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Conceptual Design of Electrical System for KJRR

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1. Introduction

The KIJANG Research Reactor (KJRR) which started on the 1st of April 2012 is an open pool type reactor with 15 MW of thermal power. The main goals of KJRR are to self-sufficiently supply radioisotopes (RI), improve the production capacity in neutron transmutation doping (NTD), and conduct research on reactor-related technologies.

The purpose of this paper is to explain the electrical system for KJRR at the stage of its conceptual design. By the functional classification, the electrical system for KJRR is classified roughly into six parts: a 154 kV power system, primary power system, secondary power system, diesel generator, DC power supply and UPS system, and an auxiliary electric system. In this paper, these parts are briefly introduced, and the design concept of an electrical system suitable for the research reactor is proposed to meet the basic principles such as safety, reliability, and performance.

2. Design Classification

There are four classes of power supply for KJRR according to their functional importance. The normal power (Class IV) is supplied to loads which can tolerate a long interruption without affecting personnel or equipment safety. This power comes from the Korea Electric Power Corporation (KEPCO). The diesel generator power (Class III) is supplied to loads which can tolerate a brief interruption (less than 25 seconds). This power comes from the 480V non-class 1E diesel generator on a loss of normal power. Uninterruptible 120V AC power (Class II) and 125V DC power (Class I) are supplied to loads which must not be interrupted regardless of the normal power failure. The uninterruptible 120V AC power comes from an AC uninterruptible power supply (UPS) which is fed from a DC power supply system. The 125V DC power comes from the DC power supply system which is fed from the battery, which is also a part of the DC power supply system. The overall classification of the major electrical equipment for KJRR is described in Table I.

Table I: Electrical System Classification

Power Supply Class	Equipment	Classification			
		Safety	Seismic	Quality	Electrical
Class IV	154kV Gas Insulated Switchgear	NNS	Non	S	Non-1E
Class IV	154/4.16kV Main Transformer	NNS	Non	S	Non-1E
Class IV	4.16kV Switchgear	NNS	Non	S	Non-1E
Class IV	480V Load Center	NNS	Non	S	Non-1E
Class IV	480V Motor Control Center	NNS	Non	S	Non-1E
Class III	Diesel Generator	NNS	Non	S	Non-1E
Class II	120V UPS System (Ch. A,B,C)	3	I	Q	1E
Class II	120V UPS System (Ch. M,N)	NNS	Non	S	Non-1E
Class I	125V DC System (Ch. A,B,C)	3	I	Q	1E
Class I	125V DC System (Ch. M,N)	NNS	Non	S	Non-1E

3. Functional Requirements

The off-site power supply system delivers sufficient electrical power to the reactor site. This power is supplied from two different sources. The power distribution system is designed to provide reliable power to all low voltage loads during normal operation. Loss of this power shall be considered as abnormal, during which time the emergency power supply shall supply all critical loads. The power distribution system is comprised of load centers, motor control centers, and an emergency power supply. The 480V load centers are fed from 4.16 kV switchgears and provide power to 480V motor control centers, motors rated from 60 through 250 HP, and non-motor loads from 100 through 400 kW. The 480V motor control centers distribute power to motor loads at less than 60 HP and non-motor loads at less than 100 kW. The emergency power supply provides an alternate power for the operation of emergency equipment or a safety system in the event of normal power outage. The 120V AC uninterruptible power supply is fed from the 480V emergency motor control center which has an emergency diesel generator as stand-by power source. The 125V DC power supply provides uninterruptible DC power for the instrumentation and control [1].

4. Description for Electrical System

As mentioned above, the electrical system for KJRR is sorted into six parts depending on the functional classification. In this section, each part of the electrical system is explained shortly. Figure 1 shows the configuration of the electrical system for KJRR.

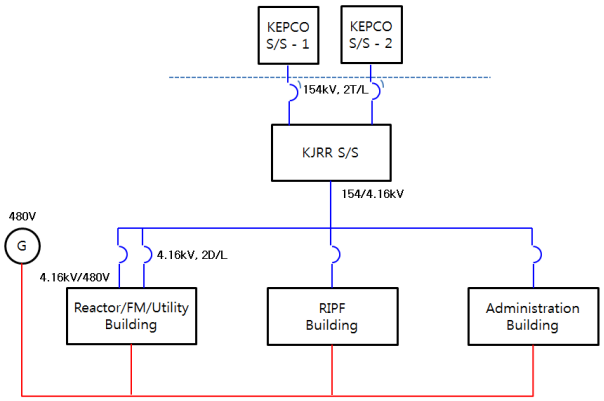

Fig. 1. Configuration of the electrical system for KJRR.

4.1 154kV Power System

The 154 kV power system receives 154 kV of normal power from a Korea Electric Power Corporation substation through two independent transmission lines and distributes the normal power to the main transformers. Because the capacity of the transmission lines is a maximum of 20 MVA, it is enough to cover all loads using only the capacity of one transmission line. This design concept is based on redundancy.

This system consists of two gas insulated switchgears which include not only the main buses, circuit breakers, and associated disconnecting and grounding switches but also monitoring, control, and protection equipment.

4.2 Primary Power System

The primary power system is comprised of two 154/4.16 kV main transformers and 4.16 kV switchgears. The main transformers receive normal power and drop the voltage from 154 kV to 4.16 kV. The switchgears receive 4.16 kV of normal power and provide it to the 480V load centers.

4.3 Secondary Power System

The secondary power system includes the 480V load centers and the 480V motor control centers. The load centers lower the voltage from 4.16 kV to 480V by using load center transformers and supply it to the larger loads (motors rated from 60 through 250 HP, and non-motor loads from 100 through 400 kW) and motor control centers. The motor control centers are fed from the load centers and supply the smaller loads (motor loads less than 60 HP and non-motor loads less than 100 kW).

4.4 Diesel Generator

In the event of a loss of normal power, the 480V diesel generator provides alternate AC power for the operation of essential equipment or safety systems such as motor-operated valves, motors, DC system, UPS system, and essential lighting. Because the safety class is NNS, only one diesel generator is installed.

4.5 DC power supply and UPS system

The DC power supply and UPS system supplies a continuous, reliable, regulated source of 125V DC and 120V AC power to the Reactor Protection System (RPS), Post Accident Monitoring System (PAMS) and so on during Design Basis Events (DBE) for instrumentation and control needed for a safe shutdown of the reactor without interruption upon a failure of the normal power supply.

The class 1E 125V DC power supply and 120V AC UPS system are triplicated to ensure reliability and stability through three physically separated and independent channels. By the same token, the non-class 1E 125V DC power supply and 120V AC UPS system are also duplicated.

4.6 Auxiliary Electric System

An Auxiliary Electric System includes a lighting and receptacle system, grounding and lightning protection system, cathodic protection system, heat tracing system, communication system, security system, and fire detection and alarm system.

5. Conclusion

The characteristic of a research reactor is that the system configuration is varied in accordance with the application and capacity of the reactor. However, the basic principles of the reactor design such as safety, reliability, and performance are equal to the power plant. In this paper, the design concept of the electrical system suitable for the facility feature of KJRR is proposed. The results of this paper can be used for the conceptual design of an electrical system for various new research reactors. On 10th of April 2013, the Daewoo engineering & construction Co., Ltd., a subcontractor joined the project as an architect engineering (AE) company.

REFERENCES

[1] Jung Hoan-Sung, Kim Hyung-Kyoo, Kim Young-Ki, Wu Jong-Seop, Ryu Jeong-Soo, Design Requirement for Electrical System of an Advanced Research Reactor, Korea Atomic Energy Research Institute Technical Report, KAERI/TR-2856/2004, 2004.