UK EPR	UK EPR GDA PROJECT			
	Title: Resolution Plan for GI-UKEPR-FS04			
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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
Steam Generator Tube Rupture	Fault Studies	Structural Engineering, Human Factor C&I

GDA Issue	The safety case for steam generator tube rupture faults needs revising to incorporate significant design changes identified by EDF and AREVA. The safety case should demonstrate that the proposed detection and management strategy is ALARP and provide justification for the claims on operation actions. If the analysis shows that the proposed strategy is not ALARP, then alternative strategies will need to be developed.

2.0 OVERVIEW OF SCOPE OF WORK

The safety case for steam generator tube ruptures (SGTR) in the UK EPR PCSR for Step 4 (November 2009 PCSR) identified thermo hydraulic means of detection of small SGTRs and following automatic actions. During Step 4 it was identified that the flow capacity of the CVCS was such that it could compensate for tube breaks up to and including a complete 2A tube rupture. Therefore if the CVCS and MFWS SG level control are working correctly at the time of the break, the thermo hydraulic trip settings may not be reached.

EDF and AREVA have provided a revised SGTR mitigation strategy which sets the principles for management of small SGTRs: activity detection on secondary side and manual reactor trip by the operator. For this, two N16 detectors are to be installed on each steam line as a prompt for a manual Class 1 (F1A) reactor trip. The modification of activity detectors on the secondary side (in order to cope with Class 1 detection) is presented in CMF-022. An ALARP discussion has been provided in Step 4 to explain why EDF and AREVA prefer the option of operator actions for the UK EPR over an alternative automatic trip. Transient analysis assuming EDF and AREVA's preferred strategy have also been performed. The larger N16 detectors proposed for implementation allow following an early

management strategy of small leaks that has been successfully adopted in the EDF French fleet. This strategy aims to detect the leaks early and to prevent the leaks from developing into the full 2A-tube ruptures. The mitigation strategy document discusses the ALARP arguments for a manual reactor trip (versus automatic). In addition to this initial reactor trip, the revised mitigation strategy also requires the operator to perform other manual actions (SG isolation, EFWS start up).

For a PCC-4 4A-SGTR fault (i.e. 2 complete tube ruptures) at power, EDF and AREVA have proposed no changes to the existing safety case as the CVCS is not able to compensate the loss of inventory from the primary to secondary side and the thermo hydraulic automatic protections are still effective.

The November 2009 PCSR also presents analysis of both PCC-3 and PCC-4 SGTR faults from 2% power to demonstrate through bounding analysis that the secondary side of the steam generators will not overfill. The modified N16 detectors are not claimed to be effective below 20% power while measurements of secondary side pressure and level can still be claimed at low power, hence the safety case should not be impacted by the Step 4 design change.

Following the submissions of the documents in Step 4, ONR has required:

- further ALARP arguments to justify the appropriateness of additional manual actions (following manual RT),
- a detailed Human Factors analysis of all the manual actions,
- a revised submission of SGTR faults at 2% power with updated assumptions.

3.0 GDA ISSUE ACTIONS AND RESOLUTION PLAN DELIVERABLES

3.1 Action GI-UKEPR-FS04.A1

Action I/D	Action Description
GI-UKEPR-FS04.A1	EDF and AREVA to provide a revised safety case and an ALARP argument to ONR to justify their proposed design to detect and mitigate PCC-3 Steam Generator Tube Ruptures. EDF and AREVA need to provide additional arguments and evidence to justify their design approach for PCC-3 SGTR faults or propose an alternative strategy. Therefore: • more information on the safety classification of these manual actions is required and an ALARP argument as to why they cannot be automated is to be provided, or • if an alternative strategy is identified, this similarly needs to be fully justified and substantiated, including new transient analysis. Any proposed modification arising from the above is to be handled through the agreed process for managing design change in GDA. EDF and AREVA shall update the PCSR and Fault Schedule in accordance with the agreed safety case. With agreement from the Regulator this action may be completed by alternative means.

3.1.1 Deliverables already submitted to ONR/EA in response to GI-UKEPR-FS04.A1

	Date of submission
RFFF- Monitoring Reactor coolant / secondary side leaks in PWRs – D4550.15-11/0406 Rev 001 – Sent through Letter EPR00800N	*23/02/2011*

3.1.2 Planned submissions in response to GI-UKEPR- FS04.A1

3.1.2.1 Description of Scope of Work

EDF and AREVA have presented arguments as to why they prefer to utilise a mitigation strategy for small SGTRs driven by manual actions. This consists in the implementation of N16 detectors on the secondary side to follow an early management strategy of small leaks that has been successfully adopted in the EDF French fleet. This strategy aims to prevent the leaks from developing into the full 2A-tube ruptures.

The ALARP document sent to ONR in December 2010 concentrates on the comparison between manual and automatic reactor trips. However, the proposed mitigation strategy also requires the operator to perform additional manual actions such as isolation of the affected SG, start of the EFW, etc.

As these manual actions required to go to controlled state and subsequently to the safe shutdown state are identified as Class 2 (F1B) in the PCSR, ONR is questioning the appropriateness of class 2 manual actions to terminate the fault.

EDF and AREVA will provide additional arguments and evidences to justify the design approach for PCC-3 SGTR faults with more information on the safety classification of the manual actions.

An update of the PCSR (all SGTR cases PCC-3 events) and supporting documentation (e.g. fault schedule) will be provided.

3.1.2.2 Description of Methodology to be employed

1) AREVA and EDF will propose an additional transient calculation for the penalizing case of radiological consequences (SGTR and MSRT stuck open). This transient will model only the initial manual Reactor Trip in order to demonstrate that in case of failure of the operator to carry out manual actions, the protection system protects the plant automatically from the initiating event. An evaluation of radiological consequences will be performed to make a comparison with the current PCSR bounding case.

This transient analysis will be sent to ONR by 15th September 2011.

2) In addition AREVA and EDF will provide more information on the classification of the manual actions identified to reach controlled state and subsequently the safe shutdown state.

This information will be provided through a dedicated meeting in July 2011 (date to be confirmed).

3) The mitigation strategy document (PEPR-F DC 38 – rev A sent to ONR on 23/12/2010) will be revised to include:

a) Integration of additional elements regarding back up automatic protection by the RPS for the penalising case (see Point 1)).

b) Additional ALARP arguments about EDF/AREVA SGTR strategy with regard to leak cancelation achievement.

c) Additional ALARP arguments for small SGTR degrading to larger leaks.

d) Information on classification of the required operator manual actions.

e) Feedback from the Human Factors task analysis (see description in GI-UKEPR-FS04 Action 2).

This action will be performed by 28th October 2011.

4) Update of the PCSR and supporting documentation (e.g. fault schedule if needed) by 28th October 2011.

3.1.2.3 Deliverable description	**Submission date to ONR/EA**
PEPR-F.10.1665: EPR™ UK - GDA – rev B Update of single Tube Steam Generator Tube Rupture Analysis for the UK EPR Update of the document with additional calculations as described in point 1.	15/09/2011
PEPR-F DC 38 – rev B – Update of ALARP – mitigation strategy for small SGTRs Update of ALARP document to include elements from additional calculations and human factors feedback	28/10/2011
PCSR chapter 14.4.6 “Steam Generator Tube Rupture (1 tube)” – update of PCSR chapter – draft chapter	Advanced copy 28/10/2011 Final chapters 30/12/2011

3.2 Action GI-UKEPR-FS04.A2

Action I/D	Action Description
GI-UKEPR-FS04.A2	EDF and AREVA to provide a detailed human factors justification of the actions claimed in the design basis safety case for the PCC-3 fault. In support of the ALARP case required in Action 1, a detailed human factors justification of any manual actions claimed in the design basis safety case for the PCC-3 fault is to be submitted to HSE-ND. SGTR faults are amongst the most challenging events to ONR's Target 4 for design basis fault sequences because of the potential for radioactive products to be discharged to atmosphere through the main steam relief train. EDF and AREVA have proposed a new mitigation strategy for the PCC-3 fault that departs from the typical UK EPR safety case principle of relying on automatic F1A (Class 1) actions to reach the controlled state. In addition to a manual reactor trip, the current proposals require the operator to perform additional manual actions such as isolation of the affected SG, start of the EFW. With agreement from the Regulator this action may be completed by alternative means.

3.2.1 Planned submissions in response to GI-UKEPR- FS04.A2

3.2.1.1 Description of Scope of Work

In support of the ALARP case required in Action 1, a detailed human factors justification of any manual actions claimed in the design basis safety case (up to the controlled state, leak termination and subsequently onto the safe shutdown state) for the PCC-3 fault will be performed.

This detailed post accident human factor analysis will be performed on the simulator to analyse operator response times. This Action is linked to Human Factors GI-UKEPR-HF01 which requires qualitative substantiation of a range of human based safety claims.

3.2.1.2 Description of Methodology to be employed

SGTR analysis is included in task analysis foreseen in response to human factors GDA issue GI-UKEPR-HF01. The analysis is based on the simulation of the post fault operator actions on a simulator to validate timings for operator actions.

Input data of typical response time for operators considered in fault studies will be provided to the HF group. Realistic response times will be evaluated as well as bounding fault studies response times

(e.g. 30 min in PCC rules for operator actions). Following this analysis, recommendations will be made by the HF group on likeliness of errors and adequacy of operators response times to the Fault Studies group.

The Human Based Safety Claims will be identified by Fault Studies area and the Human Factor topic will substantiate the SGTR HBSC following the Task analysis method statement for post-fault human errors.

If necessary, feedback from the Human Factors task analysis will be included in the ALARP document provided as a response to Action 1.

The date for the identification of HBSCs for the SGTR case is October 14th 2011.

3.2.1.3 Deliverable description	**Submission date to ONR/EA**
New document: Human factors analysis of PCC-3 SGTR SGTR HBSC following the Task analysis method statement for post-fault human errors	14/10/2011

3.3 Action GI-UKEPR-FS04.A3

Action I/D	Action Description
GI-UKEPR-FS04.A3	EDF and AREVA to provide transient analysis to show that there is a margin to overfill for the design basis PCC-3 and PCC-4 SGTR faults, with assumptions appropriate for the UK EPR. The UK EPR design has diverged away from the analysis presented in the PCSR to such an extent that new analyses of the PCC-3 2A-SGTR and PCC-4 4A-SGTR events are required to demonstrate there is a margin to overfill and that the long term safe shutdown state can be reached with safety criteria met. EDF and AREVA shall update the PCSR to reflect the revised analysis. With agreement from the Regulator this action may be completed by alternative means.

3.3.1 Planned submissions in response to GI-UKEPR- FS04.A3

3.3.1.1 Description of Scope of Work

The analysis in the PCSR demonstrating a margin to overfill and that the safe shutdown state can be reached following a SGTR fault considers a single transient occurring from 2% power without LOOP. The analysis proposed may be still valid even considering the proposed design changes, however, the following assumptions are considered:

- 4900 MWth is assumed rather than 4500 MWth
- MHSI injection is assumed to have a delivery pressure 5 bar lower than for the 4500 MWth design
- The CVCS charging flow is assumed to be 20 kg/s (less than the maximum break flow from a 2A-SGTR) compared to the 28 kg/s now identified as the charging flow capacity (more than the break flow from a 2A-SGTR)
- Manual isolation of the CVCS charging line is assumed after 30 minutes instead of the automatic isolation available in the 2008 design freeze
- A partial cooldown rate of 100°C/h is assumed rather than 250°C/h.

EDF and AREVA will update the PCSR for PCC-4 SGTR faults to reflect the revised assumptions.

3.3.1.2 Description of Methodology to be employed

The different cases presented in the PCSR will be performed according to the PCC-4 events methodology described in the PCSR and with the UK EPR specific assumptions, as described above.

The four (4) cases of the PCSR are to be updated in order to take into account the CVCS new

assumptions: short term Cases with and without LOOP and long term cases with and without LOOP.

A revised PCSR chapter will be provided to ONR by 29th September 2011.

3.3.1.3 Deliverable description	**Submission date to ONR/EA**
Update of PCSR chapter 14.5.10 “Steam Generator Tube Rupture (2 tubes in 1 SG)” Inclusion of revised calculations.	Advanced copy 29/09/2011 Final chapters 09/12/2011

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 14.4.6 “Steam Generator Tube Rupture (1 tube)”	**U**	GI-UKEPR-FS04-A1	Advanced copy 28/10/2011 Final chapters 30/12/2011
PCSR chapter 14.5.10 “Steam Generator Tube Rupture (2 tubes in 1 SG)”	**U**	GI-UKEPR-FS04-A3	Advanced copy 29/09/2011 Final chapters 09/12/2011
GDA reference design documents (SDM in UKEPR-I-002) NONE			
Other GDA submission supporting documents			
PEPR-F DC 38 A: Steam Generator Tube Rupture Mitigation Strategy	**U**	GI-UKEPR-FS04.A1	28/10/2011
PEPR-F.10.1665: EPR™ UK - GDA - Single Tube Steam Generator Tube Rupture Analysis for the UK EPR	**U**		15/09/2011
Human factor studies	**C**	GI-UKEPR-FS04.A2	14/10/2011

5.0 JUSTIFICATION OF ADEQUACY

Additional evidences justifying the SGTR PCC-3 event mitigation strategy based on manual actions will be provided including:

- supporting calculation to show that adequate automatic actions are available in the penalising case should the operator fail to perform the manual actions,

- an updated ALARP analysis of manual actions versus automatic actions, including considerations regarding layout/cost of a potential automated solution, as well as comparison of radiological consequences between different cases

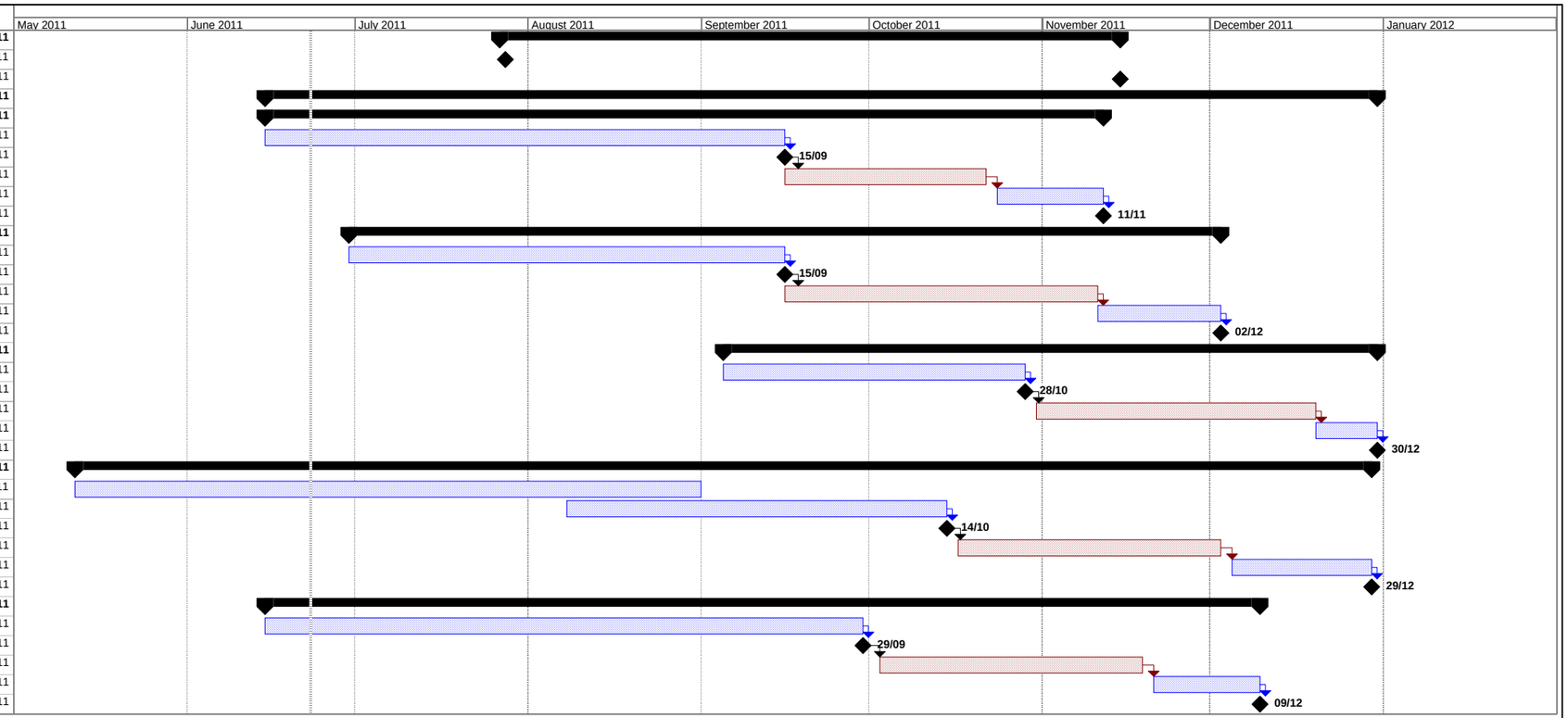
The response to Action 2 will be coordinated with the Human Factors topic group to provide a detailed human factors post accidental study. The use of the simulator will allow simulation of the post fault operator actions to validate timings. If needed, the feedback from this detailed HF analysis will be included in the Fault Studies response to Action 1.

Additionally all PCC-3 and PCC-4 SGTR studies will be updated in the PCSR (chapter 14) taking into account the methodology and rules given for PCC studies in chapters 14.0 and 14.1.

6.0 TIMETABLE AND MILESTONE PROGRAMME LEADING TO THE DELIVERABLES

See attached schedule.

ID	Nom de la tâche	Duration	Start	Finish
1	**Meetings**	**79 days?**	**Wed 27/07/11**	**Mon 14/11/11**
2	Meeting 1 - Safety classification of manual actions	1 day?	Wed 27/07/11	Wed 27/07/11
3	Meeting 2 - if necessary - discussion on submission	1 day?	Mon 14/11/11	Mon 14/11/11
4	**Action 1 - Revised safety case and ALARP arguments**	**143 days**	**Wed 15/06/11**	**Fri 30/12/11**
5	**A1.1 - Additional supporting calculations**	**108 days**	**Wed 15/06/11**	**Fri 11/11/11**
6	calculations and draft report	67 days	Wed 15/06/11	Thu 15/09/11
7	Transmission to ONR	0 days	Thu 15/09/11	Thu 15/09/11
8	ONR review	26 days	Fri 16/09/11	Fri 21/10/11
9	Update following ONR comments (including reviews)	15 days	Mon 24/10/11	Fri 11/11/11
10	Submission of revised report	0 days	Fri 11/11/11	Fri 11/11/11
11	**A1.2 - Update of ALARP analysis**	**112 days**	**Thu 30/06/11**	**Fri 02/12/11**
12	Draft report	56 days	Thu 30/06/11	Thu 15/09/11
13	Transmission to ONR	0 days	Thu 15/09/11	Thu 15/09/11
14	ONR review	40 days	Fri 16/09/11	Thu 10/11/11
15	Update following ONR comments	16 days	Fri 11/11/11	Fri 02/12/11
16	Submission of revised report	0 days	Fri 02/12/11	Fri 02/12/11
17	**A1.3 PCSR update**	**85 days**	**Mon 05/09/11**	**Fri 30/12/11**
18	Draft PCSR chapter report	40 days	Mon 05/09/11	Fri 28/10/11
19	Draft PCSR chapter - transmission to HSE	0 days	Fri 28/10/11	Fri 28/10/11
20	ONR review	36 days	Mon 31/10/11	Mon 19/12/11
21	Update following ONR comments	9 days	Tue 20/12/11	Fri 30/12/11
22	Submission of final PCSR chapter	0 days	Fri 30/12/11	Fri 30/12/11
23	**Action 2 - Human Factors detailed analysis**	**166 days?**	**Thu 12/05/11**	**Thu 29/12/11**
24	Detailed HF analysis	80 days	Thu 12/05/11	Wed 31/08/11
25	Draft document	50 days	Mon 08/08/11	Fri 14/10/11
26	Report - transmission to ONR	0 days	Fri 14/10/11	Fri 14/10/11
27	ONR review	35 days?	Mon 17/10/11	Fri 02/12/11
28	Update report following ONR comments	19 days?	Mon 05/12/11	Thu 29/12/11
29	Submission of revised report	0 days	Thu 29/12/11	Thu 29/12/11
30	**Action 3 - PCC-4 analyses update**	**128 days**	**Wed 15/06/11**	**Fri 09/12/11**
31	calculations and draft report	77 days	Wed 15/06/11	Thu 29/09/11
32	Report - transmission to ONR	0 days	Thu 29/09/11	Thu 29/09/11
33	ONR review	35 days	Mon 03/10/11	Fri 18/11/11
34	Update following ONR comments (including reviews)	15 days	Mon 21/11/11	Fri 09/12/11
35	Submission of revised report	0 days	Fri 09/12/11	Fri 09/12/11



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

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