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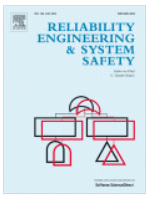


# A new method for explicit modelling of single failure event within different common cause failure groups

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## Abstract

Redundancy and diversity are the main principles of the safety systems in the nuclear industry. Implementation of safety components redundancy has been acknowledged as an effective approach for assuring high levels of system reliability. The existence of redundant components, identical in most of the cases, implicates a probability of their simultaneous failure due to a shared cause—a common cause failure.

This paper presents a new method for explicit modelling of single component failure event within multiple common cause failure groups simultaneously. The method is based on a modification of the frequently utilised Beta Factor parametric model. The motivation for development of this method lays in the fact that one of the most widespread softwares for fault tree and event tree modelling as part of the probabilistic safety assessment does not comprise the option for simultaneous assignment of single failure event to multiple common cause failure groups. In that sense, the proposed method can be seen as an advantage of the explicit modelling of common cause failures. A standard standby safety system is selected as a case study for application and study of the proposed methodology. The results and insights implicate improved, more transparent and more comprehensive models within probabilistic safety assessment.

## Keywords

Common cause failures; Probabilistic safety assessment; Fault tree; Explicit modelling

Figures and tables from this article:

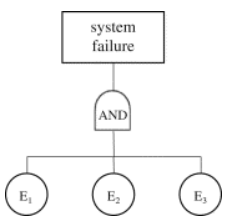


Fig. 1. Fault tree (component-level)—an example.

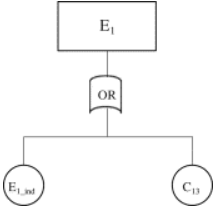


Fig. 2. Explicit modelling of CCF within FTA (sub-component-level FT).

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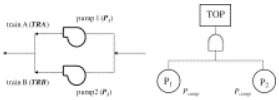


Fig. 3. Example system of two redundant pumps and its corresponding FT.

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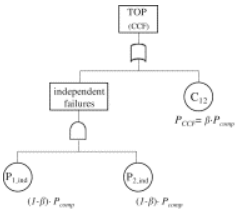


Fig. 4. Equivalent FT for the system with two redundant pumps.

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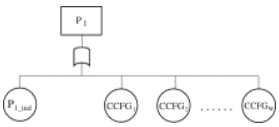


Fig. 5. Explicit modelling of single BE in *W* CCFGs—BE $P_1$ case.

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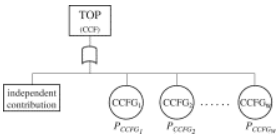


Fig. 6. Equivalent FT for the scenario with W different CCFGs .

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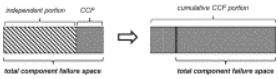


Fig. 7. Partition of component failure space .

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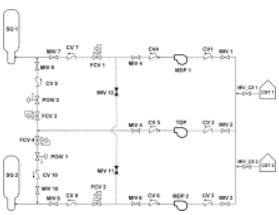

Fig. 8. Case study—Auxiliary Feedwater System (AFWS).

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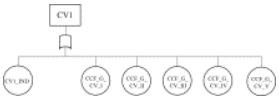


Fig. 9. Method application—explicit modelling of CV1 within 5 CCFGs (CCF_G_CV_I – CCF_G_CV_V) simultaneously.

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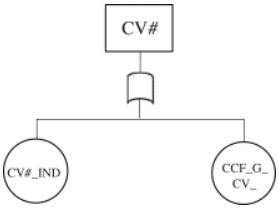


Fig. 10. Explicit modelling of CCF for CVs other than CV1 comprised within some of the 5 CCFGs associated to CVs.

Figure options

Table 1. AFWS components reliability data.

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Table 2. Individual CCFG data.

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Table 3. MCSs results for the case without considering CCF.

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Table 4. MCSs results for the case considering CCF, prior applying PRF-approach.

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Table 5. New, modified β factors after applying the PRF-approach.

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Table 6. MCSs results for the case considering CCF, after applying PRF-approach.

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