Ref. 15). The development of the PCSR during Step 4 has been managed and controlled by EDF and AREVA's joint project procedure UKEPR-I-031 Specification – Consolidated Step 4 PCSR (Ref. 40), supported by a number of project tracking tools, such as the PCSR Route Map. The quality assurance arrangements for these activities have been discussed in the MSQA topic area report (Ref. 8).

38 The RP includes in its design change control process (Ref. 39) the requirement to undertake an Independent Nuclear Safety Assessment (INSA) to underpin the safety submission for safety-related Category A1 design change proposals. Application of INSA is widely used in the UK by nuclear plant operators and is considered by the Regulators to be good practice (Ref. 23).

39 The design changes which have not been incorporated into the March 2011 PCSR will be controlled through the joint project procedure UKEPR-I-003 and the design change submission programme. It is recognised that further design changes may be required in response to GDA Issues and that further updates to the March 2011 Consolidated PCSR will be required to incorporate the additional assessment work. This will be followed up by GDA Issue **GI-UKEPR-CC-02.**

> ***GI-UKEPR-CC-02:*** *EDF and AREVA to continue to control, maintain and develop the GDA submission documentation, including the SSER, SML and design reference document and deliver final consolidated versions of these as the key references to any DAC/SODA ONR or Environment Agency (the joint Regulators) may issue at the end of GDA. These should include the management and acceptance of changes to GDA submission documentation impacted by design changes agreed for inclusion in GDA. This GDA Issue is raised by both ONR and Environment Agency.*

40 This GDA Issue is not only concerned with impact on the consolidated PCSR from design changes, but also from GDA Issue resolution and from the March 2011 Consolidated PCSR chapter review completed by the Regulators. The GDA Issue has been raised jointly with the Environment Agency as the GDA submission includes the PCSR, PCER, SML and DR which are of interest to both regulatory bodies. These key submission documents would be referenced from any interim Design Acceptance Confirmation (iDAC) / interim Statement of Design Acceptance (iSODA) we may issue.

41 It is our joint expectation as Regulators (ND and Environment Agency) that EDF and AREVA will continue to control, maintain and develop the GDA submission documentation, including the SSER, SML and the design reference and deliver final consolidated versions of these documents as the key references to any DAC/SODA we may issue at the end of GDA.

42 It is also our expectation that EDF and AREVA shall ensure that these key deliverables are subject to appropriate review and that the review comments (including Design Safety Review Committee (DSRC) recommendations) are included, as appropriate, in the final consolidated submission (including any outstanding comments from Step 4).

43 There are three actions associated with GDA Issue **GI-UKEPR-CC-02,** these are as follows:

> ***GI-UKEPR-CC-02.A1:*** *EDF and AREVA to fully implement its processes to manage the implementation and acceptance of amendments to documentation impacted by design changes agreed for inclusion in GDA, including any other additionally agreed design changes associated with other GDA Issues Resolution Plans. This should involve the incorporation of all relevant amendments into the impacted documentation associated with design changes, including the Reference Design Configuration Document UKEPR-I-002 and the PCSR.*
>
> ***GI-UKEPR-CC-02.A2:*** *EDF and AREVA to apply the revised Design Change procedure in order to identify and transfer all relevant agreed incomplete GDA design changes into NSL and permissioning activities.*
>
> ***GI-UKEPR-CC-02.A3:*** *EDF and AREVA shall continue to control, maintain and develop the GDA submission documentation, including the SSER, SML and design reference document and shall deliver final consolidated versions of these as key references to any DAC / SoDA we may issue at the end of GDA.*

44 This GDA Issue will also progress the outstanding work associated with design changes, as some of these design change proposals are at an early stage of development and await impact assessment. The amount of assessment undertaken in GDA to date has been limited and further assessment will be required in GDA to progress these.

45 Additionally, full implementation of design changes that have been included in GDA shall be completed during the site specific stage by the future UK EPR licensee and this requirement is captured here for all the agreed design changes in Table 2 in the following Assessment Finding.

> ***AF-UKEPR-CC-01:*** *A future EPR licensee shall ensure design changes included in GDA are implemented into the UK EPR safety case. Milestone: During operational phase.*

46 A summary of the assessment of agreed design changes is presented in the following sections for each design change type.

4.1.1 Assessment

4.1.1.1 Design Changes to Address Regulatory Concerns Raised During our GDA Assessment

47 The design changes considered in this are those raised by EDF and AREVA in response to a regulatory concern and are presented by Change Management Form (CMF) number order. Reference is made, to supporting GDA technical topic assessment reports for further details.

48 **CMF-014** (Ref. 78) Non Computerised Safety System (NCSS) and **CMF-015** (Ref. 78) Communication of EPR protection system with other systems. These significant design changes were initiated by EDF and AREVA as part of the response to our Regulatory Issue (RI) (Ref. 12) in the UK EPR C&I Architecture.

49 EDF and AREVA categorised these 2 design changes as A1 and these each require an INSA. Although EDF and AREVA claim that an INSA has been performed for each of these changes, the outcome of this process has not been shared with the Regulators.

50 For **CMF-014** (Ref. 78) EDF and AREVA have provided safety case submissions to support the developing design including updates to the PCSR Chapters 1.3, 3.2, 7 and 18.3. However, at this stage details of the design change are limited and further work is required to develop this design change in GDA and this will be taken forward as part of the C&I GDA Issue **GI-UKEPR-CI-01** (see Ref. 8).

51 For **CMF-015** (Ref. 78) EDF and AREVA have provided safety case submissions to support the developing design. However, at this stage details of the design change are limited and further work is required to develop this design change in GDA and this will be taken forward as part of the C&I GDA Issue **GI-UKEPR-CI-01**.

52 Further details on our assessment on both these design changes may be found in our Step 4 C&I assessment report (Ref. 8).

53 **CFM-016** (Ref. 78) Safety Fire Compartments Doors Monitoring System. This design change was raised to address a regulatory concern on the engineered features in the EPR design to control opening of fire doors (closure of fire doors is required to maintain nuclear fire barriers). This design change was initially categorised by EDF and AREVA as an A1 change but was re-categorised as A2 after the completion of the supporting impact assessment.

54 EDF and AREVA have modified the PCSR (Chapter 9.5 Section 1.6) to describe the principles of a door monitoring system and made reference to a supporting specification document. This has been assessed in the Internal Hazards topic area (Ref. 8) where it is stated that the approach taken to address the principles of design, operation of the system and the specific identification of the doors is satisfactory. Although there are a number of areas yet to be developed by EDF and AREVA, these are identified within the supporting specification. An Assessment Finding was raised in the Internal Hazards topic area (Ref. 8) to ensure that the door control systems are adequately specified, designed and implemented within a UK EPR by a future licensee.

55 Implementation of this design change will bring the UK EPR design in line with that at Olkiluoto 3 and is in line with our expectations in this area. No further work is anticipated to be undertaken in GDA for this design change.

56 **CMF-018** (Ref. 78) Reactor Building Liner Anchorage. This design change was raised to address our regulatory concern on construction Operating Experience Feedback (OEF) from Flamanville 3, where difficulties were encountered in attaching the EPR containment building metallic liner to the concrete base mat. This design change was categorised by

EDF and AREVA as an A2 change. EDF and AREVA have provided amendments to safety case submissions to support this design change including an update to the PCSR Chapter 3.3.

57 No further assessment is required on this design change in GDA.

58 **CMF-022** (Ref. 78) Modification of small Steam Generator Tube Rupture (SGTR) mitigation. This design change was initiated by EDF and AREVA in response to our regulatory concern on SGTR TQ-949 (Ref. 10). It proposes operator intervention rather than automatic initiation of the protection system, in the event of small SGTR, to avoid spurious shut down of the plant.

59 Early detection and effective management of SGTR are necessary to mitigate the consequences of potential releases to the public and the environment. The current UK EPR design provides for automatic actuation of the protection system in the event of detection of a SGTR.

60 It was recognised during Step 4 that the automatic protection system would not be triggered for a small SGTR as the current UK EPR CVCS capacity is sufficient to compensate for the rupture of a single SG tube. EDF and AREVA have recognised this and they have an on-going programme to modify the design and update the safety case, with a reliance on detection of increased secondary activity levels to initiate action.

61 Although EDF and AREVA have submitted an ALARP analysis for detection of small SGTR and thermo hydraulic impact analysis for this design change they have yet to complete an impact analysis on this design change proposal or confirmed the final Categorisation A1 or A2. The further work required to progress this design change proposal in GDA will be taken forward as part of the Fault Studies GDA Issue **GI-UKEPR-FS-04** (see Ref. 8).

62 **CMF-024** (Ref. 78) SSC Classification. This design change was raised to address a regulatory concern (RO-UKEPR-043) (Ref. 11) on the methodology and criteria applied for SSC Classification.

63 In response to our concern EDF and AREVA has revised its SSC methodology and is now applying this to the GDA design for the following three important safety systems; Reactor Core Surveillance System (RCSL), Safety Automation System (SAS), and Safety Injection System (SIS). The changes are summarised in the table below:

System	Modification	Regulatory Concern
RCSL	For the core controls, the RCSL will be classified as Class 2 (previously F2), to comply with IEC61226 requirements	RO-UKEPR-43 RO-UKEPR-41 RI-UKEPR-02
SAS	RRC-A functions that are credited as a diverse line for frequent faults will be Class 2 (previously F2)	RO-UKEPR-43 RO-UKEPR-41 RI-UKEPR-02
RIS	RIS accumulators and connected lines will be mechanically classified as M2 (previously M3)	RO-UKEPR-43 RO-UKEPR-41

64 This design change is welcomed by ND and captures the commitments made by EDF and AREVA to upgrade the classifications of these systems to meet our SAPs (Ref. 4) and or IEC 61226 (Ref. 49) requirements for C&I and international good practice.

65 Further work to progress this design change will be progressed through the Cross-cutting GDA Issue on SSC Classification **GI-UKEPR-CC-01**.

66 **CMF-025** (Ref. 78) Automatic Emergency Boronation System (EBS) for Steam Line Break (SLB). This design change was raised to address our regulatory concern (RO-UKEPR-63) (Ref. 11) on the adequacy of design measures to mitigate the consequences of SLB faults.

67 EDF and AREVA submitted a sensitivity study on SLB (Ref. 66) and amended PCSR Chapters 6.7, 7.3, 14.1 and 14.5. Details of the assessment that has been completed in GDA are provided in our Fault Studies technical topic area assessment report (Ref. 8).

68 In summary, the introduction of this design change to automate the actuation of the EBS injection on detection of low SG pressure, is supported by ND since it increases the effectiveness and reliability of the EBS in such faults.

69 Further work is required by EDF and AREVA to complete the impact assessment and to confirm the Categorisation A1/A2 for this design change proposal and to provide more developed supporting safety submissions. This will be progressed in GDA through the Cross-cutting GDA Issue on update of the GDA submission to include agreed design changes **GI-UKEPR-CC-02**.

70 **CMF-026** (Ref. 78) Class 1 interface in the Main Control Room (MCR) and remote shutdown station (RSS) and **CMF-027** (Ref. 78) Safety Information and Control System Class upgrade (Class 1) were raised to address part of our Regulatory Issue (Ref. 12) on the absence of an adequate C&I Architecture in the UK EPR C&I design.

71 EDF and AREVA provided conceptual level descriptions of both these proposed changes (Ref. 67) and these appear reasonable. However, further work is required by EDF and AREVA to complete the impact assessment and to confirm the Categorisation as A1 or A2 for each of these design change proposals and to provide more developed supporting safety submissions and these matters will be progressed within GDA through GDA Issues **GI-UKEPR-CI-06** (see Ref. 8) and **GI-UKEPR-CI-01** respectively.

72 **CMF-028** (Ref. 78) Monophasic start-up mode. This design change was raised to address queries raised on UK EPR start-up and shutdown operating modes in our Chemistry technical topic area and is also associated with our regulatory query (Ref. 11) on design limits and conditions.

73 This design change proposal was received late in Step 4, and EDF and AREVA have updated the PCSR Chapters 3.4, 5.1, 5.5, 9.3 and 18.2 to include these operating mode changes but these have not been assessed by ND.

74 In summary, the original design concept for EPR was to start-up in a bi-phasic mode, as is undertaken on KONVOI and many other PWR plants. This involves creation of the pressuriser steam bubble before operation of the main RCPs. The design change proposal alters the steps of this sequence, using the RCPs to heat the RCS to 90 °C before operation of the pressuriser and creation of the steam bubble. This latter, Monophasic start-up process allows better homogenisation of the coolant before creating a discontinuity between the RCS and pressuriser volumes. In principal this should offer advantages from a chemistry perspective.

75 This design change proposal is at an early stage of development, and further work is required by EDF and AREVA to complete the impact assessment and to confirm the Categorisation as A1 or A2 for this design change proposal and to provide more developed supporting safety submissions and this design change will be progressed in GDA through GDA Issue **GI-UKEPR-CC-02**.

4.1.1.2 Design Changes Derived from Construction/Design Development Experience on EPR projects in France, Finland, US and China.

76 The design changes considered in this section are those proposed by EDF and AREVA to improve the UK EPR design (in addition to those described in 4.1.1.1 which were made in response to regulatory concerns). These are derived from construction/design development experience on EPR projects in France, Finland, US and China. The design changes included here are presented by Change Management Form (CMF) number order and reference is made, as appropriate, to supporting Step 4 technical topic reports for further assessment details.

77 **CMF-010** (Ref. 78) Partial Cooldown Gradient Modification. This design change was initiated by EDF and AREVA and included in the EPR design reference configuration document (Ref. 37) with several other design changes namely CMFs 004 to 009 and 011 to 012 (Ref. 78) prior to the December 2008 design freeze date. However, the impacted documentation associated with this design change had not been completed at the design freeze date and as this A1 categorised design change has a significant safety impact it has been assessed in Step 4 in our Fault Studies technical topic area (Ref. 8) partially in response to our Regulatory Observation RO-UKEPR-57 (Ref. 11) on Intermediate Break (IB) and Large Break (LB) Loss of Coolant Accident (LOCA) faults.

78 Details of the assessment we have completed are provided in our Fault Studies technical topic area assessment report (Ref. 8) and may be summarised as follows:

- The additional analysis undertaken by EDF and AREVA of PCC-4 intermediate and large break LOCA faults with the revised partial cooldown rate shows acceptable peak cladding temperatures and clad deformation. HSE ND are satisfied that this analysis, supported by independent confirmatory analysis commissioned by HSE ND, shows that the consequences have been assessed in an appropriate and conservative basis in accordance with SAP FA.7.
- Other, less limiting faults are affected by this design change. In some cases, the evidence provided by EDF and AREVA to support their safety case still retains transient analysis assuming the previous partial cooldown rate. GDA Issue **GI-UKEPR-FS-04.A3** and Assessment Findings **AF-UKEPR-FS-15** and **AF-UKEPR-FS-16** (Ref. 8) require some of these analyses to be updated assuming proposed UK EPR parameters, including the revised partial cooldown rate.
- Some further work is required to progress this design change proposal in GDA and this will be taken forward as part of the GDA Issue **GI-UKEPR-CC-02**.

79 **CMF-13** (Ref. 78) Rod Cluster Control Assembly (RCCA) design. This proposed design change was initiated by EDF and AREVA from design development experience on the FA3 and OL3 projects. The RCCA comprises the control rods themselves, which are inserted into the Fuel Assemblies, and the RCCA spider, which attaches to the top of a set of control rods, and which connects to the CRDM drive rod.

80 The design change has been driven by a need to decrease the rod drop time in order to provide an increased margin in line with a change in the applicable design codes, and to compensate for the reduction in length of the drive rod, due to plant spatial constraints. This necessitates an increase in the RCCA mass with respect to the original mass, and the need to maintain or increase neutronic efficiency to ensure that any change is still bounded by RCCA Operational Experience Feedback (OEF).

81 EDF and AREVA have submitted layout details for this design change together with supporting analysis for control rod failure and ejection accidents (Ref. 64) and these have been assessed in Step 4 in the Mechanical Engineering and Fuel Design topic areas. Further details are given in our assessment reports (Ref. 8).

82 The revised design of the Silver-Indium-Cadmium (AIC) bar lengths and boron pellet designs are now standard with other plants worldwide, and so EDF and AREVA claim the design change is bounded by RCCA operating experience.

83 The revised design has proved satisfactory from a seismic re-validation perspective, and from a physical test perspective, covering rod vibratory behaviour, drag force, and endurance effects.

84 ND considers that EDF and AREVA have described a rational and substantiated design change that takes account of OEF, and is satisfied that this design change can be incorporated within the UK EPR reference design for the GDA. However, this proposed design change was categorised by EDF and AREVA as Category A1 but has not yet been subject to INSA and further work is required in GDA to complete our assessment of the GDA submission including update to the PCSR (Ref. 15) and the supporting INSA and this will be progressed under GDA Issue **GI-UKEPR-CC-02**.

85 **CMF-017** (Ref. 78) Use of material 20MND5 for Steam Generator (SG) and pressuriser shells. This design change was initiated by EDF and AREVA to expand the option for material choices for some EPR components.

86 EDF and AREVA completed an impact assessment for this design change proposal and categorised it as A2. However, the Regulators' considered this change important to safety and EDF and AREVA were requested to treat this change as A1 and make it subject to an INSA (Ref. 25). EDF and AREVA confirmed the categorisation of this design change as A2 and agreed to provide an INSA for this proposed design change (Ref. 26).

87 EDF and AREVA subsequently submitted several documents, including the INSA (Ref. 29) to support this proposed design change and these were assessed in our Structural Integrity (SI) technical topic area (Ref. 8).

88 EDF and AREVA have also revised the PCSR Chapters 3.8 and 5.4 to include details of this design change but these have not yet been fully assessed.

89 Our assessment completed in GDA may be summarised as follows:

- The new material option 20MND5 is acceptable for the proposed use, but the Ni value should be limited to 0.8% and sample non-destructive testing should be performed to check that underclad cracks are avoided. These requirements are captured as GDA Assessment Findings in our SI technical assessment report (Ref. 8).
- It was noted that the INSA (Ref. 25) did not raise any significant comments on this design change proposal.

90 Our assessment of any further updates to GDA documentation associated with this design change proposal will be progressed as part of GDA Issue **GI-UKEPR-CC-02**.

91 **CMF-019** (Ref. 78) Major reduction of Microtherm (lagging) in the pressuriser. This design change was initiated by EDF and AREVA to reduce the potential for clogging of the UK EPR sumps under certain accident conditions by reducing the lagging material around the pressuriser. The Regulators have agreed, in principle, to include this design change in GDA but the safety submission documents have not yet been developed for this proposal. An Assessment Finding (Ref. 8) has been raised by the Fault Studies Severe Accidents topic area, requesting a future licensee to demonstrate that the proposed

changes are ALARP. This is in addition to an extant Assessment Finding from the Mechanical Engineering assessment (Ref. 8) requesting the satisfactory completion of equipment qualification tests.

92 EDF and AREVA have yet to complete an impact assessment for this proposal to identify changes needed to the safety submission documents and to confirm design change categorisation.

93 Further work is required in GDA to assess this design change proposal, including consideration of any INSA and this will be progressed in GDA through GDA Issue **GI-UKEPR-CC-02**.

94 **CMF-020** (Ref. 78) Modification of HVAC systems for accident conditions. This design change was initiated by EDF and AREVA from design development experience on the FA3 project. The identified problem is that in the event of certain postulated fault scenarios, including severe accident conditions, leakage from containment penetrations could contaminate peripheral buildings, creating potential direct leaks to the environment, greater radiological contamination for equipment within these buildings, and subsequent accessibility difficulties for plant operators for subsequent remedial operations.

95 The Regulators have agreed, in principle, to include this design change in our GDA assessment, but only limited assessment has been completed during GDA and EDF and AREVA are yet to develop the relevant safety submission documents. EDF and AREVA are also to complete an impact assessment to identify any changes related to the safety submission documents and to confirm the design change categorisation.

96 These changes proposed are considered rational and reasonable, and it is our expectation that they will be incorporated into the UK EPR design. Further work is required in GDA to assess this design change proposal, including consideration of any INSA and this will be progressed in GDA through GDA Issue **GI-UKEPR-CC-02**. In addition, an Assessment Finding has been raised in the Fault Studies Severe Accident assessment report (Ref. 8) requesting that a future licensee demonstrates the risk of uncontrolled radiological releases from the primary containment has been reduced to the lowest reasonably practicable level and is in accordance with relevant good practice.

97 **CMF-021** (Ref. 78) Average Coolant Temperature (ACT) and PZR level LCO modification at low power. EDF and AREVA have submitted an initial analysis report (Ref. 64) to support this design proposal, and have amended the PCSR Chapters 14.3-5 and 16.5. However, these have not been assessed in Step 4 and EDF and AREVA have not yet completed the impact assessment nor confirmed the final change categorisation as A1 or A2.

98 ND has no objection to the inclusion of this proposed design change in GDA. However, any further work required to progress this proposal including consideration of any INSA, will be taken forward through GDA Issue **GI-UKEPR-CC-02**.

99 **CMF-023** (Ref. 78) Addition of new reactor trip signals. This design change was initiated to implement lessons learnt from the Flamanville 3 and Olkiluoto 3 EPR projects on the provision of sufficient signalling to address functional diversity requirements for frequent faults.

100 This design change proposal by EDF and AREVA is for new signals to be provided on a diverse protection system to trip the reactor on low Reactor Coolant Pump (RCP) speed, High Neutron Flux, High hot leg pressure and high axial offset. This design change will reduce the time until the reactor trip occurs which is a positive development from a safety perspective and is fully supported by ONR. This change will also be beneficial for the case of EDF and AREVA's failing to trip the reactor following a Loss of Off-site Power

(LOOP) event or a forced reduction in flow fault. Further details of the assessment completed on this design change are given in our Fault Studies assessment report (Ref. 8).

101 Although EDF and AREVA have submitted an analysis report (Ref. 65) on functional diversity and amended PCSR Chapter 16.5 to support this design change proposal further work is required by them to complete the impact assessment for this design change and to confirm the Categorisation as A1 or A2.

102 The further assessment of this design change proposal will be progressed under GDA Issue **GI-UKEPR-FS-02** in the Fault Studies technical topic area (Ref. 8).

4.1.1.3 EDF and AREVA Proposal to Update UK EPR Design Reference Against a Revised FA3 Design Reference

103 The design changes considered in this section are those proposed by EDF and AREVA to update the UK EPR GDA design reference from the previous December 2008 version based on the FA3 design at that time, to a revised version based on the FA3 design at December 2010. This update would require the inclusion of around 100 A2 and 200 B category design changes within GDA (Ref. 70).

104 Documentation impacted by agreed GDA design changes including System Design Manuals (SDM) (Ref. 24) is to be updated by EDF and AREVA within GDA, unless justified otherwise and any outstanding impacted documentation will be transferred to site specific activities for completion.

105 The RP has delayed making the necessary amendments to SDMs in order to be able to capture the changes resulting from design changes agreed in GDA. One of the reasons for the delay is that EDF and AREVA wants to incorporate all relevant design changes, including these lower category FA3 proposed design changes into a revised design reference. However, these lower category design changes have not been assessed in GDA.

106 EDF and AREVA have developed a process for control of these proposed FA3 related design changes. These changes will not be subject to INSA as they are not categorised as A1. EDF and AREVA have proposed an alternative management process to the Change Management Form (CMF) and committed to conducting an impact analysis on each change. The information will be recorded and tracked to completion using a dedicated spreadsheet managed by EDF and AREVA, the joint procedure UKEPR-I-003 (Ref. 39) has been amended to reflect these arrangements.

107 The Regulators have agreed to consider the inclusion of these additional proposed FA3 related design changes in GDA post Step 4 and this will be taken forward through selection of a sample of A2 and B category design changes for technical and process review. Sampling is required to provide the Regulators with confidence in the application of EDF and AREVA's categorisation process and is an important consideration for the acceptance of these changes within GDA.

108 Although the Regulators have not requested the inclusion of these additional FA3 related design changes in GDA, if through sampling we do agree to the inclusion of some or all of them then any impacted documents associated with these agreed changes will be subject to the requirements of our GDA Issue **GI-UKEPR-CC-02** on the control of the GDA submission.

4.1.2 Findings / Conclusions – Design Changes and GDA Submission Update

109 From my assessment of Design Changes agreed for inclusion in GDA the following strengths were identified:

- For the purposes of the project, EDF and AREVA have robust arrangements for the identification and tracking of design changes agreed for inclusion in GDA.
- The safety justifications provided to support design changes agreed for inclusion in GDA are generally sufficient (excluding INSA as these have not been reviewed by the Regulators).

110 From my assessment of Design Changes agreed for inclusion in GDA the following observations were identified:

- The RP has established a categorisation system based on impact on the GDA submission in terms of safety, environment and security. The application of this categorisation process has not been tested at the lower level categorisations, A2 and B, within GDA as only a relatively small number of design changes have been agreed by the Regulators for inclusion in GDA, mainly A1. These have been assessed on a case by case basis.
- A future licensee shall have to develop and implement an appropriate design change categorisation process to meet nuclear site licence condition requirements.
- Although EDF and AREVA has arrangements for applying an INSA process in GDA for the highest category design changes (Category A1 normally), and this is in line with UK and international good practice, no evidence was provided within Step 4 of the output of this process. The output is important as it provides an independent view on the adequacy and sufficiency of the safety case for the design change proposal. As the adequacy of INSA process was not demonstrated in Step 4 this will need to be progressed through GDA Issue **GI-UKEPR-CC-02** Action 3.
- Some of the design changes agreed for inclusion in GDA cannot be fully implemented as supporting information will only become available during the nuclear site licensing and permissioning phase. This leads to the Assessment Finding:

  AF-UKEPR-CC-01: *A future EPR licensee shall ensure that design changes included in GDA are fully implemented into the UK EPR safety case. Milestone: During operational phase.*

- There will be a significant number of changes to submission documentation impacted by agreed GDA design changes. The RP will have to ensure that sufficient time is given in their Resolution Plan for GDA Issue **GI-UKEPR-CC-02** for the Regulators to carry out their sample assessment of these submission documents.

111 From my assessment of EDF and AREVA's proposal to update the GDA Design Reference Configuration through the inclusion of a large number of Category A2 or B, FA3 originated design changes the following observations are identified:

- Although the supporting information for these additional changes was not available within GDA Step 4 I have agreed to consider these through the assessment of a sample later within GDA.
- If as a result of my sample assessment I do not agree with either the categorisation applied or the adequacy of the supporting design change information, then these design change proposals will not be agreed for inclusion in the GDA design reference.

Consequently, if a future licensee wishes to take these additional design change proposals forward post GDA they shall have to work with the Regulators through appropriate licence design change arrangements. This leads to the Assessment Finding.

AF-UKEPR-CC-02: *A future UK EPR licensee shall ensure that any proposed generic updates to the UK EPR GDA design reference that have not been agreed in GDA are progressed through site licence condition requirements. Milestone: Fuel Load.*

4.2 Safety Function (SF) Categorisation and Structures, Systems and Components (SSC) Classification

4.2.1 Assessment of SF Categorisation and SSC Classification

4.2.1.1 Background to the Development of our Assessment

112 This section deals with the background of the development of our assessment of EDF and AREVA's methodologies, criteria and arrangements for SF Categorisation and SSC Classification within GDA. It is intended to complement the information previously presented in our Step 3 assessment reports (Ref. 9).

113 SF Categorisation and SCC Classification are important considerations across a wide range of technical topic areas to a greater or lesser degree. Hence, the progress of this subject as a Cross-cutting technical topic.

114 During GDA Step 3, initial discussions were held with EDF and AREVA on our expectations in this area. A summary of our Step 3 assessment is documented in our letter (Ref. 42). This letter outlined our expectations and approach to SF Categorisation and SSC Classification. Our expectations for SF Categorisation and SSC Classification are given in HSE's SAPs (Ref. 4) - specifically ECS .1 – ECS. 5 and paragraphs 148 – 161. For C&I and Electrical Systems further guidance is given in IEC 61226:2009 (Ref. 43).

115 A key element of both the SAPs (Ref. 4) and IEC 61226:2009 (Ref. 43) is that SF Categorisation is distinct from but strongly linked to SSC Classification and that the Classification approach should be applied consistently to all SSCs. The terminology Class 1, Class 2 and Class 3 should be applied to all SSCs across all technologies (example C&I, mechanical and electrical).

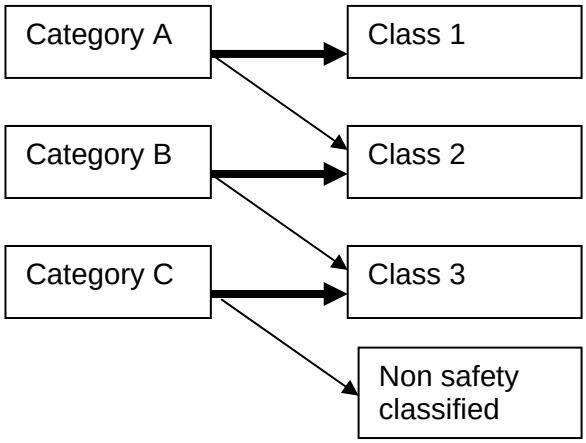
116 In the UK we view Safety Functions at the highest level and tend to be guided by what we call the three Cs – Criticality, Cooling and Containment and these are generic to all nuclear facilities and form an important basis of our regulatory approach.

117 The UK practice and our expectation is that EDF and AREVA would firstly categorise the safety functions with regard to their nuclear safety significance (Category A to C in decreasing importance) and then to classify the SSCs which deliver these functions with regard to their importance (Class 1 to 3 in decreasing importance).

118 Although SSC class can be mapped directly to SF Categorisation, as illustrated in Figure 2 below there may be exceptions. For example it is not necessarily the case that a Category A function must always be supported by a Class 1 system. Paragraph 154 of our SAPs allows Class 2 systems to contribute to fulfilling a Category A function. A key determining factor will be the deterministic claims made on the system and the likelihood of the function being called upon.

119 The Figure below presents a simplified illustration of the relationship between SF categories and SSC classes.

Figure 2: Simplified Illustration of the Relationship between SF Categories and SSC Classes



120 It is for EDF and AREVA to generate their own structure to reflect the principles described above, based on considerations of hazard and risk. This subject is important for the UK EPR design since it has a direct input into the definition of design requirements, procurement processes (specifically assurance activities), installation and commissioning activities, and is of particular importance to the Examination, Maintenance, Inspection and Testing (EMIT) requirements for SSCs during plant operations under a Nuclear Licence. EMIT is discussed further in Section 4.3 of this report.

121 Our Step 3 assessment of the GDA submission had shown, in some of the technical topic areas (for example Mechanical Engineering, C&I and Structural Integrity) that EDF and AREVA's system of SF Categorisation and SSC Classification was leading to a misalignment in comparison with the application of the UK's process as SF Categorisation should be regarded first, above all system classifications including seismic and mechanical.

122 EDF and AREVA identified four types of safety functions in the PCSR (Ref. 13); F1A, F1B, F2 and non-categorised. An F1A safety function is a function that is required for a Plant Condition Category (PCC) event to reach the controlled state. An F1B safety function is a function that is required to reach the safe shutdown state. F2 safety functions are claimed for Risk Reduction Category (RRC)-A and RRC-B sequences.

123 A system was classified by EDF and AREVA according to the safety functional requirements F1A, F1B, F2 or non-categorised. The resulting SSC Classification is based on the highest safety function it must perform. However, as there is generally a one to one relationship between the functions and the systems, the terminology F1A, F1B and F2 is used by EDF and AREVA for both SF Categorisation and SSC Classification.

124 From the information provided by EDF and AREVA it was difficult in GDA Step 3 for HSE ND to understand EDF and AREVA's approach and the order in which they derive SF Categorisation and SSC Classification. Additionally, the EDF and AREVA system of classifying mechanical systems appeared to result in a significant anomaly in that their

M1, M2 and M3 Classification referred only to the integrity of the mechanical system pressure boundary and there appeared to be no classification system for the mechanical systems in their role of delivering a safety function.

125 This contrasts with the control and instrumentation systems where EDF and AREVA use different nomenclature (E1A, E1B and E2) for the safety classification of systems, compared to the nomenclature for the safety functional requirements (F1A, F1B and F2). It differed again for electrical systems where the nomenclature EE1 was used to cover both F1A and F1B safety functions and EE2 for F2 safety functions. Whereas for mechanical systems the SF Categorisation and SSC Classification are identical.

126 Additionally, after EDF and AREVA assign safety class to an SSC they then assign design requirements as appropriate in the following areas:

- Seismic design.
- Civil Structure design.
- Mechanical design and manufacturing.
- Electrical and I&C design.
- Qualification.

127 The design requirements applicable to an SSC also depend on other factors, such as the type of SSC (i.e. whether it is a structure, a system or a component), and its safety role and associated functional requirements.

128 For GDA the design requirements are normally specified in French EPR construction codes ETC-C, RCC-M, RCC-E etc. (Refs 44 - 46) However, some items such as diesels, lifting equipment and ventilation systems are not covered by these codes and for these the design requirements are addressed in specific books of technical specifications (BTS) (Ref. 30) or other specifications.

129 Different requirements may be applied depending on the role of the SSC or Safety Functional Group (SFG). Typical requirements are stability, integrity, operability, functional capability or some combination of the latter.

130 The GDA Step 3 assessment also identified the following concerns:

- Our preliminary review of the engineering standards applied to M3 shows that they are more closely aligned to commercial standards than we would expect for items important to safety required to perform F1A or F1B safety function.
- For C&I systems EDF and AREVA appeared to have a strong basis for both SF Categorisation and SSC Classification, with F1A, F1B and F2 for safety functions and E1A, E1B and E2 for SSC Classifications. However, these do not fully align with our SAPs (Ref. 4) or relevant international C&I standards i.e. BS IEC 61513 (Ref. 48) and BS IEC 61226:2005 (Ref. 49). This concern was initially raised with EDF and AREVA as part of our Regulatory Issue **RI-UKEPR-02** (Ref. 12).
- In parts of the PCSR Chapters for C&I systems, the E1A, E1B and E2 are largely ignored and instead F1A, F1B and F2 are used interchangeably for both SSC Classification and SF Categorisation. This also applies to much of the supporting documentation supplied in this topic area.
- For electrical systems EDF and AREVA have the usual three SF Categorisations F1A, F1B and F2 but then map them onto 2 Classes (EE1 and EE2). No reason was given in the PCSR why this differs to the closely related C&I Classification approach. Similar

comments applied to the ventilation functions and systems, where we noted another variation in the PCSR. In this area EDF and AREVA have two safety functions F1 and F2 and there appears to be a mapping of the F1 functions to the M2/M3 mechanical classification scheme.

- The safety functions for the buildings have a single safety classification scheme (C1).

131 Our Step 3 inquiries also brought into focus the differences between the French and UK processes. Both have been derived through extensive developments over many years from the design, construction, operation and decommissioning of nuclear facilities and can claim to be consistent with international practice. However there are differences and the application of our SAPs has produced conflicting outcomes in terms of SF Categorisation and SSC Classification.

132 In our meetings with EDF and AREVA the UK approach was explained. The history of the modern AGRs and Sizewell B is that for all frequent faults identified within the Design Basis Accident Analysis (DBAA), protection is provided by two diverse Class 1 safety systems. For more infrequent DBAA faults, the practice has been one Class 1 system often supplemented by other systems of lower class for probabilistic risk reduction targets, but these are rarely Class 3 SSCs. The consideration of PSA requirements also highlights a difference between the UK and French practice. In the UK we supplement the functional link from Category to Class with probabilistic targets. The links between PSA (given here as probability of failure-on-demand, *pfd*) and SSC Class for C&I, is given by the following inequalities: Class 1 $10^{-5} \leq pfd \leq 10^{-3}$ Class 2 $10^{-2} \leq pfd < 10^{-3}$ Class 3 $10^{-2} < pfd \leq 10^{-1}$.

133 Our findings at the end of GDA Step 3 were that EDF and AREVA should use the F1A, F1B and F2 (or equivalent) nomenclature for purely safety functional analysis of the safety requirements for all safety functions regardless of the technological type. A consistent classification scheme should be applied to all SSCs, similar to those used for the C&I and mechanical systems where you relate the safety functions (not always one-to-one) to three SSC Classes. This scheme should be applied to all SSCs.

134 Following our letter and further discussions with EDF and AREVA on this topic we raised a Regulatory Observation RO-UKEPR-43 (Ref. 11) to capture our concerns.

135 RO-UKEPR-43 provided a summary of the key findings of our assessment completed in Step 3 and had 3 actions listed below:

A1.1	Provide a revised PCSR Sub-Chapter 3.2 to demonstrate that the functional safety requirements remain distinct from that of the SSC safety classification.
A1.2	Provide further clarification and evidence to support adequacy of application of M1,M2 and M3 Classifications to ensure delivery of SF requirements
A1.3	Incorporate above information in a consolidated GDA EPR PCSR and important references such as the UK EPR Fault Schedule.

4.2.1.2 Assessment

136 This section deals with the assessment of EDF and AREVA's methodologies, criteria and arrangements for SF Categorisation and SSC Classification within the UK GDA design.

137 Our Step 4 assessment commenced with the issue of RO-UKEPR-43 (Ref. 11) and its summary of our assessment concerns. I co-ordinated the generation of this Regulatory Observation and the actions within it, and I have participated in subsequent meetings to progress the resolution of the topic.

138 In response to the RO, EDF and AREVA submitted a letter (Ref. 50) with 2 reports, NEPS-F DC 557 Rev A (Ref. 52) *Classification of Structures* in response to RO-UKEPR-43-A1, and ENSNDR100104 Rev A Justification of the adequacy of engineering standards (Ref. 62) in response to RO-UKEPR-43-A2. Also included at appendix B to report NEPS-F DC 557 Rev A (Ref. 52) was a Fault Schedule for accidents identified in Chapters 14 and 16 in the PCSR, (Ref. 13).

139 I assessed EDF and AREVA's report NEPS-F DC 557 Rev A (Ref. 52) and noted that significant progress has been made, with EDF and AREVA developing its SF and SSC methodologies to move towards alignment with our expectations and international good practice. EDF and AREVA moved towards the adoption of the A, B and C graded approach for SF Categorisation and 1, 2 or 3 for classification of all SSCs regardless of the technology type. However, they retained the use of F1A, F1B and F2 as both SF Categorisation and system classifications in parts of their documentation and this resulted in some confusion during our assessment.

140 In several technical topic areas, namely Structural Integrity, Mechanical Engineering, Fault Studies, Internal Hazards, Civil Engineering, Electrical and C&I, further evidence was required by ND to demonstrate the adequacy of EDF and AREVA's SF and SSC methodologies and their application throughout the developing GDA design.

141 The Step 4 assessment of each of these technical topic areas is summarised below.

4.2.1.3 Fault Studies

142 This topic area lead in the assessment of EDF and AREVA's demonstration of the adequacy of diversity provisions within the UK EPR GDA design. This assessment was initiated through RO-UKEPR-41 (Ref. 11) and further details are provided in our Step 4 Fault Studies assessment report (Ref. 8). The assessment in this technical topic area is closely linked to SF Categorisation and SSC Classification.

143 The provision of SSCs to mitigate the consequences of accident conditions, identified in PCSR (Ref. 13) Chapters 14 and 16 was found to be in line with our expectations. This demonstrated the adequacy and sufficiency of SSCs in the UK EPR to provide a primary or diverse means of ensuring delivery of the safety functions of cooling, containment or criticality control.

144 In response to RO-UKEPR-41, EDF and AREVA provided a Fault Schedule (Ref. 52) to supersede the version presented in Chapter 14.7 of the PCSR (Ref. 12) and this was assessed by our Fault Studies team against SAP ESS.11 who concluded that its structure and intent meet our expectations. (Ref. 8).

145 The Fault Schedule provides a useful and concise summary of the design basis safety case for all PCC and RRC-A events. Faults are identified and referenced, frequencies attributed. Additionally, front line SSCs claimed to provide safety functions are identified (together with their safety classification). However, it was noted that the Fault Schedule

did not include internal or external hazards as initiating events within the design basis safety.

146 In addition to identifying the principal SSCs to fulfil Safety Functions, diverse SSCs are identified for frequent faults to provide the same Safety Function and the Fault Schedule also provides visibility of the application of SSC Classification to the EPR design allowing HSE ND to easily identify those SSCs whose safety classification could potentially fall short of expectations outlined in SAP ECS.2.

147 The Fault Schedule illustrates that many of the SSCs that provide diverse protection to frequent faults are the same as those claimed for equivalent RRC-A faults. In the original UK EPR design, SSCs claimed for RRC-A events had a minimum classification of Class 3 (F2). HSE's expectation of the safety classification for a SSC that makes a significant contribution (but not the principal means) to fulfilling a Category A safety function is Class 2.

148 In my letter EPR70232R (Ref. 55) EDF and AREVA were requested to extend the Fault Schedule to include internal and external hazards as initiating events and to justify the allocation of Class 3 to diverse shutdown systems.

149 The EDF and AREVA response to these 2 questions were received late in GDA Step 4 (Ref. 53) and these 2 outstanding queries will be progressed within GDA through Cross-cutting GDA Issue **GI-UKEPR-CC-01** Actions 3 and 5 below:

> ***GI-UKEPR-CC-01.A3:*** *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.*
>
> ***GI-UKEPR-CC-01.A5:*** *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.*

150 The complete GDA Issue **GI-UKEPR-CC-01** and associated actions are formally defined in Annex 2 of this report

151 During the writing of the Fault Studies Step 4 report a question was raised with EDF and AREVA concerning the classification of the spent fuel cooling pool system. 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.

152 The spent fuel pond 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 UK EPR PCSR claims "break preclusion" for the M2 piping upstream of isolation valves.

153 This leads to an additional action on Cross-cutting GDA Issue **GI-UKEPR-CC-01,** Action 7, as follows:

> ***GI-UKEPR-CC-01.A7:*** *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.*

154 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.

155 In summary, in the Fault Studies technical topic area EDF and AREVA have made significant progress in developing SF Categorisation and SSC Classification methodologies and capturing these within the Step 4 consolidated PCSR (Ref. 15) and supporting references. These now generally align well with UK expectations and international good practice. However, further work is required in some areas to apply the application of these methodologies throughout the GDA design and this will be progressed via **GI-UKEPR-CC-01** Actions 3, 5 and 7.

4.2.1.4 Civil Engineering and External Hazards

156 The classification of civil structures is a relatively simple task, and there were few concerns over the original scheme. The PCSR (Ref. 13) as written currently is based on the Flamanville 3 schedule of structures and this will require updating to reflect the specific claims made for any individual UK site. The civil structures requirements apply only to structures and are not applicable to systems or components.

157 Civil structures have two main objectives:

- Protecting systems/components against hazards;
- Providing a barrier to the release of radioactivity.

158 Two requirement levels (C1, C2) are defined for Civil Structures as follows:

- Generally speaking, civil structures which house or support Class 1 or 2 components or Class 3 components which have a barrier role, are classified at Safety Class 1 and must meet C1 requirements. An exception is the turbine hall that is classified at Safety Class 2 and must meet C2 requirements.
- Civil structures which ensure a containment function are also classified as Safety Class 1 and must meet C1 requirements.
- Civil structures, whose failure could impair the integrity of Class 1 structures or those structures which house Class 3 components, are classified as Safety Class 2 structures and must meet C2 requirements.

159 EDF and AREVA's initial response to RO-UKEPR-43 (Ref. 11) was presented in report N° NEPS-F DC 557 rev A (Ref. 52) and this was reviewed by the civil engineering assessor and the following requests for further information were provided to EDF and AREVA as Actions 2, 3 and 4 of my letter EPR70232 (Ref. 55).

160 Action 2 - Clarification was sought in Step 4 through some TQs (Ref. 10) on the classification of internal structures within buildings. The responses provided should be added into an update of the GDA PCSR or site specific PCSR.

161 Action 3 - In report N° NEPS-F DC 557 rev A (Ref. 52), reference is made to “dedicated rules” for the design of C2 structures. In the work undertaken to date no such “dedicated rules” have been identified, instead, ETC-C (Ref. 44) has been used for all structures and sub components examined thus far. Further clarification of what is meant by “dedicated rules” is required.

162 Action 4 - An initial review of the Fault Schedule (Ref. 52) has not revealed any specific reference to external hazards. Whilst it is clear that the majority of hazards can be protected against by the envelope of building structures, for some other hazards such as seismic this is not the case. Consideration of external hazards in the fault schedule is required and this has already been discussed in the fault studies section of this assessment report and will be taken forward through GDA Issue Action **GI-UKEPR-CC-01.A3**.

163 In response to my letter, EDF and AREVA submitted a revised version of report NEPS-F DC 557 to rev C (Ref. 59) and through their letter (Ref. 57) provided commitments to address Actions 2 and 3 through updates to PCSR Chapter 3.2, and 3.3.

164 The PCSR update (Ref 15) included the table below showing the mapping between civil structures safety classes and civil structures requirements levels.

Civil Structure Safety Class	Civil Structure Requirements Level	Codes and Standards	Seismic Requirements
1	C1 (main structures)	ETC-C	SC1
	C1 (other structures)	Dedicated rules	SC2 as far as necessary (1)
2	C2	Dedicated rules	SC2 as far as necessary (1)

(1) SC2 requirements apply to buildings/structures that protect or whose failure can have unacceptable impact on SSC with an SC1 requirement. In particular, if the collapse of a structure/building can directly or indirectly have unacceptable impact on SSC designed with an SC1 requirement (domino effect), this structure/building must be designed with an SC2 requirement. Unacceptable impact may result from the internal hazards subsequent to an earthquake (see Section 5.1.2).

165 These updates to the PCSR arrived too late for us to consider in our Step 4 reports and these outstanding matters will be progressed through a GDA Issue action.

166 The action is:

> ***GI-UKEPR-CC-01.A2:*** *The responses to GDA TQs 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.*

167 In summary, progress has been made in the Civil Engineering and External Hazards topics areas by EDF and AREVA to provide evidence of the application of its methodology for the classification of civil structures. This methodology now aligns well with our expectation. However, further work is required in GDA to confirm the incorporation of this methodology in the GDA PCSR and to include hazards in the GDA EPR Fault Schedule and these matters will be progressed through actions under the Cross-cutting GDA Issue **GI-UKEPR-CC-01**. The complete wording of the SSC Classification GDA Issue is provided in Annex 2 of this report.

4.2.1.5 Electrical Engineering

168 Initially, in this topic area the EDF and AREVA arrangements for classification of electrical items were not aligned with UK or international good practice, which recommends the use of three safety classes. The EDF and AREVA system has 2 safety classes, EE1 and EE2, where the former covers both Class 1 and 2, and the latter (EE2) covers Class 3 SSCs. ND found it difficult to find the differentiation between EE1 and EE2 and our view was that this differentiation was not adequately covered in the RCC-E code (Ref. 46). The EDF and AREVA response (Ref. 50) to our RO-UKEPR-43 (Ref. 11) on this gap in RCC-E included some examples of more detailed specifications. However, our examination of these showed that other than seismic requirements there appeared to be little difference in the specifications of EE1 and EE2 systems.

169 Subsequently I requested EDF and AREVA to provide further information to address this matter. Action 6 of my letter (Ref. 55) requested EDF and AREVA to provide more documentary evidence to demonstrate that the difference between EE1 and EE2 systems is much broader than seismic requirements as system architecture, single failure criterion, component integrity, diversity, qualification of SMART instruments etc. need also to be considered.

170 In response to this EDF and AREVA (Ref. 53) provided a commitment to update report NEPS-F DC 557 to provide further clarification with regards to the differences for design requirements between Class 1, 2 and 3 electrical systems.

171 This will be progressed through the following GDA Issue action.

> ***GI-UKEPR-CC-01.A8:*** *EDF and AREVA to provide further clarification with regards to differentiation elements for Class 1/2/3 electrical systems both in terms of systems architecture and electrical components design.*

4.2.1.6 Internal Hazards

172 The assessment in this topic area focused on the robustness of the application of Safety Function Categorisation to the UK EPR design against internal hazards. For internal hazards EDF and AREVA utilised F1A, F1B and F2 to signify both SF Categorisation and SSC Classification and this is discussed further in our Step 4 Internal Hazards report (Ref. 8).

173 Our main concern in this topic area was that the information provided in NEPS-F DC report 557 Revision A Appendix C was confusing and not consistent with the approach provided in the Fault Schedule (Ref. 52).

174 The practice in the UK is that internal hazards are initiating events and therefore they should be covered in the Fault Schedule. Such an approach will give far greater clarity to the class of SSC called upon to respond to these important events.

175 I requested EDF and AREVA to address this shortfall as Action 7 in my letter (Ref. 55). The action required EDF and AREVA to include the credible internal hazards into the Fault Schedule structure and from that derive the Safety Functions and SSC Classifications.

176 Actions 4 and 7 of my letter were subsequently combined as a single action for EDF and AREVA to include hazards (internal and external) as initiating events in the UK EPR Fault Schedule and this will be progressed through a GDA Issue action. This action has been

discussed in the External Hazards and Fault Studies sections of this report and will be progressed in GDA through GDA Issue Action **GI-UKEPR-CC-01.A3.**

177 In summary, much progress has been made in this topic area but further work is required in GDA through the action associated with **GI-UKEPR-CC-01** to provide further evidence of the application of EDF and AREVA's SF Categorisation and SSC Classification methodologies to the UK EPR GDA design.

4.2.1.7 Control & Instrumentation

178 The detailed assessment of the application of SF Categorisation and SSC Classification to the C&I aspects of the developing GDA EPR design is given in our Step 4 C&I assessment report (Ref. 8)**.** That report also provides background to how this topic was linked to, and originated from, our Regulatory Issue **RI-UKEPR-02** (Ref. 12).

179 The detailed assessment in the C&I technical area included a review of the company level (i.e. non-project specific) standards and guidance for C&I for Systems Important for Safety (SIS). These were compared against recognised good practice as defined in a suite of international standards produced by the International Electrotechnical Commission (IEC) based in Geneva.

180 The French Association standard for design, construction and in-service inspection code for nuclear island components is titled 'RCC-E' (Ref. 46), referred to by EDF and AREVA as the design code for C&I Systems Important to Safety (SIS), our review revealed it provides necessary but not sufficient requirements and guidance for specification of the C&I SIS requirements for a UK EPR.

181 Additionally, when ND reviewed EDF and AREVA's initial response to RO-UKEPR-43 (Ref. 11) we raised several queries concerning consistency between their report 557 Rev A (Ref. 52) and standard IEC 61226:2009 (Ref. 43). We requested EDF and AREVA to provide further evidence to meet our expectations and/or to justify the approach in this area.

182 In response to these queries EDF and AREVA provided a commitment (Ref. 53) to update Report 557 and or PCSR Chapter 3.2 to improve consistency with the standard.

183 EDF and AREVA subsequently revised report NEPS-F DC 557 (Ref. 57) and PCSR Chapter 3.2 (Ref. 15). However, these have not been assessed by ND.

184 Work outstanding associated with the application of EDF and AREVA's SF Categorisation and SSC Classification methodologies to the developing EPR GDA C&I design will be progressed through the following GDA Issue action:

> ***GI-UKEPR-CC-01.A6:*** *EDF and AREVA to ensure that categorisation of C&I systems is consistent with current good practice as provided by IEC61226:2009 'Nuclear Power Plants – Instrumentation and Control Systems Important to Safety – Classification'.*

185 In summary, progress has been made in the C&I topic area and EDF and AREVA claim that their SR Categorisation and SSC Classification methodologies apply across all technical topic areas including C&I. However, further evidence will be required in GDA to demonstrate the application of these methodologies within the developing UK EPR C&I design and this will be progressed through Cross-cutting GDA Issue **GI-UKEPR-CC-01** Action 6.

4.2.1.8 Mechanical Items (not pressurised components)

186 The responses to RO-UKEPR-43 (Ref. 11) by EDF and AREVA in this technical topic area have been positive (Ref. 50) and (Ref. 53). In developing their SSC methodology EDF and AREVA now recognise the need to classify mechanical equipment based on the totality of its engineering safety functionality, and not simply on its pressure boundary containment safety function.

187 As a consequence EDF and AREVA have now started to assign appropriate SSC Classification 1, 2 and 3 to major items of mechanical equipment, such as the Polar Crane and Control Rod Drive Mechanisms (CRDM). These are now included in the SSC listings in report NEPS-F DC 557 rev C (Ref. 57) and this compares well with the expectations in our SAPs (ECS.1 and ECS.2). However, the application of this process needs to be extended to include other major mechanical items, specifically including “duty systems”.

188 ”Duty systems” are referred to as Safety Related Systems (SRS) within the ND Technical Assessment Guides, (Ref. 8) and need to be classified at an appropriate level. These ‘duty’ systems represent the normal operational equipment used within a Nuclear Power Plant (NPP), but whose failure could affect important safety functions (i.e. reactivity control, heat transfer and removal, and containment), and is typically the initiating event within a fault sequence. An example of such a ‘duty’ system is the Main Feedwater System (MFWS) which includes heat exchangers, pumps and valves.

189 The safety classification approach to SSCs set out in report NEPS-F DC 557 C (Ref. 57) is driven by the functional categorisation required of safety systems (SS) to act in response to and protect against PCC-2 to PCC-4 (and RRC) faults.

190 Safety classification, as required by SAP ECS.2, is a separate issue to that of system classification as Safety Systems (SSs) and SRSs. SS and SRS definitions are purely functional, and do not imply any particular level of integrity. Safety classification on the other hand relates to the consequence of system failure and to the failure frequency requirements placed on the systems in the safety analysis. SRSs should be allocated an appropriate safety classification.

191 The importance of the design, integrity, redundancy etc of the duty / operational systems to the initiating event frequency is also important. Table 13 of NEPS-F DC 557 C (Ref. 57) already identifies the safety classification and design requirements of UK EPR SSCs. The consequences of an alternative safety classification to that allocated in NEPS-F DC 557 C should be considered i.e. could the initiating fault frequency change, resulting in alternative PCC allocation and different safety criteria, decoupling criteria, diversity requirements, radiological consequences targets etc.

192 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.

193 In summary much positive progress has been made in this technical topic area. However further evidence is required of the application of EDF and AREVA’s SF categorisation and SSC classification methodologies to the GDA design and this will be progressed in GDA through the actions associated with the Cross-cutting GDA Issue **GI-UKEPR-CC-01.** Action 1.

194 The GDA Issue Action **GI-UKEPR-CC-01.A1** requires EDF and AREVA to review all the PCC-2 to PCC-4 initiating events and identify any duty systems that require safety classification, or an alternative safety classification to that presented in report NEPS-F DC 557 C. (Ref. 57)

4.2.1.9 Structural Integrity - Pressurised Mechanical Components

195 The UK EPR classification system is described in the PCSR Chapter 3.1, Section 1.2.5 (Ref. 15) where a functional approach is adopted using three steps:

- Identify Safety Functions and assign categories based on their importance to safety.
- Identify the Safety Functional Groups of SSCs which fulfil the Safety Functions, and assign a classification based on the importance of the safety functions they perform.
- Link the classification to a set of requirements for design, construction and operation which will ensure that the SSCs perform the safety functions expected at the required level of quality.

196 This classification concept is supplemented by a "barrier"-type approach relating design and manufacturing requirements to the potential for radioactive release in the event of failure.

197 Three design requirement levels M1, M2 and M3 are defined for pressurised mechanical components. Class 1 components must normally meet M2 requirements, but upgrading (to M1) or downgrading (to M3) is allowed according to defined criteria.

198 The mechanical requirements M1, M2 and M3 relate directly to the design level in the design code or standard to be applied. The mechanical quality requirements for pressurised equipment imply the following design codes / standards:

- M1 requires application of RCC-M Class 1.
- M2 requires application of RCC-M Class 2 or ASME III with supplements.
- M3 requires application of RCC-M Class 3 or harmonised European standards with supplements, the quality level being equivalent. The supplements bridge the gap between these European standards and RCC-M Class 3 but have not been available during the GDA process as they are being rewritten following feedback from the Flamanville project.

199 One of the findings in this topic area (Ref. 8) is that EDF and AREVA apply a Classification system, M1, M2 and M3, based largely on the integrity of the pressure boundary and on numerous occasions the lowest nuclear safety classification, M3, has been applied to systems with F1A and F1B (category A or B) Safety Functions.

200 Additionally, our preliminary review of engineering standards applied to M3 shows that they may more closely align to commercial standards than we would expect for SSCs required to perform F1A or F1B Safety Functions. This is contrary to our expectations as outlined in our SAPs Principle ECS.3 and Paragraphs 158 to 160 (Ref. 4) which specify that nuclear-specific codes and standards should be used for Class 1 or Class 2 components.

201 We required EDF and AREVA to ensure that the safety functional categorisation requirements remain distinct from those of the SSC safety classifications. We also asked that they provide further clarification and evidence, including design specifications and standards as necessary, to demonstrate that the application of M1, M2 and M3 design classifications is sufficient to ensure delivery of Safety Functional (SF) requirements.

202 A further meeting was held on 20/21 May 2010 after which EDF and AREVA sent a letter (Ref. 50) with two associated reports (Ref. 52) and (Ref. 62).

203 The information provided by EDF and AREVA demonstrated they were now applying Class 1, 2 or 3 to Pressurised Mechanical Component SSCs however, they then assign component quality requirements M1, M2 or M3 from RCC-M (Ref. 45) to these to specify the design requirements as illustrated in the table below. Their response did not address our concerns with respect to the criteria for downgrading from M2 to M3, as laid out in report NEPS-F DC 557 Rev A (Ref. 52), and no justification was provided to support the proposed allocation of M3 to Class 1 SSCs.

204 These issues were progressed by my letter (Ref. 55).

Table 3

EDF and AREVA Rules for Allocation of Design Standard Requirements to PMCS

Component Safety Class	Part of RCPB or HIC?	Mechanical Requirement	Design Standard Applied	Quality Assurance
1	Yes	M1	RCC-M1	Yes
	No	M2	RCC-M2 or ASME III with supplements or KTA with supplements	Yes
	No	M3	RCC-M3 or Harmonised European Standards with supplements or any code compliant with PED, with supplements	Yes
2	No	M3 (*)	RCC-M3 or Harmonised European Standards with supplements or any code compliant with PED, with supplements	Yes
3	No	NC (**)	Harmonised European standards (Compliant with PED)	Yes

(*) Class 2 components may need to meet M2 requirements if they have a barrier role

(**) Class 3 components may need to meet M2 or M3 requirements if they have a barrier role

205 Referring to the table above the SIS accumulators were identified as a particular example where we were not convinced that M3 Classification was appropriate, since they are part of a Safety Class 1 (F1A) safety injection system.

206 The accumulators are large pressure vessels with substantial quantities of hot water and pressurised nitrogen gas (47 bar with 32 tonnes water and 15m^3 nitrogen) and hence with considerable stored energy such that their gross failure would lead to extensive damage. However, only limited assessment has been made of the effects of gas and water release.

207 The accumulators are also currently included in RCC-M 2007 Table C2200 which implies they should be classified as M2. It is noted that in the Finnish and American EPR designs

the accumulators are assigned an ASME Class 2 Classification equivalent to RCC-M (M2).

208 Our assessment of SIS accumulator integrity is addressed in Section 4.2.2 of our Step 4 Structural Integrity assessment report (Ref. 8). The assessment in that report concludes that the mechanical Classification M3 has not yet been adequately justified and that the consequences of gross failure have not been fully analysed and further evidence is being requested under Internal Hazards under GDA Issue Action **GI-UKEPR-IH-04.A1** which concerns the consequence of failure of RCC-M designed/manufactured components (Ref. 8).

209 In response to my letter (Ref 55), EDF and AREVA agreed to revise their classification criteria which allows downgrading to M3 requirements for some Class 1 components provided that none of the requirements for a higher M application apply and to include for each case where an M3 requirement is applied to a Class 1 component, the justification that has led to this assignment.

210 In January 2011 ND received a revised version of the Classification Report (Ref. 59) which provided the rules to be applied in allocation M1-M3 design requirements to Class 1, 2 or 3 SSCs. The report stated that:

> *"Class 1 components must meet M2 requirements unless the following rules apply:*
>
> *Upgrading to M1 requirements must be made if any of the following two conditions are met:*
>
> *- The components is part of the Reactor Coolant Pressure Boundary [RCPB],*
>
> *- The component is a High Integrity Component*
>
> *Downgrading to M3 requirements may be made only when it can be shown that the failure of the component wouldn't lead to unacceptable consequences.*
>
> *Class 2 components must meet M3 requirements unless higher requirements apply due to the barrier role of the component.*
>
> *Class 3 components do not need to meet M1, M2 or M3 requirements (i.e. they do not need to be mechanically classified) unless mechanical requirements apply due to the barrier role of the component."*

211 This update to the criteria for allocation of design requirements to SSCs is more in line with our expectations than the previous version. However, ND expects EDF and AREVA to justify that the revision to report NEPS-F DC 557 and PCSR Sub-Chapter 3.2 is consistent with ND SAPs, specifically ECS.3 and supporting paragraphs 157-161. This applies particularly to the criteria which allow M3 requirements for some Class 1 systems.

212 ND also expects EDF and AREVA to justify each case where an M3 requirement is applied to a Class 1 system. This justification should explain which criteria are applicable to allow the system to be M3, taking account of the safety significance of the SSC. Additionally it should be confirmed that consequences of failure of the pressure boundary have been considered in terms of both the loss of system function and impact on the internal hazards safety case.

213 The further work required in GDA by EDF and AREVA to provide evidence to demonstrate the adequacy of the design requirements for Class 1 and 2 SSCs will be progressed via Cross-cutting GDA Issue **GI-UKEPR-CC-01** Action 4.

214 The second concern in this topic area was with the argued equivalence of RCC-M M3 to Harmonised European Standards (HES) (Ref. 62) plus supplements. On this basis it was argued that components with mechanical Classification M3 could be built to harmonised European standards plus supplements.

215 My letter to EDF and AREVA (Ref. 55) explained that this concept did not appear to be consistent with our SAPs (Ref. 4) which indicate in paragraphs 158 and 159 that nuclear-specific codes or standards should be adopted for Class 1 and 2 components, whereas non-nuclear-specific codes and standards may be applied for Class 3 components. Even if European Codes plus supplements may be argued to be equivalent to RCC-M Class 3, we would normally only expect such an arrangement for Class 3 components.

216 However, where the European harmonised standards are intended to be used for Class 1 or Class 2 components EDF and AREVA offered to provide further justifications to demonstrate that the systems in which they are used do not place high demands (e.g. temperatures, pressures) on the components or that the reliability claims for the system do not place undue expectations on the integrity of the components.

217 Report N° NEPS-F DC 557 rev A (Ref. 52) has some Safety Class 1 components listed in Table 14 which are intended to be built to European harmonised standards plus extra requirements (i.e. a non-nuclear code). These Class 1 SSCs now have some judgements made against them as to why they can be made to European Harmonised Standards (EHS). The EDF and AREVA report did not address the use of European harmonised standards for Class 2 SSCs.

218 Our position here is that EDF and AREVA should justify the use of harmonised European standards plus supplements as being adequate when compared to RCC-M mechanical Class M3. This justification needs to demonstrate consistency with ND SAPs specifically, ECS.3 and supporting paragraphs 157-161. The work to further address this structural integrity Classification issue will be progressed as part of the Cross-cutting GDA Issue on Classification **GI-UKEPR-CC-01**.

219 To progress this matter further a meeting was held with EDF and AREVA on 28 March 2011. At this meeting we reminded EDF and AREVA that the level of QA arrangements applied to the design, manufacture, installation, commissioning and operation of all SSCs will be commensurate with the safety classification of these items in line with the graded approach to QA defined in IAEA GS-R-3 and the supporting guide GS-G-3.1 (Ref. 16). This is a matter that shall be taken forward by a future licensee. This leads to the Assessment Finding:

> ***AF-UKEPR-CC-03:*** *A future UK licensee shall ensure that the level of QA arrangements applied to the procurement, design, manufacture, installation, commissioning and operation of all SSCs will be commensurate with the safety classification of these items in line with the graded approach to QA defined in IAEA GS-R-3 and the supporting guide GS-G-3.1. Milestone: Long lead items and SSC procurement specifications.*

220 At this meeting we also raised with EDF and AREVA the problem of the Manufacturer taking responsibility under EHS whereas it should be the Licensee. This leads to the Assessment Finding:

> ***AF-UKEPR-CC-04:*** *A future UK licensee shall be responsible for the management of the application of Harmonised Standards plus supplements to any SSCs for the UK EPR. Milestone: Long lead items and SSC procurement specifications.*

221 Following this meeting EDF and AREVA provided the following written commitments for the application of design codes to Class 1 and 2 SSCs in GDA: (Ref. 71).

Class 1 SSCs

- Nuclear codes only to be used
- Where M3 proposed for components in a Class 1 system justification to be provided in update to report NEPS-F DC 557.

Class 2 SSCs

- Where M2 used before this will not change.
- EDF and AREVA still propose to use EHS plus supplements for M3 items, but there will be a component by component review taking into account function and consequences of failure. A more extensive document will be provided on the similarities and differences between RCC-M3 and EHS plus supplements.

222 These commitments are welcomed by ND and although these are not captured in the Step 4 consolidated PCSR (Ref. 15) they represent significant progress and these matters will be progressed within GDA through Cross-cutting GDA Issue **GI-UKEPR-CC-01** Action 4.

223 Action **GI-UKEPR-CC-01.A4** requires 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 1 or 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 1 or 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.*

224 In summary, positive progress has been made in this technical topic area and our concerns are now primarily associated with EDF and AREVA's assignment of design and manufacturing requirements identified in French nuclear code (RCC-M) (Ref. 45) which refer to the application of European Harmonised Standards plus supplements for some SSCs. In this area the recent confirmation provided by EDF and AREVA (Ref. 71) that nuclear codes will be applied to Class 1 SSCs is welcomed as is also the decision to

upgrade the design requirements for the Class 1 SSC UK EPR accumulators from M3/ European Harmonised Standards + supplements to M2 and this now aligns well with our SAPs (Ref. 4).

225 Regarding the application of non nuclear codes for the design and manufacturing of Class 2 SSCs, this topic will be progressed further in GDA through Cross-cutting GDA Issue **GI-UKEPR-CC-01** Action 4.

4.2.2 Assessment Conclusions - Safety Function (SF) Categorisation and Structures Systems and Components (SSC) Classification

226 EDF and AREVA have made significant progress in GDA Step 4 in developing their methodologies and criteria for SF Categorisation and SSC Classification from those presented in the earlier PCSR (Ref. 13) and supporting references and these now broadly align with UK and international standards and relevant good practice.

227 Within GDA Step 4 EDF and AREVA have made significant progress in developing and applying their methodologies and criteria for SF Categorisation and SSC Classification to the UK EPR GDA design and these changes have been captured in part in the Step 4 consolidated PCSR (Ref. 15).

228 The graded approach now adopted by EDF and AREVA for SSC Classification in the UK EPR GDA submission, at a principle level, is consistent with UK and international standards and relevant good practice.

229 However, further work is required to apply these through the developing UK EPR design to include any areas impacted by design changes already agreed for inclusion in GDA or arising from GDA Issue Resolution Plans. This will be progressed in GDA through Cross-cutting GDA Issue **GI-UKEPR-CC-01 -** see Annex 2 for details.

230 The application of design requirements to SSCs from EPR design codes ETC-C, RCC-E and RCC-M has raised some regulatory concerns, for example the allocation of RCC-M M1-M3 design requirements to Class 1 and 2 SSCs. In the case of RCC-M design requirements a way forward has been agreed with EDF and AREVA and this will be progressed through Cross-cutting GDA Issue **GI-UKEPR-CC-01** Action 4. Whilst issues associated with ETC-C and RCC-E will be progressed through GDA issues in the civil engineering and electrical engineering topic areas and or as part of site licensing activities.

231 It is our expectation that the Quality Assurance (QA) arrangements applied to the design, manufacture, installation, commissioning and operation of all SSCs will be commensurate with the safety classification of these items, in line with the graded approach to QA defined in IAEA GS-R-3 and the supporting guide GS-G-3.1 (Ref. 16). This is a matter that will need to be taken forward by a future licensee. This leads to the Assessment Finding:

> ***AF-UKEPR-CC-03:*** *A future UK licensee shall ensure that the level of QA arrangements applied to the procurement, design, manufacture, installation, commissioning and operation of all SSCs will be commensurate with the safety classification of these items in line with the graded approach to QA defined in IAEA GS-R-3 and the supporting guide GS-G-3.1. Milestone: Long lead items and SSC procurement specifications.*

232 If European Harmonised Standards plus supplements are to be used for some SSCs then it shall be the responsibility of the licensee to manage their application. This leads to the Assessment Finding:

> ***AF-UKEPR-CC-04:*** *A future UK licensee shall be responsible for the management of the application of Harmonised Standards plus supplements applied to any SSCs for the UK EPR. Milestone: Long lead items and SSC procurement specifications.*

233 No items have been agreed with EDF and AREVA as being outside the scope of the GDA process with respect to categorisation and classification. However, it is recognised that the application of SSC methodology in some areas requires supplier input and this is outside the scope of GDA, as is the QA arrangements for the control of design development post GDA, and manufacturing for SSCs. This leads to the Assessment Finding:

> ***AF-UKEPR-CC-05:*** *A future UK licensee shall fully apply the SF and SSC methodologies identified in the GDA PCSR to the developing design for a UK EPR. Milestone: Long lead items and SSC procurement specifications.*
>
> .

4.3 Limits and Conditions

4.3.1 Background

234 This topic area was not assessed during Step 3 but it was included in our Step 4 assessment plans. Our published GDA guidance for Requesting Parties (Ref. 5) includes the requirement that for Step 4 EDF and AREVA should provide:

- A demonstration that the constructed plant will be capable of being operated within safe limits.
- Arrangements for moving the safety case to an operating regime; that is the arrangements to ensure that the requirements of, and assumptions in, the safety case will be captured in:

  (a) Technical specifications.
  (b) Maintenance schedule.
  (c) Procedures (normal operation, emergency, accident management).
  (d) Training programmes.
  (e) Emergency preparedness.
  (f) Operating limits.
  (g) Radiation protection arrangements for operators.

235 As well as EDF and AREVA's arrangements it is clear that a future licensee shall be responsible for developing and implementing the full site specific details of:

(a) Technical specifications.
(b) Maintenance schedule.
(c) Procedures (normal operation, emergency, accident management)
(f) Operating limits.

236 These are important requirements as the safe operation of the plant requires a wide range of operational parameters to be kept within acceptable limits. Such limits may

relate to temperature, pressure, primary coolant flow rate and chemistry, secondary water and steam conditions and so on.

237 Although a future licensee shall be responsible for fully developing and implementing these items, it is our expectation that EDF and AREVA will provide a demonstration in the GDA submission that the design basis limits for SSCs which provide the means of delivery of a safety function are clearly identified. The RP should also demonstrate that plant Operating Rules (OR) or Operating Technical Specifications (OTS) and maintenance schedules can be derived from the design basis limits and claims made in the GDA PCSR.

238 During Step 4 several regulatory queries were raised in the reactor fuel and reactor chemistry topic areas requesting EDF and AREVA to provide further details of the applicable design basis limits and specifications.

239 The information presented by EDF and AREVA on Limits and Conditions, EMIT and Operational Technical Specifications was limited to high level principles in the PCSR and it was unclear how complete the information was across all technical topic areas. Consequently, the Cross-cutting Regulatory Observation RO-UKEPR-55 (Ref. 11) was raised to seek further clarification.

240 The purpose of this RO (Ref. 11) was for EDF and AREVA to provide the Regulators with clearer visibility of the key limits and conditions, (e.g. operating envelope, set-points on protection systems, and equipment availability), embedded within the safety case, and which are required to be translated into the operating and maintenance documentation, and practice for the EPR. EDF and AREVA were requested to illustrate how plant Operating Rules (OR) or Operating Technical Specifications (OTS) and maintenance schedules may be derived from the design basis limits and claims made in the GDA PCSR, and what processes can be followed to ensure that the ORs, OTSs and/or maintenance schedules ultimately adopted by a future licensee are consistent with the design basis limits.

4.3.2 Assessment Limits and Conditions and EMIT

241 ND met with EDF and AREVA in October 2010 to discuss their proposed approach and response to RO-UKEPR-55 (Ref. 11) recognising that the Operating Rules (OR) or Operating Technical Specifications (OTS) and EMIT schedules will be dependant upon suppliers' and operator's requirements and that these will be assessed during the site specific phase.

242 At this meeting EDF and AREVA proposed to provide a technical report that will draw on information taken from the PCSR. The report has now been reviewed and is structured as follows:

- UK EPR limits and conditions identification.
- Operational Technical Specifications (OTS) – transfer of key limits and conditions to operational constraints.
- Operational documentation – link between OTS / UK EPR design and the plant operating documents.

243 Only the top two tiers of documents will be developed during GDA. Several sources of limits and conditions exist and the purpose of generic information is to allow future operators to produce operational documentation that complies with the generic safety case.

244 EDF and AREVA presented an overview of EDF and AREVA's Engineering process (see Fig. 3 on page 56) to demonstrate how limits and conditions can be derived from the key design and analysis information provided in the UK EPR GDA submission under the following process headings:

- Reactor operating states - range and domains (PT boot diagram).
- Plant design and fault studies.
- Safety and functional requirements and how these can then be developed into OTSs to include:
  i) Periodic tests.
  ii) Operational documentation.
  iii) Chemical Specifications.
  iv) In-service inspection.
  v) Safety analysis bounding limits.

245 The starting point for this process are the GDA UK EPR operating states A to F and these may be summarised as follows (and are also defined in the P T boot diagram in the PCSR (Ref. 13)):

- State A: Power states and hot and intermediate shutdown (P > 130 bar)
- State B: Intermediate shutdown above 120°C (P < 130 bar). All shutdown states during normal plant operation, where primary heat is removed by SGs
- State C: Intermediate and cold shutdown with Low Head Safety Injection (LHSI) / Residual Heat Removal (RHR). 2 SGs available for heat removal.
- State C1: RCS Press: 24.5 - 32 bar, Temp 120°C - 100°C.
- State C2: RCS Press: 24.5 - 32 bar, Temp 100°C - 55°C.
- State C3: RCS Press: 1 - 32 bar, Temp ~ 55°C.
- State D: Cold shutdown, RCS open, decay heat removal via LHSI / RHR.
- State E: Cold shutdown with the reactor cavity flooded for refuelling.
- State F: Cold shutdown with the core fully unloaded.

246 The GDA UK EPR fault studies and plant design studies are presented in Chapters 14, 15 and 16 of the PCSR (Ref. 13). These cover the PCC 2-4 studies, the PSA, and the RRC-A and RRC-B studies and have been subject to ND assessment in these technical topic areas (see Step 4 assessment reports FS, PSA Severe Accidents). In addition, the work performed under RO-UKEPR-40 on the list of faults to be included in Fault Studies, and RO-UKEPR-41 on the demonstration of diversity and passive single failure, also have an input to the limits and conditions to be identified and included in their report (Ref. 72).

247 Complementary analysis is also undertaken such as thermo-hydraulic (T-H) loading conditions with an aim to evaluate the mechanical behaviour of system components. The integrity of equipment under loading can also be monitored and underpinned throughout station life based on calculated occurrences. Inputs to this are the lists of loading conditions, T-H analysis and loading condition methodology. Outputs are a set of profile traces of the behaviour of parameters and verification of the allowable number of each loading condition design loading number of cycles etc.

248 EDF and AREVA outlined how Operational Technical Specifications (OTS) can be developed and how they include periodic test requirements, safety analysis bounding limits, and chemical specifications, from which a future operator can derive operational documentation and in service inspection programmes. The purpose of OTSs are to transfer safety (design) limits into operational constraints to:

- ensure compliance with the parameter values assumed in the safety analysis contained in the PCSR;
- ensure compliance with the system safety features assumed in the safety analysis to mitigate transients and fault scenarios;
- specify the normal operating limits of parameters;
- define and establish the requirement for the operability of SSCs; and
- define recovery actions in the event of inoperability of required SSCs or an abnormal change in the operating limit.

249 The main inputs to the OTS include:

- PCSR, table of reactor states, list of system safety features, deterministic approach, operating experience, PSA insight (extent depending on approach; State Oriented Approach (SOA) or Risk Informed Approach (RIA), T- H conditions, SSC operability requirements for management of faults (maintenance SFC considerations).
- Periodic Tests (PT): The requirements for these will be identified in the OTS. The purpose of periodic tests is to verify, throughout plant life, that SSCs can deliver the functional safety requirements identified in the design. Periodic tests are expected to form part of the EMIT programme. PCSR Chapters 14, 15 and 16 and the SDMs provide an input into periodic test requirements and PSA analysis may be used to define test frequency. The definition of the overall periodic test programme with related documentation is an activity for a future licensee to develop.
- Operational Documentation: We agreed with EDF and AREVA that the choice of format, style and content depends on operator choice. This includes, operating procedures, full EMIT etc.
- Chemical Specifications - The response provided to RO-UKEPR-55 with respect to chemical and radiochemical specifications compliments that provided by EDF and AREVA in response to RO-UKEPR-44. Boron dominates primary circuit chemistry and the requirement to preserve system integrity dominates secondary circuit chemical control. Initial chemical specification parameters are currently being established with emphasis on plant start-up and shut-down and these parameters may evolve as the design develops. We agreed that the licensee is required to ensure compliance with specifications for the life of the station to underpin safe operation.
- In-service Inspection (ISI) – EDF and AREVA presented a summary of key components to be covered in ISI including, RPV, main coolant lines, SGs, pressuriser, closure head etc and stressed the importance of ISI for break preclusion pipework. Operational monitoring is required to confirm validity of design assumptions throughout reactor life particularly with respect to stresses and fatigue damage. EDF and AREVA stated that an ISI programme is currently being developed for items other than for main primary circuit and secondary circuit components in areas including welded joints, fluids in contact with equipment, and others that are subject to specific regulatory inspections including the Lifting Operations and Lifting Equipment (LOLER) Regulations.

250 ND stated that in the topic area of ISI our main area of interest from a structural integrity perspective is seeing evidence that the generic design can readily accommodate foreseen in-service inspection requirements, rather than details of in-service inspection regimes which we recognise are an essential part of EMIT for a future operator to develop. This issue was being progressed through the Structural Integrity topic area through RO-UKEPR-54 which we recognise is linked to RO-UKEPR-55 and is now being taken forward in GDA through GDA Issue **GI-UKEPR-SI-01** Action 7.

251 Safety Analysis Bounding Limits – In this area ND had raised RO-UKEPR-72 in our Fuel Assessment technical topic area and this is linked with RO-UKEPR-55. RO-UKEPR-72 has subsequently been closed and is not linked to any GDA issues. In this area the bounding values of nuclear design encompass:

- Fuel depletion of proposed core loadings.
- All core states within Limiting Conditions of Operation (LCO).
- All core states within limiting fault conditions.
- Calculation uncertainties.
- Bounding general neutronic parameters used for point-kinetics transient analysis.
- Bounding neutronic parameters used for 3D transient analyses.

252 Typical input data includes; Doppler power and temperature coefficients etc. The output from this study will be a stand alone document specifying generic bounding neutronic parameters for management of fuel reloads. EDF and AREVA recognise that during the site specific phase a study will be required for each fuel load to confirm that this is bounded by the generic case. The site specific case forms part of the operational documentation and will link into OTS requirements such as boron concentration, physics tests etc.

253 EDF and AREVA compiled the principles and rationale outlined above into a structured report ECEF102536 A (Ref. 72) to provide the GDA design basis limits and conditions from which a future UK EPR operator could develop Operational Technical Specifications and EMIT. The report also provided some examples of how OTS and EMIT could be derived from the GDA information. This report was received under covering letter EPR00709N (Ref. 73) in December 2010.

254 A further meeting was held with EDF and AREVA in January 2011 to discuss the report and our requirements for update of the PCSR to include key design limits and conditions information.

255 We agreed that the report provided improved visibility of the design limits and conditions for the GDA UK EPR and provided an adequate demonstration (through the examples of the OTS requirements and conditions for the Emergency Feed Water System (EFWS) and the Emergency Boronation System (EBS)) of how OTS and EMIT could be developed by a future licensee.

256 Additionally, EDF and AREVA agreed to provide ND with a technical report and update to PCSR Chapter 18.2 to include:

- Links to the plant characteristics presented in PCSR Sub-Chapter 14,1.
- Illustration of OTS requirements.
- Response to RO-UKEPR-55 A3.2.

- A route map for the relevant parts of the PCSR that contribute to this topic and the related ROs.
- Clear identification of outstanding work at the time of delivery of the November 2010 report. That is, the outstanding work to be completed by EDF and AREVA and that to be completed by a future licensee.

257 The updated PCSR Chapter 18.2 was submitted in March 2011 (Ref. 15). Although, the assessment of the revised PCSR Chapter has been limited to date I consider that the information provided has addressed many of our questions in this topic area and the route map to supporting PCSR Chapters and references was particularly helpful in improving the visibility of the safety case for UK EPR limits and conditions and EMIT requirements. However, it is noted that further work is required by EDF and AREVA to update report ECEF102536 A (Ref. 72) to include the current position on our related regulatory queries in the Reactor Chemistry and Fuel technical topic areas.

258 Additionally, further clarity is required on operating assumptions in respect to the design assumptions and rules to determine configuration requirements for operation and maintenance. This will need to include the minimum number of operating trains for key systems. This information will need to be included in an update to the PCSR.

259 The revised PCSR and report ECEF102536 A (Ref. 72) will be subject to further review in GDA however, it is not anticipated that there will be a significant amount of further assessment to be undertaken to confirm their adequacy. This work will be progressed through Cross-cutting GDA Issue **GI-UKEPR-CC-02.**

4.3.3 Summary Conclusions Limits and Conditions

260 The ND assessments completed in this Cross-cutting topic are generally positive. It is considered that the GDA design basis limits and conditions provided in the PCSR form the basis from which a future licensee can develop site specific OTS / Operation Rules (OR) and EMIT.

261 Some additional work is required to further update PCSR Chapter 18.2 and supporting report ECEF102536 A (Ref. 72) to ensure that these reflect the current position on our regulatory queries on design limits and specifications including Reactor Chemistry and Fuel. I consider that this work can be progressed in GDA through Cross-cutting **GI-UKEPR-CC-02.**

262 In the Structural Integrity topic area however a GDA Issue action has been raised with respect to accessibility of parts of the plant for In Service Inspection (ISI) (**see GI-UKEPR-SI-01** Action 7, Ref. 8).

263 The design limits and conditions information that will be completed in GDA shall form the basis from which a future UK EPR licensee will be required to derive Operating technical Specifications (OTS) / Operating Rules (ORs) and EMIT and this leads to the following Assessment Findings:

> ***AF-UKEPR-CC-06:*** *A future licensee shall use the information provided in the GDA PCSR and supporting references to derive OTS /* Operating Rules (OR) *and EMIT for UK EPR operations (includes shutdowns and maintenance activities) Milestone: Fuel load.*
>
> ***AF-UKEPR-CC-07:*** *A future licensee shall use the information provided in the GDA PCSR Chapter 18.2 and supporting references as the starting basis for a live site*

specific safety case to derive OTS / Operating Rules (OR) *and EMIT for UK EPR operations (includes shutdowns, maintenance activities). Milestone: Fuel load.*

4.4 Lessons Learnt from the Fukushima Accident

264 The assessment undertaken as part of the Generic Design Assessment process and the submissions made by EDF and AREVA relating to the UK EPR reactor design, and the reactor design itself, were established prior to the events at Fukushima, Japan in March 2011. In the UK, the Secretary of State for Energy and Climate Change has asked the Nuclear Chief Inspector of the Office for Nuclear Regulation to provide an independent report of the lessons to be learned from the Fukushima event. Similarly, EDF and AREVA are also identifying lessons learned from this event. This report, together with the associated assessments, submissions and the reactor design, as appropriate, will be reviewed and revised in the light of relevant lessons learned when available. Conclusions will also be drawn at that time about the safety, environmental and security acceptability of EDF and AREVA's generic proposals for the UK EPR.

265 In recognition of this, and consequent on the Fukushima accident, a further GDA Issue has been raised on EDF and AREVA to address any lessons to be learnt for the generic design. GDA Issue **GI-UKEPR-CC-03** requests EDF and AREVA to demonstrate how they will take account of the lessons learnt from the unprecedented events at Fukushima, including from EDF and AREVA's internal reviews and from those lessons and recommendations that are identified in the ONR Chief Inspector's Interim and Final Fukushima Reports (Refs 79 and 80). The complete GDA Issue and associated actions are formally defined in Annex 2.

4.5 Overseas Regulatory Interface

266 HSE's Strategy for working with Overseas Regulators is set out in (Ref. 76) and (Ref. 77). In accordance with this strategy, HSE collaborates with Overseas Regulators, both bilaterally and multi-nationally

4.5.1 Bilateral Collaboration

267 HSE's Nuclear Directorate (ND) has formal information exchange arrangements to facilitate greater international co-operation with the nuclear safety regulators in a number of key countries with civil nuclear power programmes. These include:

- the US Nuclear Regulatory Commission (NRC);
- the French L'Autorité de Sûreté Nucléaire (ASN); and
- the Finnish Regulator, STUK.

4.5.2 Multilateral Collaboration

268 ND collaborates through the work of the International Atomic Energy Agency (IAEA) and the OECD Nuclear Energy Agency (OECD-NEA). ND also represents the UK in the Multinational Design Evaluation Programme (MDEP) - a multinational initiative taken by national safety authorities to develop innovative approaches to leverage the resources and knowledge of the national regulatory authorities tasked with the review of new reactor power plant designs. This helps to promote consistent nuclear safety assessment standards among different countries.

269 In the GDA Cross-cutting topics assessment area, insights from other Regulators looking at EPR variants have been gained through the MDEP EPR working group (EPRWG). The EPRWG focuses on the design reviews being undertaken in different countries. We have shared assessment views and findings with our MDEP partners (USA, France, Finland, Canada and China) and contributed to joint working. MDEP is expected to continue beyond GDA and ND will continue to take an active role.

270 EPR design changes have been discussed in the MDEP EPRWG and technical sub groups including C&I and this has resulted in MDEP issuing several common positions on C&I which have impacted the EPR design. Additionally, some of the design changes we have agreed for inclusion in GDA have arisen from other MDEP regulator's concerns and the implementation of these promotes the harmonisation of the EPR design across different countries

4.6 Interface with Other Regulators

271 The principal interface with other UK Regulators is with the Environment Agency with whom we have a close working relationship and a shared Joint Programme Office (JPO) for GDA. The Cross-cutting GDA Issues on GDA submission update (including design change impact) and for lessons learnt from Fukushima were agreed and issued jointly between ND and Environment Agency.

4.7 Other Health and Safety Legislation

272 Not applicable.

5 CONCLUSIONS

273 This report presents the findings of the Step 4 Cross-cutting Topics assessment of the EDF and AREVA UK EPR Reactor.

274 The Step 4 assessment in the Cross cutting topic area commenced with consideration of the relevant chapters of the PCSR and available supporting references. As the GDA submission developed during Step 4 in response to regulatory questions, amendments were made as appropriate to the PCSR and its supporting references. A review of these in the Cross cutting technical topic area concludes that the updates are as expected. The consolidated PCSR (Ref. 15) and its supporting references which are listed in the SML (Ref. 30) are therefore acceptable as the reference point for an Interim Design Acceptance Confirmation (iDAC).

275 From my assessment of the Cross-cutting topics, Design changes, Safety Function Categorisation (SF) and Structures, Systems and Components Classification (SSC), Design Limits & Conditions and Examination Maintenance Inspection and Testing (EMIT), I am broadly satisfied with the claims, arguments and evidence laid down within the PCSR and supporting documentation.

276 From my assessment of Design Change, I have concluded that Generally, EDF and AREVA have submitted sufficient supporting documentation to underpin design changes agreed for inclusion in Generic Design Assessment. However, this is not the case for those design changes at an early stage of development and further work will be required by EDF and AREVA to progress these within Generic Design Assessment after Step 4. This requirement will be progressed through GDA Issue **GI-UKEPR-CC-02**.

277 EDF and AREVA have developed robust arrangements for managing agreed design changes within Generic Design Assessment and for including them in the UK EPR design reference configuration document.

278 Although EDF and AREVA have applied an Independent Nuclear Safety Assessment process to some Generic Design Assessment design changes the output from this process has not yet been presented to the regulators for examination.

279 The application of EDF and AREVA's design change categorisation process developed for Generic Design Assessment has not been tested in detail beyond the limited number of design changes agreed for inclusion in Generic Design Assessment.

280 From my assessment of SSC classification, I have concluded that EDF and AREVA have made significant progress in GDA Step 4 in developing their methodologies and criteria for SF Categorisation and SSC Classification to the UK EPR GDA design and these changes have been captured in part in the Step 4 consolidated PCSR (Ref. 15).

281 The graded approach now adopted by EDF and AREVA for SSC Classification in the UK EPR GDA submission, at a principle level, is consistent with UK and international standards and relevant good practice.

282 However, further work is required to apply these through the developing UK EPR design to include any areas impacted by design changes already agreed for inclusion in GDA or arising from GDA Issue Resolution Plans. This will be progressed in GDA through a Cross-cutting GDA Issue, **GI-UKEPR-CC-02 -** see Annex 2 for details.

283 The application of design requirements to SSCs from EPR design codes ETC-C, RCC-E and RCC-M has raised some regulatory concerns, for example the allocation of RCC-M M1-M3 design requirements to Class 1 and 2 SSCs. In the case of RCC-M design

requirements a way forward has been agreed with EDF and AREVA and this will be progressed through Cross-cutting GDA Issue **GI-UKEPR-CC-01** Action 4. Whilst issues associated with ETC-C and RCC-E will be progressed through GDA Issues in the civil engineering and electrical engineering topic areas and or as part of site licensing activities.

284 From my assessment of EDF and AREVA's proposals for Operating Limits and Conditions and EMIT, I have concluded that the GDA design basis limits and conditions provided in the PCSR (Ref. 15) form the basis from which a future licensee can develop site specific Operating Technical Specifications (OTS) / Operation Rules (OR) and EMIT.

285 Some additional work is required to further update the PCSR and supporting documentation to ensure that these reflect the current position on our regulatory queries on design limits and specifications in the Reactor Chemistry and Fuel topic areas. I consider that this work can be progressed in GDA through Cross-cutting GDA Issue **GI-UKEPR-CC-02.**

286 I consider that from a Cross-cutting topics view point, the EDF and AREVA UK EPR design is suitable for construction in the UK. However, this conclusion is subject to satisfactory progression and resolution of the two GDA Issues identified in this report to be addressed during the forward programme for this reactor and assessment of additional information that becomes available as the GDA Design Reference is supplemented with additional details on a site-by-site basis.

287 In addition, consequent on the Fukushima accident in March 2011, a further GDA Issue has been raised on both Requesting Parties to address any lessons to be learnt for the generic design. We have raised GDA Issue **GI-UKEPR-CC-03** requesting EDF and AREVA to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including from EDF and AREVA's internal reviews and from those lessons and recommendations that are identified in the ONR Chief Inspector's interim and final reports through. The complete GDA Issue and associated actions are formally defined in Annex 2 of this report.

5.1 Key Findings from the Step 4 Assessment

5.1.1 Assessment Findings

288 I conclude that the following Assessment Findings listed in Annex 1 should be programmed during the forward programme of this reactor as normal regulatory business.

5.1.2 GDA Issues

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

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Table 1

HSE-ND Process for Agreement to Consider Changes in GDA

Step	Change Control Stage	HSE-ND Action
1	RP considers need for change	Assessor to be informed about the intended change proposal. No assessment undertaken.
2	RP formally inform NII in writing of intention for change proposal including change proposal unique number, brief description and forward plan for formal submission	Note receipt in ARG
3	NII note in principle in writing to RP	Noted at ARG. Not yet formally in GDA.
4	RP discussion with Assessor	Limited assessor discussion to understand scope and impact.
5	RP formal submission including categorisation confirmation, full change description and impact assessment	HSE-ND review scope and impact of formal proposal at ARG with assessor feedback on impact.
6	NII formal agreement (or not) in writing to inclusion of assessment of the change proposal in GDA. (NB This is not agreement of the change proposal)	Agreed at ARG. Confirmed within GDA scope. Allows “full” assessment.

ARG = HSE-ND Assessment Review Group

Table 2

Status of Deliverables Associated with Design Changes Agreed for Inclusion in GDA

CMF No and Status in GDA 6-Step Process (Ref. 78)	Description	Design Change Deliverables				
		Submitted for Step 4 Assessment	INSA Required	Included in Consolidated Step 4 PCSR	Further Assessment for Final DAC	Completion in NSL
UKEPR-CMF-010 Step 6	Partial cooldown gradient modification	Yes	No	yes	yes	no
UKEPR-CMF-013 Step 6	RCCAs design Layout change	Yes	TBD	yes	no	yes
UKEPR-CMF-014 Step 6	C&I backup system	Yes	Yes March 11	yes	yes	yes
UKEPR-CMF-015 Step 6	Communication of PS with other systems	Yes	Yes March 11	yes	yes	yes
UKEPR-CMF-016 Step 6	Door control measures for doors installed within Safety Fire Compartments	Yes	No	yes	no	yes
UKEPR-CMF-017 Step 6	SG and PZR material 20MND5	Yes	Yes Feb 11	yes	no	Yes
UKEPR-CMF-018 Step 6	Reactor Building Liner Anchorage	yes	No	yes	no	Yes
UKEPR-CMF-019 Step 3*	Reduction of Microtherm in PZR support area	yes	TBD	yes	yes	TBD
UKEPR-CMF-020 Step 3*	Modification of HVAC systems for accident conditions	yes	TBD	no	yes	TBD
UKEPR-CMF-021 Step 3*	Average Coolant Temperature (ACT) and PZR Level LCO Modification at low Power	yes	TBD	yes	yes	TBD

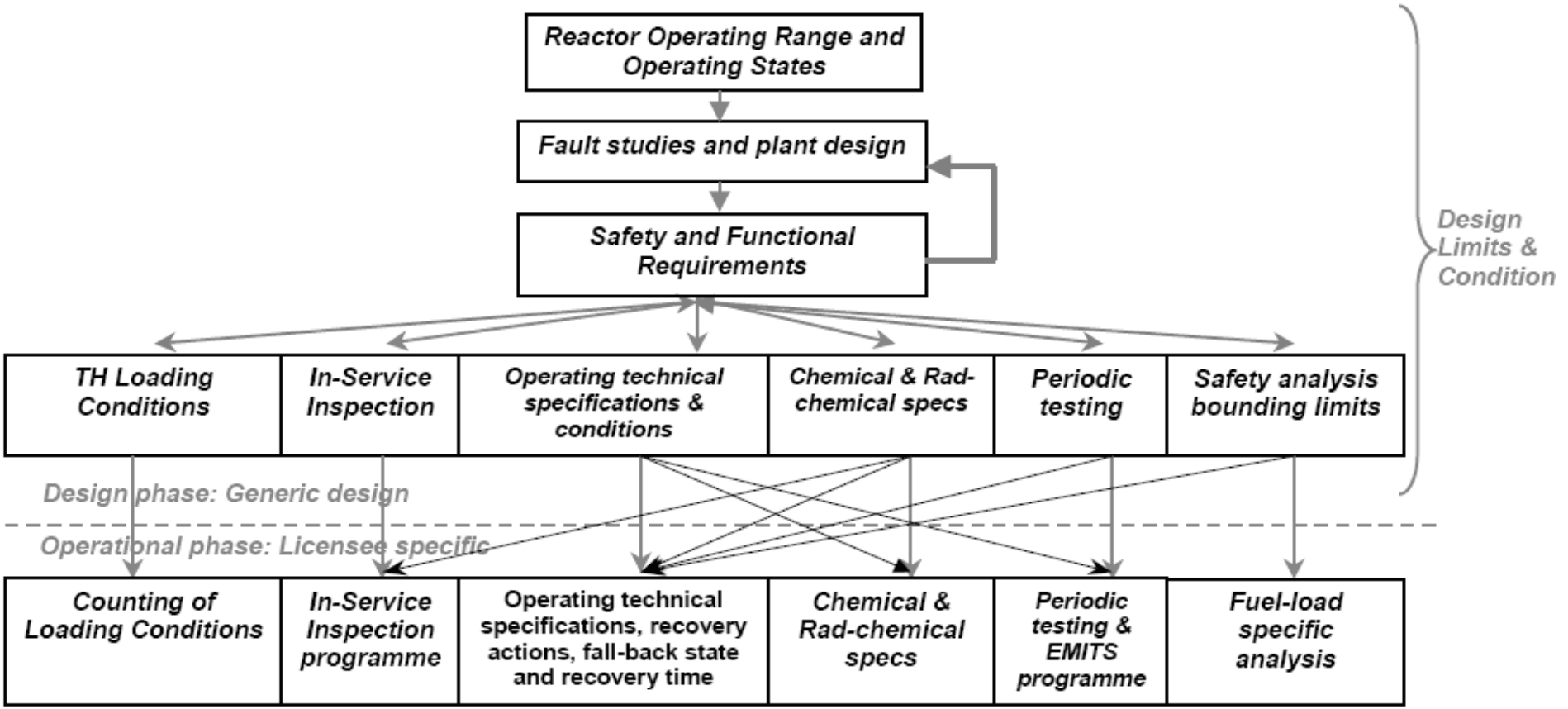
Table 2

Status of Deliverables Associated with Design Changes Agreed for Inclusion in GDA

CMF No and Status in GDA 6-Step Process (Ref. 78)	Description	Design Change Deliverables				
		Submitted for Step 4 Assessment	INSA Required	Included in Consolidated Step 4 PCSR	Further Assessment for Final DAC	Completion in NSL
UKEPR-CMF-022 Step 3*	Modification of small SGTR mitigation	yes	TBD	yes	yes	TBD
UKEPR-CMF-023 Step 3*	Addition of new Reactor Trip signals	yes	TBD	yes	yes	TBD
UKEPR-CMF-024 Step 3*	Classification	yes	TBD	yes	yes	TBD
UKEPR-CMF-025 Step 3*	Automatic EBS actuation for Steam Line Break	yes	TBD	yes	yes	TBD
UKEPR-CMF-026 Step 3*	Class 1 interface in MCR and RSS	yes	TBD	yes	yes	TBD
UKEPR-CMF-027 Step 3*	Upgrading safety info and control system	yes	TBD	yes	yes	TBD
UKEPR-CMF-028 Step 3*	Monophasic start up mode	yes	TBD	yes	yes	TBD

For the CMF marked Step 3* EDF and AREVA are claiming benefit for the inclusion of these within the agreed GDA design reference, however further work will be required to update the PCSR and supporting references as indicated in the deliverables table.

Figure 3: Overview of EDF and AREVA Engineering Process



Annex 1

Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business

Cross-cutting Topics – UK EPR

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-CC-01	A future UK EPR licensee shall ensure design changes included in GDA are implemented into the UK EPR safety case.	During operational phase.
AF-UKEPR-CC-02	A future UK EPR licensee shall ensure that any proposed generic updates to the UK EPR GDA design reference that have not been agreed in GDA are progressed through site licence condition requirements.	Fuel Load.
AF-UKEPR-CC-03	A future licensee shall ensure that the level of QA arrangements applied to the design, manufacture, installation, commissioning and operation of all SSCs will be commensurate with the safety classification of these items in line with the graded approach to QA defined in IAEA GS-R-3 and the supporting guide GS-G-3.1.	Long lead items and SSC procurement specifications.
AF-UKEPR-CC-04	A future licensee shall be responsible for the management of the application of Harmonised Standards plus supplements applied to any SSCs for the EPR.	Long lead items and SSC procurement specifications
AF-UKEPR-CC-05	A future licensee shall fully apply the SF and SSC methodologies identified in the GDA PCSR to the developing design for a UK EPR. Throughout design development.	Long lead items and SSC procurement specifications.
AF-UKEPR-CC-06	A future licensee shall use the information provided in the GDA PCSR and supporting references to derive OTS / Operating Rules (ORs) and EMIT for UK EPR operations (includes shutdowns, maintenance activities).	Fuel load.
AF-UKEPR-CC-07	A future licensee shall use the information provided in the GDA PCSR Chapter 18.2 and supporting references as the starting basis for a live site specific safety case to derive OTS / Operating Rules (ORs) and EMIT for UK EPR operations (includes shutdowns, maintenance activities).	Fuel load.

Annex 1

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 Issues – Cross-cutting Topics – 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.A1**
GDA Issue	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.		
GDA Issue Action	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.		

Annex 2

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

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.A3**
GDA Issue Action	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.		

Annex 2

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.A4**
GDA Issue Action	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.		

Annex 2

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.A5**
GDA Issue Action	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.		

Annex 2

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.A6**
GDA Issue Action	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.		

Annex 2

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.A7**
GDA Issue Action	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.		

Annex 2

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.A8**
GDA Issue Action	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.		

Annex 2

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

CONSOLIDATED FINAL GDA SUBMISSION INCLUDING AGREED DESIGN CHANGE FOR THE UK EPR

GI-UKEPR-CC-02 REVISION 3

Technical Area	**CROSS CUTTING**		
Related Technical Areas	**All**		
GDA Issue Reference	**GI-UKEPR-CC-02**	**GDA Issue Action Reference**	**GI-UKEPR-CC-02.A1**
GDA Issue	EDF and AREVA to continue to control, maintain and develop the GDA submission documentation, including the SSER, SML and design reference document and deliver final consolidated versions of these as the key references to any DAC/SODA ONR or Environment Agency (the joint Regulators) may issue at the end of GDA. These should include the management and acceptance of changes to GDA submission documentation impacted by design changes agreed for inclusion in GDA. This GDA Issue is raised by both ONR and Environment Agency.		
GDA Issue Action	EDF and AREVA to fully implement its processes to manage the implementation and acceptance of amendments to documentation impacted by design changes agreed for inclusion in GDA, including any other additionally agreed design changes associated with other GDA Issues Resolution Plans. This should involve the incorporation of all relevant amendments into the impacted documentation associated with design changes, including the Reference Design Configuration Document UKEPR-I-002, the PCSR, and the PCER. Evidence we expect to see to address this action includes: • Revision of GDA submission documentation impacted by design changes agreed for inclusion in GDA and scheduled to be updated before the end of GDA; in particular, amendments to submission level 2 design information such as SDMs impacted by design changes agreed for inclusion in GDA. • Acceptance by EDF and AREVA of amendments to submission level 2 design change documentation provided by a GDA supplier (for example SOFINEL as a supplier of amended SDMs) • Completion of INSA and IPR where applicable and incorporation of DSRC recommendations into the GDA submission documentation, where appropriate, for any design changes agreed for inclusion in GDA. • Application of appropriate surveillance arrangements for suppliers/contractors used for the products. To facilitate our assessments and our inspections in this area the programme of deliverables of amended impacted design change documentation will need to include sufficient time for us to complete our assessments before we may issue any DAC/SODA. With agreement from the joint Regulators this action may be completed by alternative means.		

Annex 2

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

CONSOLIDATED FINAL GDA SUBMISSION INCLUDING AGREED DESIGN CHANGE FOR THE UK EPR

GI-UKEPR-CC-02 REVISION 3

Technical Area	**CROSS CUTTING**		
Related Technical Areas	**All**		
GDA Issue Reference	**GI-UKEPR-CC-02**	**GDA Issue Action Reference**	**GI-UKEPR-CC-02.A2**
GDA Issue Action	EDF and AREVA to apply the revised Design Change procedure in order to identify and transfer all relevant agreed incomplete GDA design changes into Nuclear Site Licensing and permissioning activities, and Environmental Permitting. Evidence we expect to see provided to address this action includes: • Examples of application of arrangements for transfer of incomplete GDA design changes into Nuclear Site Licensing and Environmental Permitting activities. With agreement from the joint Regulators this action may be completed by alternative means.		

Annex 2

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

CONSOLIDATED FINAL GDA SUBMISSION INCLUDING AGREED DESIGN CHANGE FOR THE UK EPR

GI-UKEPR-CC-02 REVISION 3

Technical Area	**CROSS CUTTING**		
Related Technical Areas	**All**		
GDA Issue Reference	**GI-UKEPR-CC-02**	**GDA Issue Action Reference**	**GI-UKEPR-CC-02.A3**
GDA Issue Action	EDF and AREVA shall continue to control, maintain and develop the GDA submission documentation, including the SSER, SML and design reference document and shall deliver final consolidated versions of these as key references to any DAC/SODA we may issue at the end of GDA. Evidence we expect to see to address this action: • Application of EDF and AREVA due processes, including QA and technical reviews for the control and development of the GDA submission documentation scheduled to be created or updated before the end of GDA and contained within the SSER, SML and design reference document to address GDA Issue resolution, agreed design changes, and any other updates agreed with the joint Regulators. • Application of EDF and AREVA due processes, including technical reviews, INSA and IPR where applicable and QA consolidation checks on final GDA submission documentation scheduled to be created or updated before the end of GDA and contained within the SSER, SML and design reference document. The final GDA submission documentation is to be referenced from any DAC/SODA we may issue. The evidence should include: - Management and incorporation of all review comments and DSRC recommendations in the final consolidated documentation as necessary. - The full assessment of impacts arising from proposed modifications or changes in specific topic areas, including consequential impacts across the SSER. • Delivery of final consolidated GDA submission documentation scheduled to be created or updated before the end of GDA including SSER, SML and design reference document in good time for regulatory assessment prior to any decisions to issue DAC/SODA that would reference these documents With agreement from the joint Regulators this action may be completed by alternative means.		

Annex 2

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

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

GI-UKEPR-CC-03 REVISION 3

Technical Area	**CROSS CUTTING**		
Related Technical Areas	**All**		
GDA Issue Reference	**GI-UKEPR-CC-03**	**GDA Issue Action Reference**	**GI-UKEPR-CC-03.A1**
GDA Issue	EDF and AREVA are required to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including those lessons and recommendations that are identified in the HM Chief Inspector's interim and final reports.		
GDA Issue Action	EDF and AREVA to address the lessons learnt from their internal review following the Fukushima event relevant to GDA for the UK EPR. Evidence we expect to see provided to address this action includes: 1) Internal review summary report 2) A plan for the necessary actions arising from the internal review report 3) Modification of the following, as appropriate: a. Design Reference and SSERs b. Submission Master List documentation (Levels 1-3), including amendments to submission level 2 design information such as SDMs in accordance with GDA Issue GI-UKEPR-CC.02 c. Resolution Plans in response to other relevant GDA Issues 4) Confirmation that any design changes resulting from these reviews for inclusion into GDA will be managed in accordance with the UK EPR GDA Project Procedure UKEPR-I-003. With agreement from the Regulators this action may be completed by alternative means.		

Annex 2

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

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

GI-UKEPR-CC-03 REVISION 3

Technical Area	**CROSS CUTTING**		
Related Technical Areas	**All**		
GDA Issue Reference	**GI-UKEPR-CC-03**	**GDA Issue Action Reference**	**GI-UKEPR-CC-03.A2**
GDA Issue	EDF and AREVA are required to demonstrate how they will be taking account of the lessons learnt from the unprecedented events at Fukushima, including those lessons and recommendations that are identified in the HM Chief Inspector's interim and final reports.		
GDA Issue Action	EDF and AREVA to address the lessons learnt that are relevant to GDA for UK EPR from HM Chief Inspector Nuclear Installations' interim and final reports. Evidence we expect to see provided to address this action includes: 1) A Plan to address the relevant actions arising from HM Chief Inspector's interim and final reports. 2) Modification of the following, as appropriate: a. Design Reference and SSERs b. Submission Master List documentation (Levels 1-3), including amendments to submission level 2 design information such as SDMs in accordance with GDA Issue GI-UKEPR-CC.02 c. Resolution Plans in response to other relevant GDA Issues 3) Confirmation that any design changes resulting from these reviews for inclusion into GDA will be managed in accordance with the UK EPR GDA Project Procedure UKEPR-I-003. With agreement from the Regulators this action may be completed by alternative means.		

Further explanatory / background information on the GDA Issues for this topic area can be found at:	
GI-UKEPR-CC-01 Revision 1	Ref. 74.
GI UKEPR-CC-02 Revision 3	Ref. 75.
GI UKEPR-CC-03 Revision 3	Not applicable.