§25. Development of 250 MVA Motor-Generator System

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The motor-generator (MG) was constructed in 1993 to feed pulse high power to plasma heating devices. This year ten thousands of shots were operated for the NBI in the LHD [1].

Continuous efforts have been devoted to improve the performances of the system. The main items are summarized here.

i) MG computer system

The computer system of this MG was so far composed of two MG computers (MGC's) and multiple load computers (LDC's)[2].

The two MGC's were expected to operate as a single larger computer, since they were tightly linked each other. This combination, however, did not function so well as had been anticipated. Intercommunication between them was so frequent that the processing speed did not reach high enough. Two alternatives have been tried for overcoming this defect.

In the first place, one of the MGC's has been replaced by a workstation (WS). In the new system almost all the tasks are executed by the WS. The existing computers are served as an interface for input/output processor, and as one for the laser page printer.

In the second place, a data logger has been introduced in which periodic numerical data are stored. The WS receives the data when it is not busy. The duty of the MGC system is thus reduced, and it has been running stably.

ii) Load computer system

Some of the old type LDC's could operate for only one load due to shortage of the memory in CPU and operating speed. They have been replaced by computers of high speed and high performance. The new LDC's have added many functions, such as capacity for simultaneous operation of multiple loads, and multi-indication of operational condition. Instructions of operational procedure are displayed for securing human manipulation.

iii) Remote maintenance of computer software

Troubles in the computer system sometimes occurred suddenly during operation of the MG. In such cases rapid trouble-shootings might been demanded; emergent debugging or minor change of the software. To meet the requirement, the MG computer network has been linked to that in the manufacturer. Then the programmers can detect the causes of troubles, and repair the software quickly even in their factory. The linkage is performed through a router computer and the public telephone line. The instantaneous care of the computer system is thus certified.

iv) Indication of operating condition of MG

The MGC always supervises the overall operational conditions of the system. For example, when the claimed energy exceeds the limit of the MG, the MGC has to inform it to the users. To give attention on this situation in advance, graphic displays have been mounted in both MGC's and LDC's. They show the relation between ejection energy and repetition rate, and that between duration of load current and pulse length of the MG.

At plasma experiments, the timing signals for the acceleration and ejection of energy are sent from the LHD central control system. The system is modified to display them graphically.

v) Modification of sequence for output VCB

Formerly, when the VCB (Vacuum Circuit Breaker) for one load broke off due to troubles in the load system, the interlock of the MG acted and the supply to all the loads was interrupted. This caused time loss in the other sound loads. To avoid such an annoyance, the sequence has been changed not to respond whenever VCB's of any loads break off.

The VCB 's so far could not turned off even at emergency when the computer system lost its function. The sequence for the VCB's has been changed as it can be voluntarily turned off to avoid such risks.

vi) Maintenance of the whole system

To keep the whole system in good condition, temporal and annual maintenance has been executed. This year the following items were done.

a) Repair of the oil leakage in the generator, inspection of ingredient in the lubricating oil in the thrust bearings, and check of the oil filters in the thrust elevation system.

b) Inspection of the VCB's in 6.6 kV and 18 kV lines, the fast-acting breakers in the Thyristor Scherbius device, and the contactor for switching the Liquid RHeostat (LRH) and Scherbius.

c) Inspection of concentration of carbonated sodium and balancing of the movement of electrodes in the LRH.

d) Repair of the circulating pumps for cooling water, including replacement of sealing.

References

1) Kitagawa, S.: Sec. VI-1 in this Report.

2) Kitagawa, S. et al.: Annual Report of National Institute for Fusion Science [April 1997 to March 1998] p. 120.