Conceptual design of electrical power system on innovative small modular reactor

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1. Introduction

The innovative SMR(i-SMR) passed a preliminary feasibility study for national R&D project in 2022 and is scheduled to invest 399.2 billion won by 2028. i-SMR aims to acquire standard design certification in 2028. The importance of technical competitiveness of i-SMR for overseas export is increasing. In response to the market demand for supplying power to places where the grid(transmission line) is difficult to access, such as remote areas or independent islands. i-SMR to be designed considering off-grid. i-SMR's electrical power system conceptual design is as follows

2. Electrical Power System on i-SMR

2.1. Conceptual Design

The electrical power system provides a generated power by operating a main generator of power block to all electrical auxiliary loads, and to the transmission grid. The i-SMR has AC/DC power system supplied from offsite power system since it adopts passive safety systems for core cooling and containment integrity. Electrical system consists of the Switchyard (SY) system, Main Power (MP) system, Auxiliary Power (AP) system and DC Instrumentation and control Power (DC/IP) system. During normal operation, some of the power generated by the main generator is supplied to the house load via the Unit Auxiliary Transformers (UATs) and the remaining power is transmitted to the grid through the switchyard.
Ancillary Diesel Generator (ADG) is backup power for the required loads of station, operating when the normal AC (AC) power sources are not available although an accident leading to loss of on- site and off-site AC power does not affect the safety and reliability of the power plant. The DC/IP system provides reliable power to the important/essential plant loads and plant control systems during normal and abnormal operation.

2.2. Main Design Features

2.2.1 Switchyard System

There is a black start generator(BSG) for the initial startup of the power plant.

2.2.2 Main Power System

The Main Power (MP) system consists of the main generator, the Isolated Phase Bus (IPB) duct, the main transformer and Gas Insulated Bus (GIB). The primary function of this system is to generate and transmit power to the transmission system and simultaneously supply power to the unit auxiliaries.

2.2.3 AC Power System

The Auxiliary Power (AP) system encompasses the UATs, medium voltage system, low voltage system, and ADG. The medium voltage system is energized by UATs via main transformer, on normal operation, and distributes power to associated IPC and large non-class 1E motor load. The system is divided into two divisions, Div. I and Div. II, and each division consists one (1) medium voltage bus. Therefore, as per the number IPCs composing the Unit, total of eight (8) medium voltage busses are utilized in the i-SMR. It is designed so that when a failure occurs in the power supply to one IPC, Power can be supplied to the IPC from another power source. ADG supplies power more than 72 hours after Station Black Out(SBO)

2.2.4 DC/IP Power System

The enhanced DC power system is designed to supply a reliable DC power to required loads such as reactor safety system and accident monitoring system. The DC power system consists of four (4) Channels A, B, C, and D per IPC. Battery. The battery of the enhanced DC power system has a capacity of 24 hours or 72 hours and is designed to supply power to required loads such as post monitoring instruments.

3. Conclusion

Pre-design review is conducting based on conceptual design and standard safety analysis report(SSAR) will be submitted end of the 2025 to regulatory agencies. If suitability of electrical system design is verified, it is expected to contribute to the creation of a new market for i SMR.

REFERENCES

[1] IEEE 308 "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations"
[2] IEEE 603 "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations"
[3] 10 CFR Part 50, Appendix A, GDC 17
[4] US NRC Reg.Guide 1.155