中广核 CGN

Nuclear Power China Nuclear Power Engineering Co.,Ltd.

Electrical System Design of HPR1000

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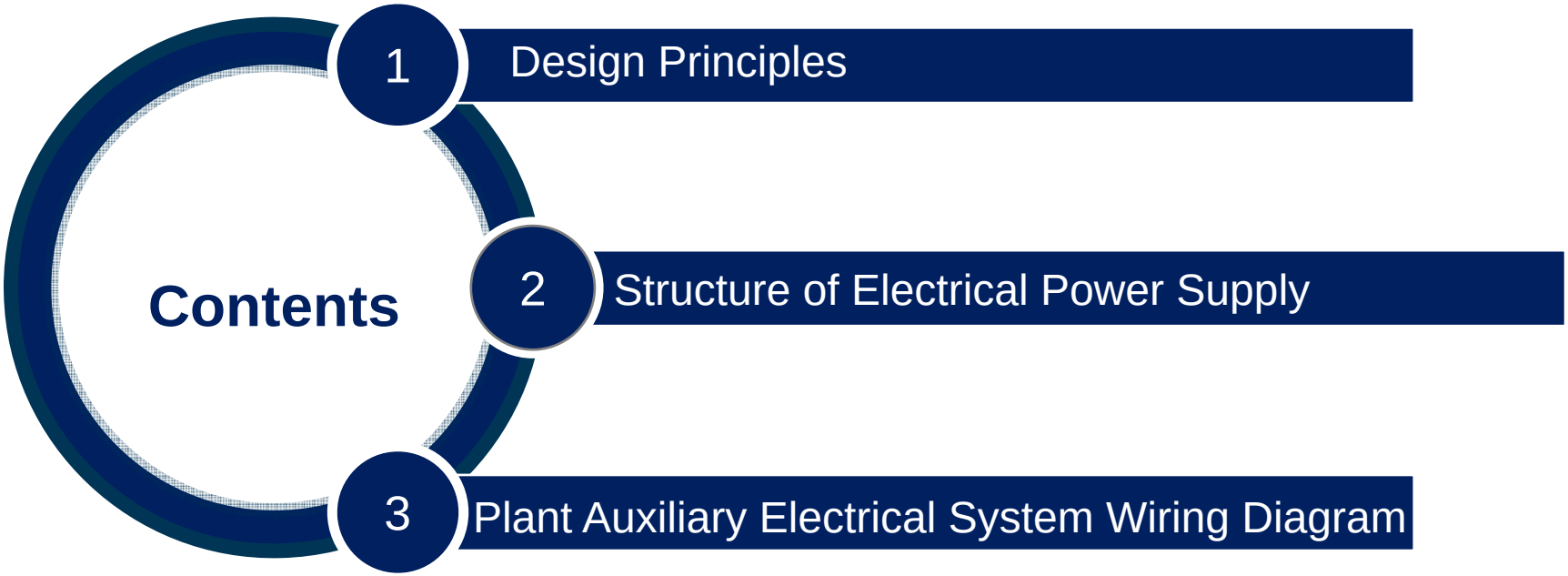
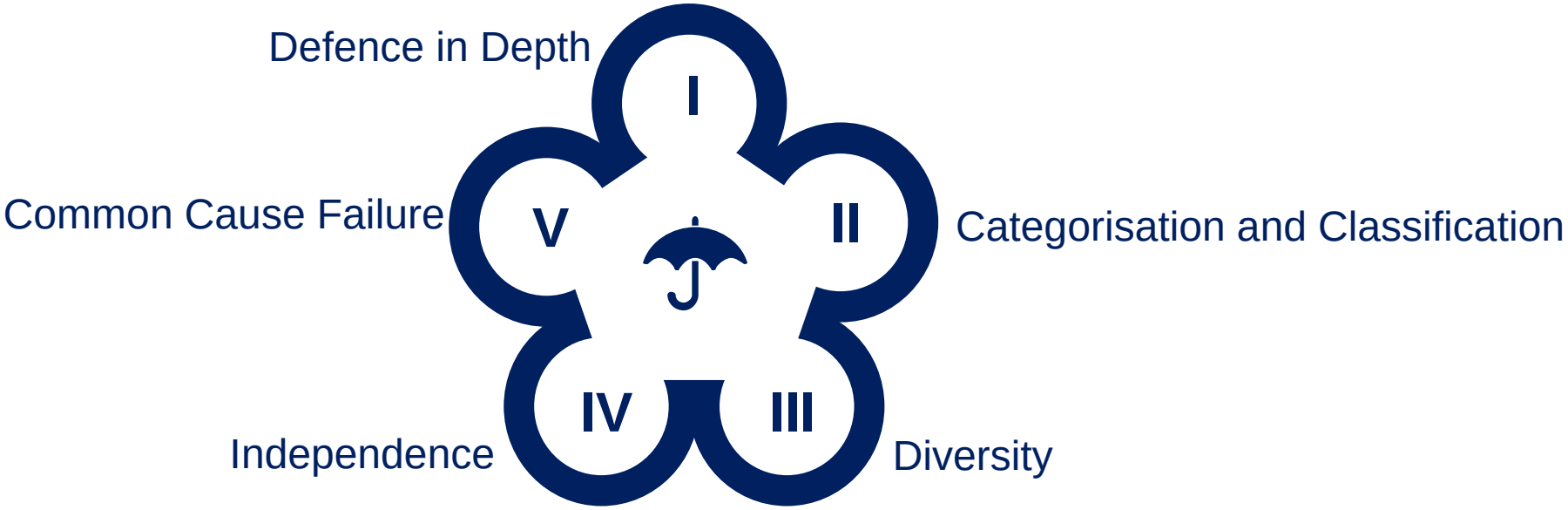
Natural Energy Powering Nature



1 Design Principles

The electrical system design of HPR1000 fulfills relevant codes and standards and requirements of NNSA (China's National Nuclear Safety Authority). The main design principles are as follows:



1 Design Principles

I. Defence in Depth

According to the concept of defence-in-depth in the IAEA's Safety of Nuclear Power Plants: Design (IAEA Safety Standards No.SSR-2/1[2]), defence-in-depth design of the electrical system is as follows:

Level 1 addresses the design of all parts of the electrical system in compliance with its design basis, including the control of voltages,

Level 2 covers current and insulation monitoring and also the switchover to the auxiliary grid connection upon loss of the main grid connection (Design Basis Condition (DBC) -1 event),

Level 3 addresses the response to LOOP and DBC-2 to DBC-4 events combined with LOOP. For such events, the emergency diesel generators and 2-hour batteries are used as the on-site sources of power for the electrical loads required in response to the events,

1 Design Principles | I. Defence in Depth

Level 4 applies to risk reduction scenarios such as LOOP with failure of all the emergency diesel generators (Design Extension Condition (DEC)-A sequence) and total loss of AC sources. As applicable to the sequence, both the SBO diesel generators and 2-hour batteries are used as the on-site sources of power for the electrical loads required in response to the sequences,

Level 5 is aimed at contribution to on-site management of identified low probability high consequence fault sequences and at mitigation of the radiological consequences of potential releases of radioactive materials that may result from accident conditions. The mobile diesel generator and the 12-hour batteries are used as applicable to the sequence.

1 Design Principles

II. Categorisation and Classification

1) The Categorisation and Classification of the electrical systems comply with IAEA Safety Standard SSG-30.

2) The Categorisation and Classification of the electrical systems are in correspondence with the Categorisation and Classification of the serviced process systems and equipment.

1 Design Principles

III. Diversity

In order to achieve the reliability targets and to fulfil the defence in depth concept, diversity shall be applied to redundant systems or components which perform the same safety function.

It can be realized by means such as different principles of operation, different physical variables, different operating conditions, production by different manufacturers, etc.

For instance: Dual power sources.

1 Design Principles

IV. Independence

1) Physical separation and electrical isolation are provided to maintain the independence of safety circuits and equipment so that the safety functions of any design basis events can be accomplished.

2) Physical separation of circuits and equipment is achieved by safety class structures, separation distance, or barriers or any combination thereof. Electrical isolation is achieved by separation distance, isolation devices, shielding and wiring techniques, or combinations thereof.

For example:

a) Independence in different distribution systems of trains

b) Independence in different cable trays and electrical equipment of trains

1 Design Principles

V. Common Cause Failure

The design of electric power system shall consider the potential risk of common-cause-failures (CCF) of items important to safety.

For example: EDG and SBO diesel generator are supplied by different manufacturers

2 Structure of Electrical Power Supply

Structure of electrical power supply：

1) The generator set can be tripped in the event of the turbine unit tripping, or the reactor tripping, or an electrical fault of the main generator. In such cases, the plant will be fed by the off-site main power supply.

2) The electrical system operational mode is such that in the event of failure of the off-site main power supply, automatic switchover occurs to allow power to be fed from the generator to supply the reactor unit house load.

3) The electrical power systems will be automatically switched to supplies from the Standby Transformer (ST) in the event of a failure of the off-site main power connection and main generator or a failure of Auxiliary Transformers (ATs).

4) The EDGs provide power to the on-site emergency distribution system in the event of Loss of Offsite Power (LOOP).

2 Structure of Electrical Power Supply

Structure of electrical power supply：

5) In the event of SBO, the SBO diesel generators provide power to specific loads.

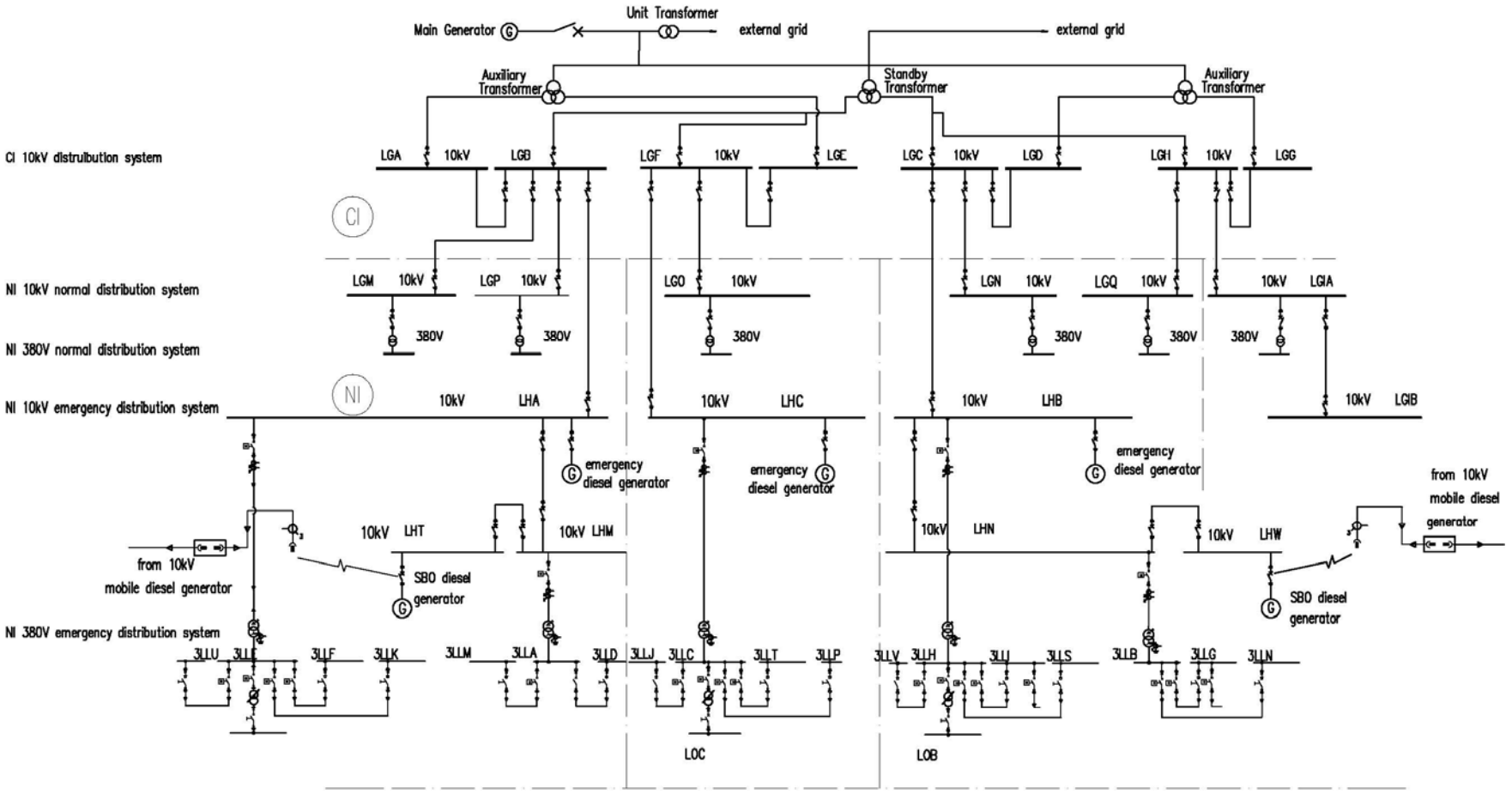
6) The mobile diesel generator is the backup power supply in the event of a failure of the SBO diesel generators.

7) The emergency power distribution system is capable of keeping reliable operation in the event of external and internal hazards which are properly assessed.

8) The 2-hour battery backed DC and AC uninterruptible power supply can continuously provide power for 2 hours in the event of a design basis accident or a complicated accident relevant to SBO.

9) The 12-hour battery backed DC and AC uninterruptible power supply ensures a continuous power supply for 12 hours in the event of a long time SBO and severe accident relevant to a long time SBO.

3 Plant Auxiliary Electrical System Wiring Diagram



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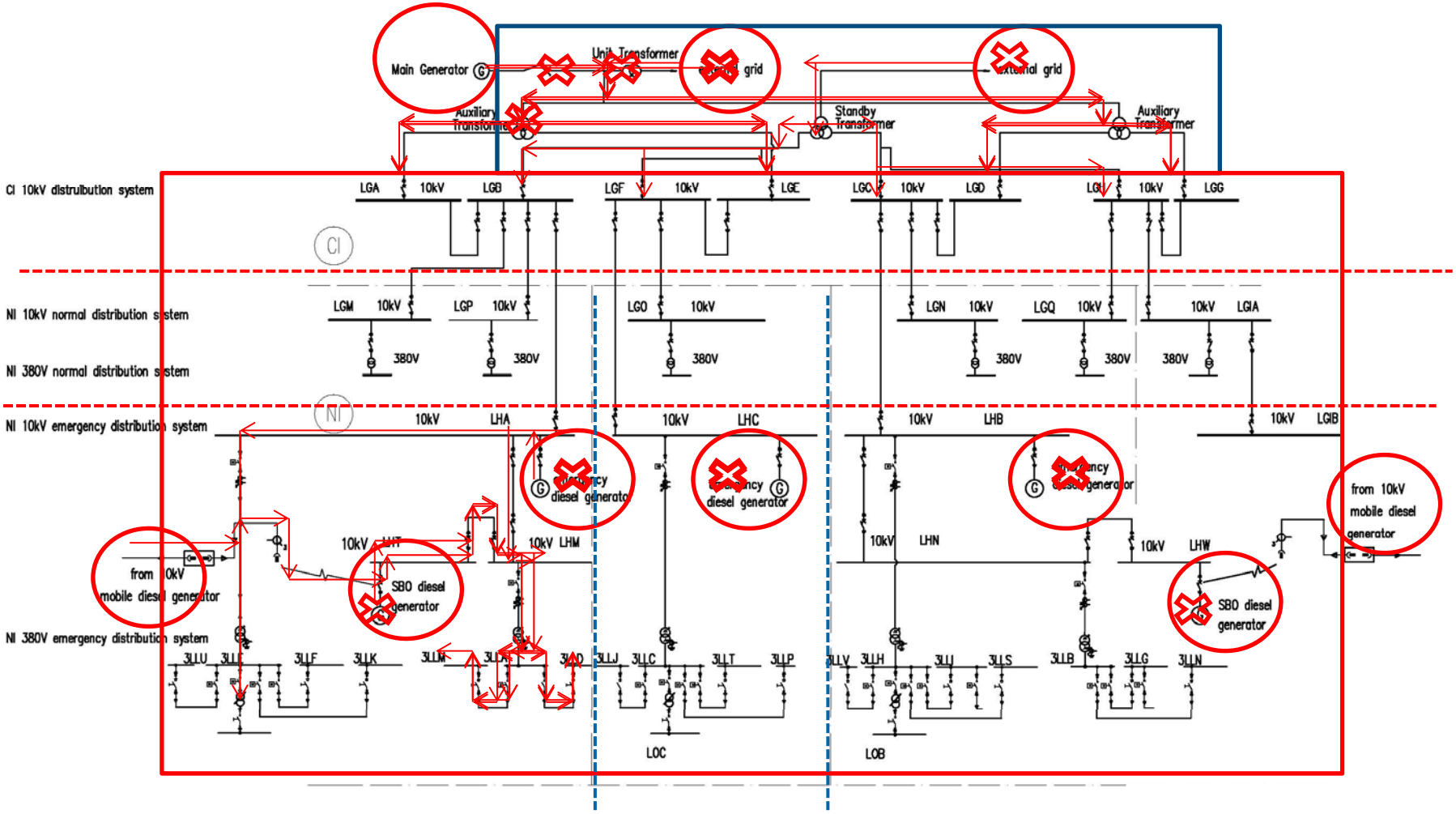

3 Plant Auxiliary Electrical System Wiring Diagram

1) Structure of Power Supply

- Main generator
- 500kV external grid power source
- 220kV external grid power source
- EDG power source
- SBO diesel generator power source
- Mobile diesel generator power source

2) Classification and Division

- Non-safety classified distribution system
- Safety classified distribution system
- 3 trains (train A, train B, train C)

3 Plant Auxiliary Electrical System Wiring Diagram

3) Distribution and Layout

- CI distribution system
- NI distribution system

4) Power Supply in Different Status

- Normal condition status
- Loss of main external grid
- Loss of Main generator (unit transformer/ auxiliary transformer)
- Loss of off-site power(LOOP)
- Loss of SBO diesel generator

Summary：

HPR 1000 electrical system has advantages that the structure of electrical power supply is simple while the safety and economy are simultaneously considered to fulfill the safe operation requirements.

Q&A

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Thank you