Westinghouse UK
AP1000® GENERIC DESIGN ASSESSMENT
Resolution Plan for GI-AP1000-FS-04
Provision of Enhanced and Diverse Flux Protection to Protect Against Adverse Power Distribution Faults

MAIN ASSESSMENT AREA	RELATED ASSESSMENT AREA(S)	RESOLUTION PLAN REVISION	GDA ISSUE REVISION
Fault Studies	Control and Instrumentation Fuel Design	2	0

GDA ISSUE:	To examine the feasibility of enhancing the flux protection on the **AP1000®** to provide automatic and diverse protection against frequent adverse power distribution faults possibly using the current design of in-core instrumentation.
ACTION: GI-AP1000-FS-04.A1	Westinghouse is required to provide a report demonstrating a comprehensive assessment of the potential for enhancing the protection provided by installed in-core instrumentation against adverse power distribution faults. Westinghouse is proposing to use the BEACON computer code as an on-line monitoring system to provide continuous indications of power distributions and key safety parameters. These surveillances are used to alarm conditions where the margin to key safety limits becomes unacceptable. The software reliability of such complex computer codes is not considered sufficient in isolation to provide this function to a high level of reliability. In addition, BEACON is not integrated into the protection system. In Sizewell B, the core power profile and margin to safety limits is monitored by the reactor primary protection system using a matrix of ex-core detector importance factors. These factors are subject to a rigorous QA process independent of the core design process and validated against flux maps. Given the rigor with which the primary protection system software is validated, the monitoring of core power peaking and of the margin to safety limits is carried out with a high degree of confidence. The situation was a requirement placed on Sizewell B as part of the licensing process, and is considered relevant good practice within the UK. ONR requires that Westinghouse demonstrate whether it is reasonably practicable to provide extra protection against adverse power-distribution faults using the current design of in-core instrumentation. It is not considered credible that this can be achieved using a system relying solely on a software system including a reactor physics code similar to that of BEACON. The response to this GDA issue should include an ALARP assessment, which demonstrates whether it is reasonably

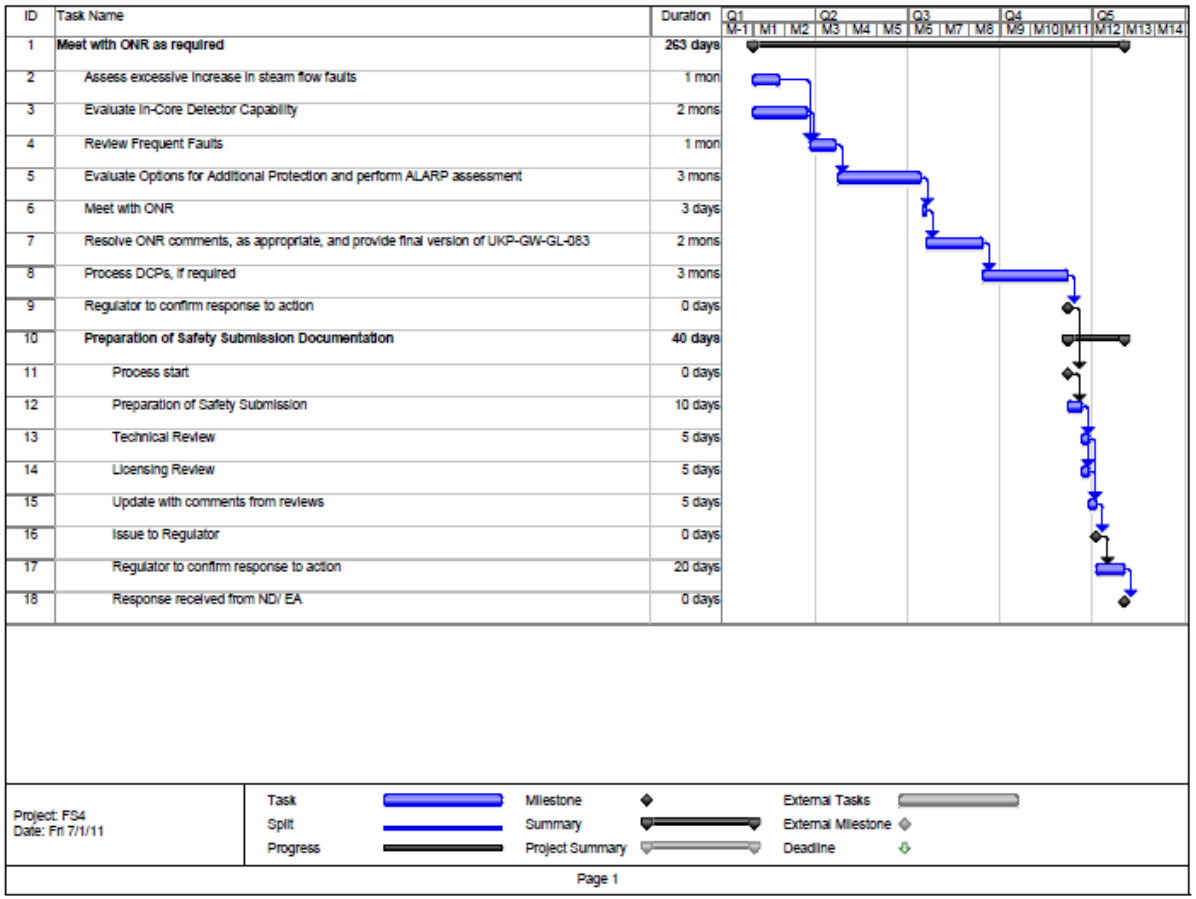
	practicability to provide additional protection on the peak linear and the margin to CHF, based upon in-core instrumentation. Furthermore, the assessment should consider the use of rod freeze protection to ensure that limits on shutdown margin are not violated. The design for any proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR. With agreement from the Regulator this action may be completed by alternative means.
ACTION: GI-AP1000-FS-04.A2	Westinghouse is required to demonstrate that diverse protection is provided against frequent reactivity and power distribution faults such as the excessive increase in secondary steam flow and rod misalignment faults. Consideration should be given to the possibility of enhancing the installed in-core instrumentation to provide diverse protection against these faults. Westinghouse has demonstrated that the hot leg temperature trip on the DAS provides diverse protection against RCCA bank withdrawal faults occurring at power. However, the responses provided do not demonstrate diverse protection against excessive increase in secondary steam flow faults greater than 10% flow or demonstrate diverse flux protection for rod misalignment faults up to and including rod drop faults. ONR requires Westinghouse to demonstrate that there is automatic diverse protection against these frequent faults. In seeking to demonstrate adequate protection for these faults, Westinghouse should consider the feasibility of using the current design of in-core instrumentation enhanced in accordance with the previous action of this GDA issue. The response to this GDA issue should include a transient analysis assessment for the excessive increase in secondary steam flow fault at full power and rod misalignment faults including rod drop faults in which the ex-core detectors are assumed to be ineffective due to a common mode failure. The design for any proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR. With agreement from the Regulator this action may be completed by alternative means.
RELEVANT REFERENCE DOCUMENTATION RELATED TO GDA ISSUE	
Technical Queries	N/A
Regulatory Observations	RO-**AP1000**-91
Other Documentation	UKP-GW-GL-083 Revision A, "**AP1000** Flux Protection and Diversity for Frequent Faults (Response to RO-91)" located on row 013753 of the eRoom

Scope of work:
Westinghouse must demonstrate whether it is reasonably practicable to provide extra protection against such faults including the possibility of enhancing the current design of in-core instrumentation.

Description of work:
Westinghouse has provided a report addressing most of the ONR requests for Action is with UKP-GW-GL-083, Rev A. Due to the timing of the submittal In January 2010, Westinghouse and ONR have not yet the time to discuss ONR comments on the assessment. As part of the resolution plan, Westinghouse will work to address ONR comments, as discussed during the development of the Resolution plan, on the draft RO-91 response provided by UKP-GL-GL-083, Rev.A. Therefore, Westinghouse will issue an updated response to address ONR comments and the following areas will be more completely considered and reviewed in a revised response document: • Consolidate Justification and Assessment that frequent faults are addressed in a comprehensive way, and that relevant potential common mode failures and modes of operation are considered • Complete the ALARP assessment of options Consideration of BEACON and operator reliability To address these general actions, the following specific actions will be pursued to provide resolution of this GDA issue: 1. The assessment of frequent faults will be expanded to include additional consideration for excessive increases in steam flow faults (where the ONR has requested additional justification or consideration or potential increases greater than 10%), dropped rod faults with a common mode failure of flux protection, and the boron dilution faults from shutdown condition (demonstration that these faults are bounded by at-power faults). 2. The ALARP options evaluation will be expanded to evaluate also the capability of the current in-core detectors and verify if they could be used, in some manner, for additional diverse flux protection. The evaluation should include: • Evaluation of current in-core detector capability • Review of the complete list of frequent faults to identify for which faults, if any, could benefit be provided from additional protection, and quantify the benefit • Evaluate different options for implementation and their practicality, especially with consideration of the DAS and PLS Complete the ALARP assessment by reviewing the potential implementation approaches, their benefits and practicality, including of course consideration also of human actions and operator reliability. Relevant Good Practice will be included in the final ALARP assessment. • Additional information on fast-acting in-core detectors and their development outlook will be provided.

Schedule/ programme milestones:

Because all Resolution Plan start dates are subject to future contract placements, dates are presently undefined; therefore schedule dates have been anonymised for consistency. Actual dates will be inserted when contracts are placed.



ID	Task Name	Duration
1	**Meet with ONR as required**	**263 days**
2	Assess excessive increase in steam flow faults	1 mon
3	Evaluate In-Core Detector Capability	2 mons
4	Review Frequent Faults	1 mon
5	Evaluate Options for Additional Protection and perform ALARP assessment	3 mons
6	Meet with ONR	3 days
7	Resolve ONR comments, as appropriate, and provide final version of UKP-GW-GL-083	2 mons
8	Process DCPs, if required	3 mons
9	Regulator to confirm response to action	0 days
10	**Preparation of Safety Submission Documentation**	**40 days**
11	Process start	0 days
12	Preparation of Safety Submission	10 days
13	Technical Review	5 days
14	Licensing Review	5 days
15	Update with comments from reviews	5 days
16	Issue to Regulator	0 days
17	Regulator to confirm response to action	20 days
18	Response received from ND/ EA	0 days

Methodology:
At the conclusion of the ALARP assessment, if any design change is identified as ALARP, design change proposals will be developed processed in a manner consistent with Westinghouse procedures. In general, the methodology by which this issue will be addressed is presented in the description of work. No new methodologies will be employed in the execution off this plan.

Justification of adequacy:
Following completion of the defined effort Westinghouse will provide a robust safety case addressing all of the concerns raised by this issue. The approach herein outlined expands and completes the assessment of the overall flux protection diversity safety case.

Impact assessment:
The Safety Case has been updated to include the all aspects of the provided response to RO-**AP1000**-91. Any further aspects of the response will be reflected in the PCSR as applicable. UKP-GW-GL-083, Rev. A.