DESIGN, INSTALLATION, OPERATION AND MAINTENANCE OF ELECTRICAL POWER SUPPLY FOR RI BEAM FACTORY

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ABUSTRACT

RIKEN NISHINA center's RI Beam Factory (RIBF see Fig.1) which succeeded in extracting first beam with Al on December 28th, 2006, is currently under service for exotic Isotope experiments. We will explain the alternative power source for RIBF, especially for the main transformer (TR) with 66/6.6kV 25/30MVA, MV/LV TR's windings, and the motor starters including 315kW cryogenic system compressors. All motor starters are direct connecting type which enables a quick start and an efficient restart. They are also more reliable and economical than reactor and/or Y-△ starters. Power supplies which via the current-limiting reactor with a capacity of 9MVA to the existing facility.

INTRODUCTION

The RI Beam Factory (RIBF) requires a large amount of electrical power for operation. In order to provide this necessary power, the No.2 high voltage substation was constructed on the RIBF building roof in the spring 2003. In this substation, 66kV vacuum circuit breakers (VCB) are used instead of gas circuit breakers (GCB). VCB require less maintenance, space, and cost than GCBs. The substation is Gas insulated type (GIS).

At the same time, many medium-voltage metal-clad Switch gears (M/C), called alternative power source, were provided in the building.

The MV cubicle Switch gears for the zero-degree forward spectrometer (ZDS) and Spectroscopy of hadronic system with radioactive quantum beam (SHARAQ) were installed in 2005 and 2007.

A diagram of the electric power system for the RIBF is shown in Fig.2.

DESIGN and INSTALLATION

The RIBF substation (No.2 HV S/S) is connected to the No.1 high-voltage substation located near the West Gate by two 66kV XLPE underground cables. The cross-sectional area and length of cables are 325mm^2 and 750ms respectively. One is for normal use and the other is for use as extra. Each cable has sufficient capacity for the expected volume increase in the future. The capacity of a 66/6.6kV transformer was determined as 25MVA. By using additional cooling fans, the capacity will increase to30MVA. Its percent impedance (%IZ) was selected as 11% (actual 10.67%) on the basis of voltage regulation. The transformer is equipped with automatic on load tap changer.

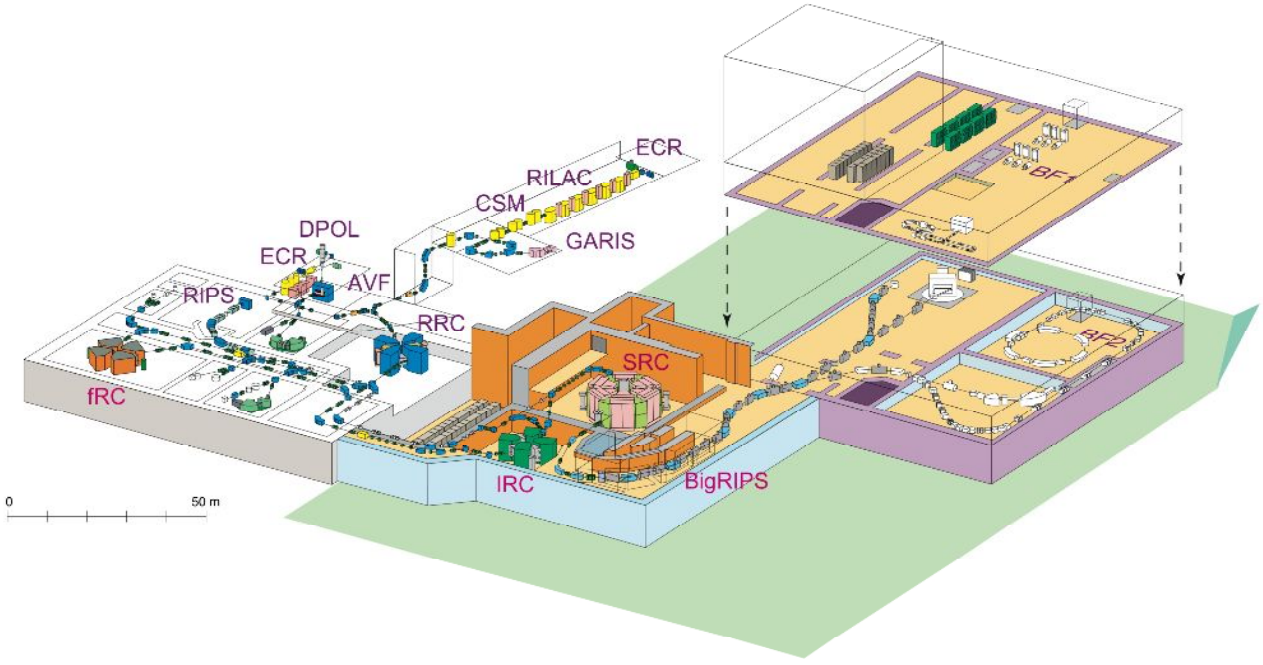

Fig.1 Birds-eye view of RIBF

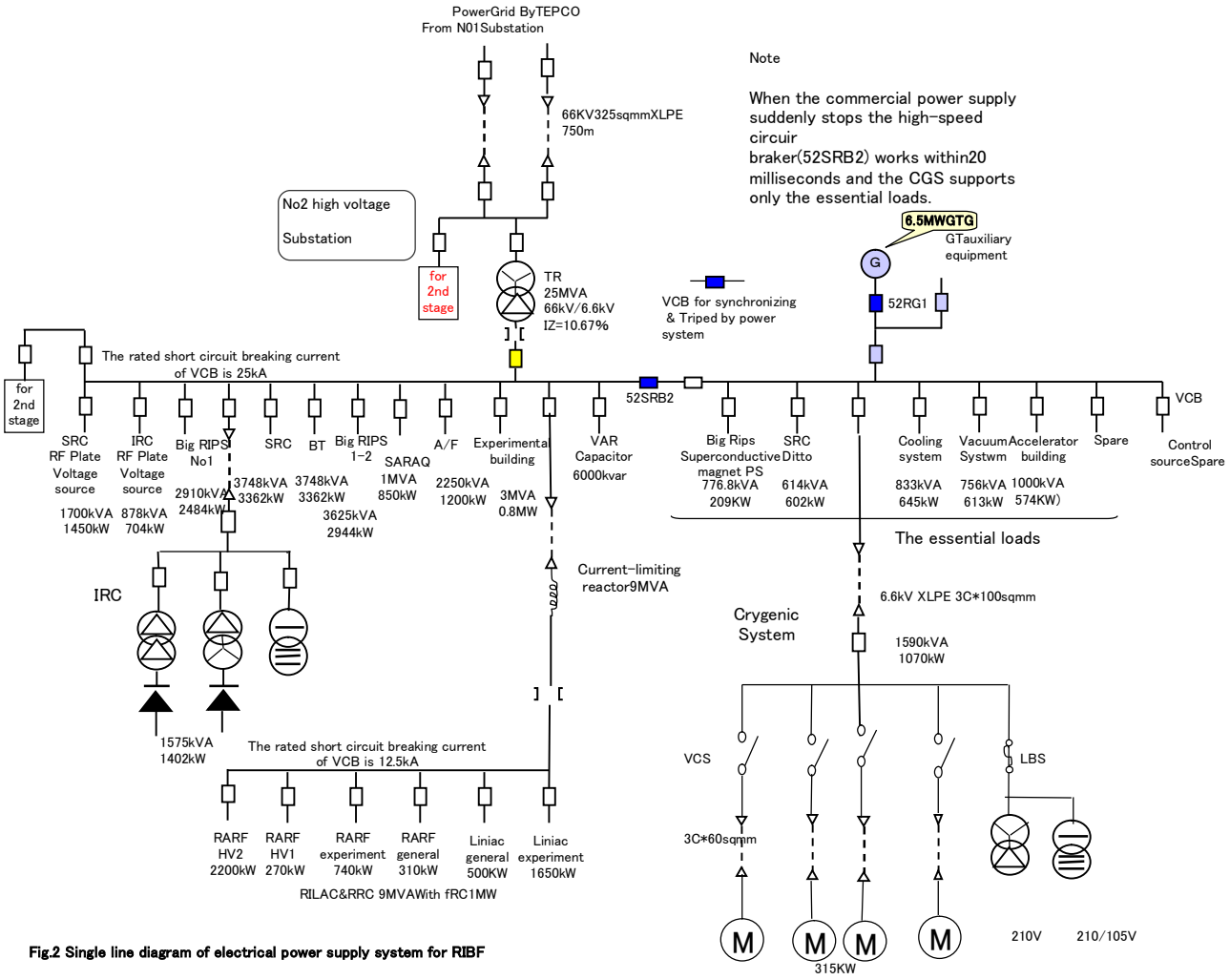

Fig.2 Single line diagram of electrical power supply system for RIBF

The MV switch gear is metal-clad type according to the JEM (Japan electrical Manufacturers) standard and is very compact. The capacities of 18MVA for the magnets are built in one room of the basement. This capacity is the largest in the Wako fire department district (Wako city, Asaka cty and Niza city) to be built in one room. But its volume is almost the same as that of the RARF 9MVA cubicles. The switchgear incorporates VCBs and characterised by ultra-thin depth, allows all maintenance to be performed from the front only.

It is capable of rated normal currents of 600A and a maximum rated braking capacity of 25kA VCBs were arranged a 2 tiers. The M/C can be operated in a power outage because the DC power supply with battery is used for its control. This feature makes the M/C much safer than existing cubicles.

Installation work for the M/C and power receiving took only 11days with night hours.

The DC power source used for the accelerators produces undesirable harmonic currents. To prevent this from happening, two MV/LV transformers with the △-△ and △-Y connections were used for the IRC and others as shown in Fig.2. This results in the same effect as multi phase rectifiers. Transformers are placed inside of a building, dry-type ones are used. The dry-type transformers require no insulation oil. and they meet the Fire Defence low requirement. In addition, all transformers are highly efficient (98.96 to 99.25%) and meet the law according to the Rational Use of Energy Policy.

Main cyclotron (SRC) and Fragment Separator of RIBF are superconducting system. They are required to run the system as uninterrupted as possible. To this end starters adopted “Direct connection type” (Fig.3) for all motors, including four 315kW cryogenic system compressors. Ministry of Land, Infrastructure and Transport (MLT) recommend reactor starting system(Fig.4) for MV and Y-△ starters for LV motors(Fig.5). However, the direct-type starter enables a quick start and an efficient restart.

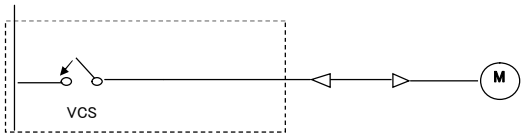

Fig.3 Direct starter

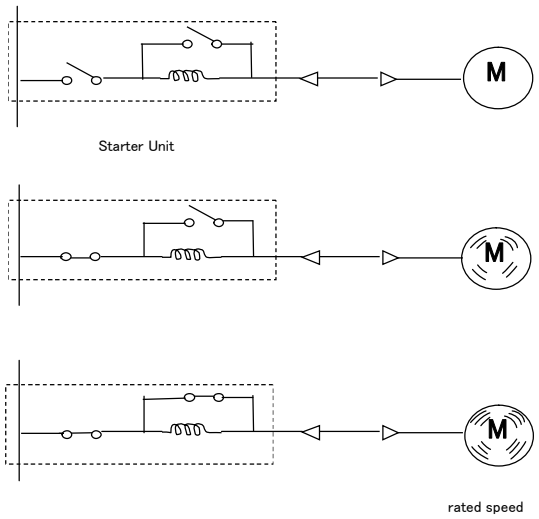

Fig.4 Reactor starting system

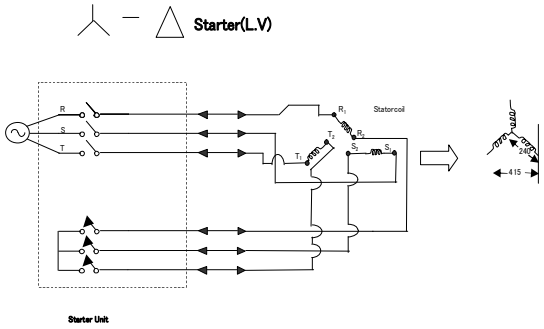

Fig.5 Star-delta starting system at the starting time

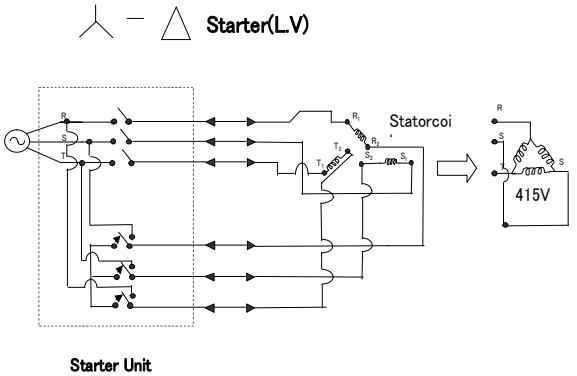

Fig.5 Star-delta starting system at the running time

They also are more reliable and economical than the others. In addition, Supervisory authority for REKEN is Ministry of Education, Culture, Sports, Science and Technology. (MEXT) is not MLT. The Authority for Electricity is Ministry of Economy, Trade and Industry (METI) not MLT.

The direct-type starters can only be used when the transformer's capacity is sufficiently large. We have more than 50 electrical motors used for mainly pumps of water cooling system of RIBF which are highly efficient type. For instance, 30kW normal motor is 91.65% and high-efficiency type is 93.06% (+1.41). All normal efficiencies are less than 93%. Simple LV starters are in the Motor Control Centres (MCC). MCC is the culmination of advancements in digital technology. The incorporation of CDL networking converts the MCC into a superior data information system. Short circuit protection is achieved through the use of MCCBS (Moulded Case Circuit Breakers=NFB). Above systems allow simpler hardware contraction and more straightforward operational skills. This enables an out-sourcing of operations as a cost-cutting measure.

The Cogeneration system[1)] （CGS）is separated within 20msec with a high-speed breaker(52SRB2), as shown in Fig.2, when the commercial power supply suddenly stops. In this circumstance, the CGS only supports essential loads such as cryogenic system, superconducting magnets and others, and works as a 5.4MW UPS. The highest efficiency of CGS was recorded are 62.5% on July 2, 2007, and it will be increase in the future.

A current-limiting reactor with a capacity of 9MVA was installed into the line to send electrical power to the existing facility (RARF) because the capacity of each circuit breaker (VCB) in the RARF substation is 13.8kA and thus they cannot withstand a 22.84kA short-circuit current of RIBF.

OPERATION and MAINTENANCE

RIKEN NISHINA Centre has 3 contractors for operation one is SHI Accelerator Service (SAS)for accelerators, second is Nihon Kucho Service Co, LTD (NKS) for Cryogenic system and water cooling , and the last one is NKS too for CGS and HVAC (Includes electrical power supply) All contracts were made with open bidding.

The contracts include not only operation but also daily maintenances. Operators will stay on job site at 24hr a day in during operation.

The regular inspections for accelerator are scheduled in summer. Since electric unit price is higher than other season. Legal inspection for

Cryogenic system, cranes and inspection with maintenance code by RIKEN for HV substation and MV switch gears are same time. Legal inspection for the boiler and maintenance for turbine of CGS will be carried out in winter. Maintenance is carried out according to the electrical unit price of each season. All inspection and maintenance are done by manufactures.

CONCLUSION

The electrical power supply system has successfully operated from the beginning up to now. This indicates that as we have achieved our initial goal.

REFERENCE

1) T.Fujinawa et al.: RIKEN Accel.Prog.Rep.38 (2005)