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Criteria for independence of class 1E equipment and circuits in nuclear power plants

核电厂安全级电气设备和电路独立性准则

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1 Scope

GB/T 13286-2021 is the Chinese national standard on criteria for independence of class 1e equipment and circuits in nuclear power plants, in the field of energy and heat transfer engineering. The /T suffix marks it as a recommended standard: it is not compulsory by itself, but it becomes binding as soon as a contract, a tender or a customer specification calls it up - which in practice is how most foreign buyers meet it. It was issued on 31 December 2021 by the State Administration for Market Regulation; Standardization Administration of China, and has been in force since 1 July 2022. Classification: ICS 27.120.20, CCS F83. This page is published from the official record of the standard held by the Chinese standards administration: the identification, the dates, the classification and the issuing body are taken from there. The clause text, the tables and the numeric limits are in the document itself, which is delivered complete in English translation.

This document specifies the independence criteria for physical separation and electrical isolation of safety-class electrical equipment and circuits. This document applies to the safety class of nuclear power plants and their related electrical equipment and circuits. This

document does not apply to the determination of redundant equipment and circuits.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for dated references, only the version corresponding to that date applies to this document; for undated references, the latest version (including all amendments) applies to this document.

GB/T 5204 Periodic surveillance testing of the safety system of nuclear power plant

GB 8624 Classification for burning behavior of building materials and products

GB/T 12790 Method for identification of documents related to safety class 1E equipment and systems for nuclear power plants

GB 50016 Code for fire protection design of buildings NB/T 20070 Criteria for design, installation, and qualification of raceway systems for class 1E circuits in nuclear power plants NB/T 20213 Qualification procedure of safety-related electric cables and field splices for nuclear power plants

3 Terms and definitions

The following terms and definitions apply to this document.

3.1 The independence of safety-class electrical equipment and circuits shall not be compromised by the functional failure of auxiliary supporting features. For example, auxiliary supporting features (such as ventilation devices in safety-class switchgear rooms) shall be specified as belonging to the same division as the safety-class electrical system they support, to prevent the failure of a mechanical function in one division from causing the failure of an electrical function in another division.

4.5 Associated circuits

4.5.1 General In addition to the exceptions mentioned in 4.6c), d), e), non-safety-class power supplies, control, instrumentation circuits may become associated circuits due to one or more of the following situations:

a) Electrically connected to the safety-class power supply without using an isolation device (see Figure 1);

b) Electrically connected to the related power supply without using an isolation device (see Figure 1);

c) Close to safety-class equipment and circuits without a physical separation or barrier that meets the requirements (see Figure 2);

d) Close to related equipment and circuits without a physical separation or barrier that meets the requirements (see Figure 2);

e) Sharing a safety-class or related signal source without using an isolation device (see Figures 3 and 8).

4.5.2 Guidelines Associated circuits shall meet one of the following requirements.

a) They shall be marked according to the requirements of the associated circuit or safety class and can be traced back to the safety class division related to them, that is, they shall be physically separated in the same way as the safety class circuits related to them. Unless it is proved by analysis or test that it will not cause the performance of the safety class circuit to be reduced to an unacceptable level, they shall meet the requirements of the safety class circuit.

b) All associated circuits, including safety class equipment and isolation devices, shall comply with the requirements of 4.5.2a). If the circuit behind the isolation device is no longer related to the safety class system, it is not necessary to comply with the requirements of this document.

c) It shall be proved by analysis or test that these associated circuits will not cause 2) Through analysis, it is proved that the non-safety circuit will not cause the performance of the safety circuit to be degraded to an unacceptable level. The analysis shall evaluate the category of the non-safety circuit and its possible energy.

e) Non-safety fiber optic loops do not need to be physically isolated from safety circuits or associated circuits. Electrical isolation is an inherent characteristic of fiber optic loops. Because fiber optic loops do not cause the safety circuit to degrade, they can be treated as non-safety circuits rather than associated circuits.

4.7 Mechanical system Safety-class circuits shall be laid or protected in a manner that prevents failure of a division of mechanical equipment from causing failure of safety-class circuits or equipment necessary for redundant systems or equipment to perform their safety functions. When safety-class equipment or circuits are used to mitigate the consequences of a mechanical system failure or misoperation, the impact of these failures or mis-operations on the division itself shall be evaluated. At the same time, the impact of pipe swing, jet impact, water spray, flooding, radiation, pressurization, temperature rise or moisture on redundant electrical systems, as caused by mechanical system failure, misoperation or operation, shall be evaluated. In addition, the potential hazards of flying objects caused by rotating equipment or high-energy system failures shall also be evaluated.

4.8 Structures and equipment Safety-class electrical systems shall maintain their independence and redundancy during and after the failure of structures and equipment that have not been identified for design basis events.

4.9 Fire protection system When redundant division equipment and circuits are arranged within the range of the same fixed fire protection system, the design of these equipment and circuits shall be coordinated with the fire protection system, so that the independence of the safety-class electrical system is not impaired; the impact of false operation of the fire protection system on equipment rooms and cable channels shall be evaluated.

4.10 Fire

4.10.1 An electrical fire occurring within a safety class division shall not cause the loss of function of its redundant division.

4.10.2 Redundant safety class equipment and circuits shall maintain independence; a fire in a fire hazardous area shall not prevent its redundant equipment and circuits from performing safety functions.

4.11 Electromagnetic interference/Radio frequency interference The possibility of electromagnetic interference/radio frequency interference affecting the independence of redundant safety class equipment and circuits shall be evaluated. Corrective measures to mitigate electromagnetic interference/radio frequency interference interactions may include the following: grounding, use of low-voltage components, physical separation, isolation devices, shielding of susceptible equipment or circuits, shielding of electromagnetic interference sources, etc., see Appendix B of GB/T 13284.1-2008. The following interactions of EMI/RFI shall be evaluated:

a) EMI/RFI generated by a safety class division shall not reduce the ability of redundant safety class equipment or circuits to perform safety functions;

b) EMI/RFI generated outside the safety class circuit (such as non-safety class circuits and equipment, broadcasting, telephone) shall not reduce the ability of safety class equipment and circuits to perform safety functions.

5.1.1 General

5.1.1.1 Grading of areas The cable laying and equipment areas of the safety class and its associated circuits shall be reviewed, to find out whether there are potential hazards such as high-energy pipelines, flying objects, flammable materials, ignition sources and flooding. These areas shall be divided as follows:

a) Non-hazardous areas (see 5.1.3);

b) Low-hazard areas (see 5.1.4);

c) Hazardous areas (see 5.1.5). In the early stages of design, a separation equivalent to the degree of potential hazardous damage shall be provided through separate rooms, barriers and other facilities. If there is sufficient heat dissipation capacity, the sides of the room or area can also be used as a partition.