

Office for Nuclear Regulation

An agency of HSE

Redgrave Court Merton Road Bootle Merseyside L20 7HS
Tel: 0151 951 4000 www.hse.gov.uk/nuclear

EDF AND AREVA UK EPR GENERIC DESIGN ASSESSMENT

GDA ISSUE

GI-UKEPR-FS-02 – REVISION 0

Technical Area	FAULT STUDIES		
Related Technical Areas	Probabilistic Safety Assessment Control and Instrumentation Human Factors		
GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A1
GDA Issue	Demonstration of functional diversity for frequent faults		
GDA Issue Action	<p>Implement the proposed modification to provide a diverse high hot leg pressure trip signal on an appropriately diverse protection system for a loss of normal feedwater fault with failure of the reactor protection system to trip.</p> <p>EDF and AREVA have identified that a modification is required to provide a reactor trip signal on high hot leg pressure on a non-TXS based protection system. This is to protect against a loss of normal feedwater fault with failure of the TXS based reactor protection system to trip the reactor. The design for the proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A2
GDA Issue Action	<p>Provide improved protection for the excessive increase in secondary steam flow fault with failure of the reactor to trip due to either mechanical failure of the rods to insert or failure of the reactor protection system.</p> <p>In NEPR-F DC 592, analysis is presented for the case of excessive increase in secondary steam flow with failure of the reactor to trip. The analysis demonstrates that for such transients, the fault continues for a considerable period and that the variation in DNB is significant. This is true for both the mechanical failure of the rods to insert and the failure of the TXS-based reactor protection system:</p> <ul style="list-style-type: none"> • In the case of the mechanical failure to insert, the position has been made worst by the recent design change to increase the partial cooldown rate for SBLOCA faults which has resulted in a relaxation of the SG pressure drop trip set point which now means that low SG level is the most effective trip parameter for these faults. • In the case of mechanical failure of the rods to insert, EDF and AREVA will justify why it is not ALARP to provide an additional trip signal or tighten the protection set points for this fault. • In the case of TXS failure, EDF and AREVA will perform an ALARP study to explore the feasibility of providing an extra trip parameter on a non-TXS based diverse protection system. <p>Any design modifications identified as necessary will need to complete the six-stage modification process for inclusion in the consolidated PCSR.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A3
GDA Issue Action	Implement the proposed modification to provide a diverse low RCP speed trip signal on an appropriately diverse protection system for a reduction in flow fault with failure of the reactor protection system to trip. EDF and AREVA have identified that a modification is required to provide a reactor trip signal on low RCP speed on a non-TXS based protection system. This is to protect against a flow reduction fault with failure of the TXS based reactor protection system to trip the reactor. The design for the proposed modification will need to complete the six-stage modification process for inclusion in the consolidated PCSR. With agreement from the Regulator this action may be completed by alternative means.		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A4
GDA Issue Action	Implement the proposed modification to provide diverse high axial offset and high neutron flux trips on an appropriately diverse protection system for a RCCA bank withdrawal fault with failure of the reactor protection system to trip. EDF and AREVA have identified that two extra reactor trip signals need to be added to a non-TXS based protection system. The extra trip signals are a high axial offset trip and a high neutron flux trip. These changes are to protect against a RCCA bank withdrawal fault with failure of the TXS based reactor protection system to trip the reactor. The design for the proposed modification will need to complete the six-stage modification process for inclusion in the consolidated PCSR. With agreement from the Regulator this action may be completed by alternative means.		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A5
GDA Issue Action	<p>Demonstrate the provision of diverse protection against rod misplacement faults including one or more dropped rods.</p> <p>No analysis of these faults is presented within NEPR-F DC 592 and yet these faults will be very difficult to detect should there be a failure of the TXS-based reactor protection system. For this reason, EDF and AREVA are to provide explicit transient analysis using design basis analysis techniques for these faults to demonstrate that the diverse protection systems are functionally capable of maintaining adequate margin to departure from nucleate boiling. A modification to include the provision of a negative-rate flux trip signal on a non TXS-based protection system is to be considered as a possible ALARP measure.</p> <p>The design of any proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A6
GDA Issue Action	<p>Demonstrate the provision of diverse protection against loss of CVCS following a normal reactor trip and xenon decay including demonstration of diversity to operator action.</p> <p>After every reactor trip from full power there is an eventual decay in the level of xenon poisoning within the reactor core. The resultant swing in reactivity needs to be compensated for through increasing the boron concentration in the reactor to ensure an adequate shutdown margin. While the emergency boration system (EBS) and the in-containment refuelling water storage tank (IRWST) provide two diverse sources of borated water, should the operator fail to ensure adequate shutdown margin using the Chemical and Volume Control System (CVCS), both these systems are also dependent upon operator action for actuation. Although timescales are long (many hours), this implies a combined human reliability of 1×10^{-7} per demand to meet the design basis target. For this reason, EDF and AREVA are to provide an ALARP study into the feasibility of automatically actuating the CVCS system to inject borated water after every reactor trip and for the EBS to be automatically actuated following failure of the CVCS. Alternatively, EDF and AREVA may wish to provide a consequence analysis of what would happen should the operator fail to ensure adequate shutdown margin.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A7
GDA Issue Action	<p>Demonstrate the provision of diverse protection against a homogenous boron dilution fault occurring in shutdown conditions with failure of the reactor protection system.</p> <p>No analysis of this fault is presented within NEPR-F DC 592 and yet such a fault would be very difficult to detect should there be a failure of the TXS-based reactor protection system. For this reason, EDF and AREVA are to provide explicit transient analysis using design basis analysis techniques for this fault to demonstrate that the diverse protection systems are functionally capable of maintaining adequate margin to departure from nucleate boiling. A modification to include the provision of a boron dilution block signal and an EBS actuation signal on a non TXS-based protection system (actuated by low doubling time and/or high source-range flux level) is to be considered as a possible ALARP measure.</p> <p>The design of any proposed modification will need to complete the six-stage modification process for inclusion within the consolidated PCSR.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A8
GDA Issue Action	Demonstrate the provision of diverse protection for the frequent faults involving the loss of essential support systems (e.g. loss of cooling chain, electrical, HVAC). EDF and AREVA are to provide a demonstration of diversity for frequent faults involving loss of essential support systems including loss of cooling chain, electrical and HVAC systems. EDF and AREVA are to demonstrate that any diverse systems claimed are appropriately categorised. In the case of loss of grid with failure of the TXS-based protection system, the feasibility of automatically actuating the station-blackout diesel generators (SBO DGs) on a non-TXS based protection system will need to be considered as a possible ALARP measure. Any design changes identified from the review 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.		

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GDA Issue Reference	GI-UKEPR-FS-02	GDA Issue Action Reference	GI-UKEPR-FS-02.A9
GDA Issue Action	Demonstrate that there exists a diverse means of achieving the safe shutdown state from the controlled state for frequent faults. EDF and AREVA are to demonstrate that diverse means of achieving a safe shutdown state from the controlled state exist for all frequent faults and that all structures, systems and components are appropriately categorised. Any design changes required because of any reclassifications will need to complete the six-stage modification process for inclusion in the consolidated PCSR. With agreement from the Regulator this action may be completed by alternative means.		