UK EPR	UK EPR GDA PROJECT			
	Title: Resolution Plan for GI-UKEPR-FS03			
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	GI-UKEPR-FS03-RP	0	23.06.2011	1 of 15

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Name/Initials  *Date 23/06/2011*	*Name/Initials*  *Date 23/06/2011*

Resolution Plan Revision History

Rev.	Description of update	Date issued
Rev 0	First revision	23/06/2011

1.0 GDA ISSUE

GDA Issue Title	Main Assessment Area	Related Assessment Area
Spent Fuel Pool Safety Case	Fault Studies	PSA / Mechanical Engineering / Structural Integrity / Internal Hazards

GDA Issue	The safety case for the spent fuel pool is to be extended to consider faults associated with the Cask Loading Pit and leaks currently excluded from the design basis by break preclusion arguments.

2.0 OVERVIEW OF SCOPE OF WORK

ONR inspectors made a visit to the Chooz N4 plant on 26 March 2010 to look at a spent fuel cask loading process similar to that proposed for the UK EPR. In addition, a number of queries were raised during Step 4 of GDA to clarify the safety case claims made for this process:

- Integrity of the cask loading pit: The spent fuel cask loading pit has a penetration at its base to allow a cask to be connected. The loading pit is usually empty during normal operation (and refuelling operations). A gate and penstock separate the loading pit from the spent fuel pool. No discussion has been found (either PCC or RRC-A events) of a fault where spent fuel pool inventory is lost via the penetration in the cask loading pit.
- An engineering Sequence Diagram was requested to describe the loading of spent fuel casks from the fuel building area. Specifically the response illustrated the water levels in the affected fuel pools and pits, plus the positions / location of sluice gates, penstocks, and other doors and hatches.
- During fuel loading into the cask, when both the cover and door are open, description of the actions that would be undertaken for the following fault scenarios: leak from the cask

detected, leak from penetration detected, seismic event, mechanical / control failure of the spent fuel mast, loss of electrical supply to the spent fuel mast, loss of division 1 electrical supply. The response included elements on manual operability of the spent fuel mast, cover and door, as well as estimates for timings of these operations.

Following the Chooz B walkdown and the review of the responses, the ONR recognised the advantages of a bottom loading of the fuel, avoiding the need for a heavy lift over the spent fuel pool area. The ONR also recognised the engineering features that reduce the risk of a loss of inventory through the bottom of the cask loading pit.

Even if engineered features are put in place to reduce or mitigate the initiation fault, the UK approach requires that any initiating event shall be clearly identified and a frequency shall be attributed to it. While the significant number of preventive features, defence in depth features and mitigation features have been recognised by the Regulators, there is currently no systematic way to attribute importance to the individual SSCs.

RO-UKEPR-75 was raised during Step 4 requiring a programme of work for the inclusion of faults associated with the cask loading pit within the safety case. The forward work programme (2011) has been agreed with the Regulators leading to closure of RO-UKEPR-75 and opening of this GDA issue.

The following faults are to be considered for the resolution of GI-UKEPR-FS03:

- Draining events from the spent fuel pool through a malfunction of the cask loading pit or through a malfunction of the cask while connected to the cask loading pit,
- Mishandling on the fuel assembly during transfer (stranded or dropped fuel assembly),
- The wrong (too hot) fuel assembly transported into the cask.

The boundaries of the additions to the safety case should be:

- The beginning point is just after "the fuel cask transfer machine is secured to the building structure using seismic restraints" and before "the biological lid is removed", when the lower plate of the penetration is removed.
- The end point is between "the biological lid is replaced" and "the seismic restraints are unlocked and the fuel cask transfer machine is finally positioned beneath the handling opening is opened" steps, just after the lower plate of the penetration is placed back and bolted to the leak tightness flange.

In addition a number of leaks associated with spent fuel pool are currently excluded from the design basis analysis presented in the PCSR using break preclusion concept and arguments. The rigour required to show that the likelihood of failure is so low that the consequences of failure can be discounted is high in UK and should not be put forward to avoid making a consequences analysis. A more detailed safety case is required for these leaks in response to this GDA Issue.

3.0 GDA ISSUE ACTIONS AND RESOLUTION PLAN DELIVERABLES

3.1 Action GI-UKEPR-FS03.A1

Action I/D	Action Description
GI-UKEPR-FS03.A1	EDF and AREVA to evaluate Cask Loading Pit Initiating Events. They need to determine the updates required to DBA or PSA safety cases for faults associated with the cask loading pit. A FMECA (Failure Modes, Effects and Criticality Assessment) should be performed to determine failure modes leading to the fault events. For each fault, initiating events and sequences leading to a faulty state need to be determined. Frequencies associated to each initiating event need to be determined. Faults needed to be added to the PSA and/or DBA safety cases appropriately. A report should be provided to ONR presenting the considered initiating events, sequences and attributed frequencies. This report should identify for each family of faults if it will be included in the PSA and DBA safety cases. The relative importance of administrative controls, interlocks, equipments, equipment classification, operator actions and associated claims should be included and described. With agreement from the Regulator this action may be completed by alternative means.

3.1.1 Planned submissions in response to GI-UKEPR-FS03.A1

3.1.1.1 Description of Scope of Work

Action 1 of GI-UKEPR-FS03 aims at making a detailed analysis of all potential faults in order to determine the appropriate failure modes leading to the fault. Initiating events and sequences will be defined and appropriate frequencies will be associated to each fault for analysis in GI-UKEPR-FS03.A2.

3.1.1.2 Description of Methodology to be employed

A FMECA (Failure Modes, Effects and Criticality Assessment) will be performed to determine failure modes leading to the fault events. For each fault, initiating events and sequences leading to a fault state will be determined.

*FMECA: **Failure mode, effects, and criticality analysis (FMECA)** is used for analysis of potential failure modes within a system for classification by the severity and likelihood of the*

failures. The FMECA identifies potential failure modes based on past experience with similar products or processes, enabling to design those failures out of the system. FMECA extends FMEA by including a criticality analysis, which is used to chart the probability of failure modes against the severity of their consequences. The result highlights failure modes with relatively high probability and severity of consequences, allowing remedial effort to be directed where it will produce the greatest value

Based on the FMECA analysis, on EDF PWR feedback, worldwide PWR feedback, material generic reliability database and engineering judgment when needed, frequencies associated with each initiating event and sequences of events will be determined.

If the frequency of the initiating event is lower than the targets defined in SAP FA.5. then the fault will be added in the PSA safety case. If not, then the fault will be added in the DBA and PSA safety cases.

Task 1 - FMECA (Failure Modes, Effects and Criticality Assessment) on DMK system, top-gate/water-tight door, Fuel assembly burnup measurement system

A FMECA (Failure Modes, Effects and Criticality Assessment) will be performed to determine failure modes leading to the fault events. For each fault, initiating events and sequences leading to a faulty state will be determined.

FMECA are scheduled for:

- DMK system.
- Stop-gate/water-tight door,
- Fuel assembly burnup measurement system.

Results of the FMECA study will be presented to the ONR through a dedicated meeting to be held in November 2011 (exact date tbd).

Task 2 - Identification of each initiating event and evaluation of their associated frequencies

Frequencies associated to each initiating event and sequence of events (identified in Task 1) will be determined on the basis of EDF PWR feedback, worldwide PWR feedback, material generic reliability database and engineering judgment when needed.

If the frequency of the initiating event is lower than the targets defined in SAP FA.5. then the fault will be added to the PSA safety case. If not, then the fault will be added to the DBA and PSA safety cases.

Results of the frequencies evaluation will be presented to the ONR through a dedicated meeting to be held in November 2011 (exact date tbd).

Task 3 - Initiating events evaluation - Determination of updates needed to DBA or PSA

A report presenting the considered initiating events and sequences and their attributed frequencies will be sent to ONR. This report will identify for each family of faults if the analysis will be included to the PSA or to the DBA safety case. Relative importance of administrative controls, interlocks, equipments, equipment classification, operator actions and associated claims will also be included and described.

If a specific event is shown to be bounded by another more penalizing event, visibility of any safety claim, safety classification of SSCs which ensure that the event is bounded will be given.

This report will be sent to the ONR (December 2011). Comments from the ONR shall be taken into account in a revision of the document, if needed.

3.1.1.3 Deliverable description	**Submission date to ONR/EA**
Presentation of results of tasks 1 and 2 – Results of FMECA study and list of initiating events with associated frequencies	November 2011
Report presenting the considered initiating events and sequences and their attributed frequencies List of all sequences which could lead to spent fuel cask fault and associated frequency will be presented	30/12/2011

3.2 Action GI-UKEPR-FS03.A2

Action I/D	Action Description
GI-UKEPR-FS03.A2	EDF and AREVA to provide an updated safety case for the spent fuel pool, incorporating the faults associated with the cask loading pit. The safety case needs to formalised: • If new PSA initiating events are identified by Action 1, additional event trees need to be incorporated into the PSA model. • If additions to the DBA are required: the category of the additional events (PCC-3/4) should be determined and adequate calculations or ALARP analysis undertaken to ensure that all criteria are met. A report should be provided to ONR describing the proposed changes to the safety case. EDF and AREVA shall update the PCSR accordingly with the agreed safety case developed through Action 1. With agreement from the Regulator this action may be completed by alternative means.

3.2.1 Planned submissions in response to GI-UKEPR-FS03.A2

3.2.1.1 Description of Scope of Work

In response to Action 2 of GI-UKEPR-FS03, EDF/AREVA will provide a formalisation of the safety case (following identification of considered initiating events and sequences GI-UKEPR-FS03.A1).

The PCSR will be updated accordingly to the document presented in the resolution task of GDA Issue Action GI-UKEPR-FS03.A2, for inclusion in the Final DAC PCSR.

3.2.1.2 Description of Methodology to be employed

Task 1: PSA/DBA Analyses

In response to Action 2 of GI-UKEPR-FS03, EDF/AREVA will provide a formalisation of the safety case (following identification of considered initiating events and sequences GI-UKEPR-FS03.A1).

- If an addition to the PSA is required: risk spectrum analysis to ensure that all criteria are met and addition in the PSA failure trees documentation.

- If an addition to the DBA is required: identification of the category for addition of the event/sequence (PCC-3/4) and adequate calculations or ALARP analysis to ensure that all

safety criteria are met.

A report presenting the proposed PSA changes and the proposed additions to the DBA analyses will be sent to the ONR (date to be confirmed). Comments from the ONR shall be taken into account in a revision of the document, if needed.

Task 2: Impact on the PCSR

The PCSR will be updated accordingly to the document presented in Task 1 of Action GI-UKEPR-FS03.A2, for inclusion in the Final DAC PCSR.

- If an addition to the PSA is required, chapter 15.3 – Probabilistic Safety Analysis - PSA of Accidents in the Spent Fuel Pool and PCSR chapter 15.5 Level 3 PSA – Assessment of off-site risk due to postulated accidents will be updated,

- If an addition to the DBA safety case is required, chapter 14 – Design Basis Analysis (sub chapter 14.3 – PCC-2 events through 14.5 – PCC-4 events) will be updated.

Advanced copies of the PCSR chapters will be sent to the ONR. If required modifications will be made for the final PCSR submission.

3.2.1.3 Deliverable description	**Submission date to ONR/EA**
Report presenting the proposed PSA changes and the proposed additions in the DBA analyses	30/03/2012
PCSR chapter 3.2 Classification of Systems, Structures and Components	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 9.1.3 Spent fuel cooling and purification system - PTR (excluding IRWST)	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 9.1.4 Fuel handling system	Advanced copy 30/04/2012

		Final 15/06/2012
PCSR chapter 14.3	Analysis of PCC-2 events	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 14.4	Analyses of the PCC-3 events	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 14.5	Analyses of the PCC-4 events	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 15.3	PSA of Accidents in the Spent Fuel Pool	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 15.5	Level 3 PSA – Assessment of off-site risk due to postulated accidents	Advanced copy 30/04/2012 Final 15/06/2012

3.3 Action GI-UKEPR-FS03.A3

Action I/D	Action Description
GI-UKEPR-FS03.A3	EDF and AREVA shall provide a consequences analysis for spent fuel pool leaks previously not considered within the design basis because of break preclusion arguments. EDF and AREVA identify a number of leaks associated with spent fuel pool which are currently excluded from the design basis analysis presented in the PCSR by evoking a break preclusion concept. The rigour required to show that the likelihood of failure is so low that the consequences of failure can be discounted is high in UK and should not be put forward to avoid making a consequences analysis. While a small number of High Integrity Components (HIC) have been recognised associated with the primary reactor circuit, the safety case as currently presented does not identify the spent fuel pool components as part of the HIC envelope. A consequences analysis of the identified leaks is to be provided, and a safety case (with accompanying ALARP arguments) identifying the design features and systems required to ensure the consequences are acceptable shall be submitted to ONR for assessment. The PCSR is to be updated to reflect any changes in the safety case. With agreement from the Regulator this action may be completed by alternative means.

3.3.1 Planned submissions in response to GI-UKEPR-FS03.A3

3.3.1.1 Description of Scope of Work

Leaks from the following locations are not considered in the design basis fault analysis because the flow rates cannot be compensated by normal makeup systems:

- the three FPCS suction lines from the spent fuel pool to the second isolation valve;
- the FPPS suction lines from the fuel transfer canal and the cask loading pit up to the second isolation valve;
- the FPPS suction lines from the reactor vessel pit, the reactor internals storage pit, and the fuel transfer canal of the reactor building to the second isolation valve; and
- the fuel transfer canal of the reactor building and the fuel transfer canal of the fuel building.

The exclusion of these breaks from the PCC faults is justified by evoking a break preclusion concept.

A consequences analysis of the identified leaks is to be provided, and a safety case identifying the design features and systems required to ensure the consequences are acceptable shall be submitted to ONR for assessment. It is acknowledged that isolation valves do need to be placed in a practical location and inevitably some piping will be upstream of them and therefore non-isolatable. EDF and AREVA will discuss how the location of these valves has been optimised to minimise the length of piping for which they need to make break preclusion arguments.

3.3.1.2 Description of Methodology to be employed

The exclusion of the faults listed above from the PCC faults is justified by evoking a break preclusion concept. A meeting will be organised to present the break preclusion concept to the ONR (September 2011 – date to be defined).

Task 1 – Consequence Analysis

The faults listed above, that are not compensated for by the normal FPCS make-up system, will be analysed in order to determine the consequences of leaks from those locations. The type of analysis that will be applied is consistent with those carried out in the Specific Studies chapter of the PCSR, 16.4. In these studies, the rules that are applied differ from those applied to design basis analysis. As detailed in PCSR Sub-chapter 16.4 are:

- Neither single failure nor preventative maintenance is considered in the transients studied.
- The assumptions applied to the studies are best estimates,
- The postulated fault in this case is not 2A double guillotine type failure. These lines are classed as medium-energy for which leaks are generally considered. The leak section is A_L , where $A_L = (d_i \times s)/4$, where d_i is the internal diameter of the line and s is the pipe wall-thickness.
- A fuel assembly is considered to be in the process of handled.

Based on these assumptions, the 4 leaks will be analysed individually.

If the consequences are found to be unacceptable, enhancements to the current design will be considered and an ALARP analysis will be performed.

A report presenting the consequence analyses will be sent to the ONR. Comments from the ONR shall be taken into account in a revision of the document, if needed.

Task 2 – PCSR Update

The PCSR will be updated to reflect the document presented in the resolution task of GDA Issue Action GI-UKEPR-FS.03.A3.

- Sub-chapter 16.4 – Specific Studies. A specific study relating to the Spent Fuel Pool break preclusion lines and associated ALARP analysis will be added.

Advanced copies of the PCSR Sub-chapters will be sent to the ONR (date of drafts available for co-applicant review 15/04/2012) for review and comments.

3.3.1.3 Deliverable description	**Submission date to ONR/EA**
Presentation the break preclusion concept to the ONR	September 2011
Report presenting the consequence analyses for the postulated line faults	16/01/2012
PCSR chapter 16.4 – Specific Studies Update to add new Spent Fuel Pool break preclusion specific study	Advanced copy 30/04/2012 Final 15/06/2012

4.0 SUMMARY OF IMPACT ON GDA SUBMISSION DOCUMENTATION

4.1 GDA submission documents impacted by GDA Issue and scheduled to be created (C) or updated (U) within GDA

GDA Submission Documents	C/U	Related GDA Issue Action(s)	Submission Date to ONR/EA
SSER sub-chapters PCSR chapter 3.2 Classification of Systems, Structures and Components	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 9.1.3 Spent fuel cooling and purification system - PTR (excluding IRWST)	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 9.1.4 Fuel handling system	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 14.3 Analysis of PCC-2 events	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 14.4 Analyses of the PCC-3 events	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 14.5 Analyses of the PCC-4 events	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final

			15/06/2012
PCSR chapter 15.3 PSA of Accidents in the Spent Fuel Pool	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 15.5 Level 3 PSA – Assessment of off-site risk due to postulated accidents	U	GI-UKEPR-FS03.A2	Advanced copy 30/04/2012 Final 15/06/2012
PCSR chapter 16.4 – Specific Studies: Update to add new Spent Fuel Pool break preclusion specific study	U	GI-UKEPR-FS.03.A3	Advanced copy 30/04/2012 Final 15/06/2012
GDA reference design documents (SDM in UKEPR-I-002) None			
Other GDA submission supporting documents			
Report presenting the considered initiating events and sequences and their attributed frequencies	C	GI-UKEPR-FS03.A1	30/12/2011
Report presenting the proposed PSA changes and the proposed additions in the DBA analyses	C	GI-UKEPR-FS03.A2	30/03/2012
Report presenting the consequence analyses for the postulated line faults	C	GI-UKEPR-FS.03.A3	16/01/2012

5.0 JUSTIFICATION OF ADEQUACY

The resolution plan proposes to perform a systematic review of all the initiating events / sequences leading to cask loading pit faults and to perform adequate safety studies for each identified fault.

Appropriate QA processes will be applied in line with GDA requirements (including co-applicant review and internal QA arrangements for review).

GI-UKEPR-FS03.A1:

The FMECA studies on the equipments whose failure would lead to one of the events to be avoided ensures identification of all failure modes. It ensures exhaustiveness of the analysis.

Screening of the EDF and worldwide PWR feedback reinforces the robustness of the methodology

GI-UKEPR-FS03.A2:

DBA and PSA analyses will be carried out by employing methodology, assumptions and rules that are consistent with those used for other DBA and PSA studies presented in the PCSR (chapters 14 - Design Basis accidents and chapter 15 – Probabilistic safety analyses). Additions to design basis analyses or probabilistic safety analyses will be recorded to the GDA PCSR as required by the GDA processes.

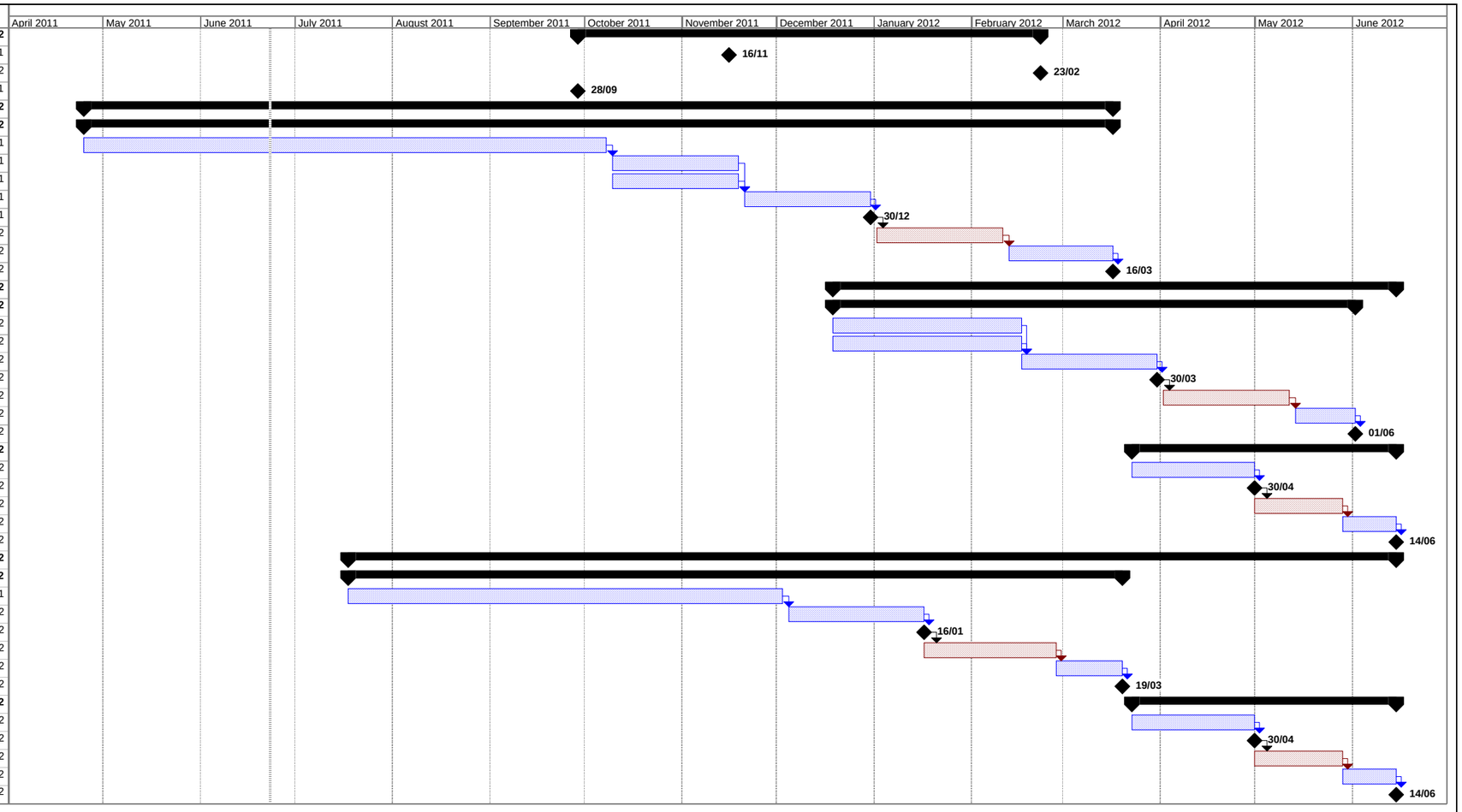
GI-UKEPR-FS03.A3:

The analysis that will be applied is consistent with other specific studies that are presented in 16.4 with realistic assumptions. The application of these realistic assumptions will allow an appropriate consideration of credible faults on the FPCS lines. Analysis of these faults will establish whether the consequences are unacceptable and if the consequences are unacceptable, potential design measures to mitigate these consequences will be examined through an ALARP analysis.

6.0 TIMETABLE AND MILESTONE PROGRAMME LEADING TO THE DELIVERABLES

See attached schedule

ID	Nom de la tâche	Duration	Start	Finish
1	**Meetings**	**105 days**	**Wed 28/09/11**	**Thu 23/02/12**
2	Meeting 1 - Progress meeting on Action 1	0 days	Wed 16/11/11	Wed 16/11/11
3	Meeting 2 - Progress meeting on Action 2 deliverables	0 days	Thu 23/02/12	Thu 23/02/12
4	Meeting 3 - Presentation of break preclusion concept	0 days	Wed 28/09/11	Wed 28/09/11
5	**Action 1 - Evaluation of initiating events**	**235 days**	**Mon 25/04/11**	**Fri 16/03/12**
6	**Task 1 - FMECA and frequency evaluation**	**235 days**	**Mon 25/04/11**	**Fri 16/03/12**
7	FMECA Analysis	120 days	Mon 25/04/11	Fri 07/10/11
8	Analysis of frequencies	30 days	Mon 10/10/11	Fri 18/11/11
9	Need for PSA/DBA analyses	30 days	Mon 10/10/11	Fri 18/11/11
10	Preparation of report	30 days	Mon 21/11/11	Fri 30/12/11
11	Report - transmission to ONR	0 days	Fri 30/12/11	Fri 30/12/11
12	ONR Review	30 days	Mon 02/01/12	Fri 10/02/12
13	Update following ONR comments	25 days	Mon 13/02/12	Fri 16/03/12
14	Final submission	0 days	Fri 16/03/12	Fri 16/03/12
15	**Action 2 - PSA/DBA Analyses**	**129 days**	**Mon 19/12/11**	**Thu 14/06/12**
16	**Task 1 - PSA/DBA analysis**	**120 days**	**Mon 19/12/11**	**Fri 01/06/12**
17	Risk Spectrum analysis (PSA)	44 days	Mon 19/12/11	Thu 16/02/12
18	DBA analysis	44 days	Mon 19/12/11	Thu 16/02/12
19	Preparation of report	31 days	Fri 17/02/12	Fri 30/03/12
20	Transmission to ONR of draft report	0 days	Fri 30/03/12	Fri 30/03/12
21	ONR review	30 days	Mon 02/04/12	Fri 11/05/12
22	Update following ONR comments	15 days	Mon 14/05/12	Fri 01/06/12
23	Submission of final report	0 days	Fri 01/06/12	Fri 01/06/12
24	**Task 2 - PCSR Update**	**60 days**	**Fri 23/03/12**	**Thu 14/06/12**
25	Draft PCSR chapters (except PSA)	27 days	Fri 23/03/12	Mon 30/04/12
26	Submission of draft PCSR Chapters	0 days	Mon 30/04/12	Mon 30/04/12
27	Review of draft PCSR chapters by ONR	20 days	Tue 01/05/12	Mon 28/05/12
28	Update following ONR comments	13 days	Tue 29/05/12	Thu 14/06/12
29	Final PCSR chapters	0 days	Thu 14/06/12	Thu 14/06/12
30	**Action 3 - Fuel Pool Cooling Trains**	**239 days**	**Mon 18/07/11**	**Thu 14/06/12**
31	**Task 1 - Consequences Analysis**	**176 days**	**Mon 18/07/11**	**Mon 19/03/12**
32	Consequences analysis	100 days	Mon 18/07/11	Fri 02/12/11
33	Preparation of report	31 days	Mon 05/12/11	Mon 16/01/12
34	Transmission to ONR of draft report	0 days	Mon 16/01/12	Mon 16/01/12
35	ONR review	30 days	Tue 17/01/12	Mon 27/02/12
36	Update following ONR comments	15 days	Tue 28/02/12	Mon 19/03/12
37	Submission of final report	0 days	Mon 19/03/12	Mon 19/03/12
38	**Task 2 - PCSR Update**	**60 days**	**Fri 23/03/12**	**Thu 14/06/12**
39	Draft PCSR chapters (except PSA)	27 days	Fri 23/03/12	Mon 30/04/12
40	Submission of draft PCSR Chapters	0 days	Mon 30/04/12	Mon 30/04/12
41	Review of draft PCSR chapters by ONR	20 days	Tue 01/05/12	Mon 28/05/12
42	Update following ONR comments	13 days	Tue 29/05/12	Thu 14/06/12
43	Final PCSR chapters	0 days	Thu 14/06/12	Thu 14/06/12



Projet : GI-FS03_V1
Date : Thu 23/06/11

Tâche
Fractionnement
Avancement
Jalon
Récapitulative
Récapitulatif du projet
Tâches externes
Jalons externes
Échéance