Office for Nuclear Regulation

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Redgrave Court Merton Road Bootle Merseyside L20 7HS
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# WESTINGHOUSE AP1000® GENERIC DESIGN ASSESSMENT

## GDA ISSUE

## PROVISION OF ENHANCED AND DIVERSE FLUX PROTECTION TO PROTECT AGAINST ADVERSE POWER DISTRIBUTION FAULTS

## GI-AP1000-FS-04 REVISION 0

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|---|---|---|---|
| **Technical Area** | **FAULT STUDIES** | | |
| **Related Technical Areas** | Control and Instrumentation<br>Fuel Design | | |
| **GDA Issue Reference** | **GI-AP1000-FS-04** | **GDA Issue Action Reference** | **GI-AP1000-FS-04.A1** |
| **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. | | |
| **GDA Issue Action** | 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.<br>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.<br>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.<br>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.<br>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. | | |

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| **Technical Area** | | **FAULT STUDIES** | |
| **Related Technical Areas** | | Control and Instrumentation<br>Fuel Design | |
| **GDA Issue Reference** | **GI-AP1000-FS-04** | **GDA Issue Action Reference** | **GI-AP1000-FS-04.A1** |
| | The design for any proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR.<br>With agreement from the Regulator this action may be completed by alternative means. | | |

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| **Technical Area** | | **FAULT STUDIES** | |
| **Related Technical Areas** | | Control and Instrumentation<br>Fuel Design | |
| **GDA Issue Reference** | **GI-AP1000-FS-04** | **GDA Issue Action Reference** | **GI-AP1000-FS-04.A2** |
| **GDA Issue Action** | 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.<br>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.<br>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.<br>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.<br>The design for any proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR.<br>With agreement from the Regulator this action may be completed by alternative means. | | |