UDC[621.314.5:621.311.68] :681.32-181.2+621.316.71

BUILDING FACILITIES FOR A LARGE-SCALE COMPUTER SYSTEM

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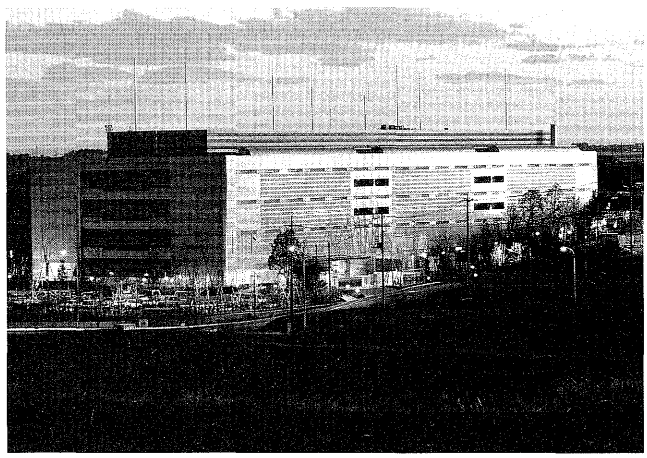
1. FOREWORD

The building facilities for a large-scale computer system introduced in this article is operated as a building 24 hours a days 365 days a year. High reliability, energysaving, labor saving, high security, lowering of initial facilities investment, etc. were woven into the facilities plan. Planning and various experiments were incorporated from the beginning so that, basically, facilities expansion work with respect to future load expansion can be performed without stopping operation. This article is centered about the UPS for which Fuji Electric was responsible and outlines the related co-generation system and central monitoring facility.

Fig. 1 Exterior view of computer building



2. UPS

2.1 Overall composition

A line connection diagram of the UPS and peripheral devices is shown in *Fig. 2*. The Final composition of the UPS is two parallel redundant systems of five units. In the beginning, it started with one 3-unit system. Thereafter, the facility was increased one unit at a time. The UPS room is shown in *Fig. 3*.

(1) Circuit composition

Power is supplied to the UPS room from the electric room by two 6kV lines. The 6kV panel has a double bus configuration and supplies power to each UPS and bypass by double stacked transfer switches. Improvement of supply reliability and safety during maintenance are taken into account and utility power is received at one bus and co-generation power is received at the other bus by means of this.

The UPS uses a 12 pulse rectifier as an input harmonic reduction countermeasure. The 3 winding transformer used for this is a molded type and is maintenance free.

Usually, the output voltage of a UPS is 200V, bit it was made 415V with this building. This was done to reduce the output wiring voltage drop and lower the current capacity of the switches and reduce facilities and work costs. Seven no break transfer circuits with bypass are provided by static transfer switch after the output of each UPS is combined by output bus panel. The power is then branched to 3 or 4 systems and supplied to each load through a shaft. By providing seven static transfer switches, power is supplied from the UPS even when there are no UPS operating normally and minimum bypass supply is stopped at the feeder. Power is supplied to the load system by two systems from different static transfer switch blocks and a constant supply of power can be secured to the load system by switching at the load side even during static transfer switch maintenance.

The battery is a lead-acid storage battery and has a compensation capability of five minutes at full load. With this power system, the UPS input power supply mixes the utility power source and co-generation source. Therefore, even if the utility power fails, operation by battery is limited to the UPS with the utility power as its input. Since the load on the battery is lighten as a result, extension of the battery operating time is featured. The battery room installation state is shown in *Fig. 4*.

(2) Expansion work

With the expansion of on-line networks, load systems must operate day and night and on holidays and planned shutdown is also difficult. In such an environment, the load cannot be stopped even during UPS maintenance and expansion work, etc. Therefore, it is important that the circuit composition, equipment construction, etc. be planned likewise from the initial planning stage.

Wigh this facility, expansion of the 6kV machines is possible at a bus-by-bus power failure by duplicating the

Fig. 2 UPS single line connection diagram

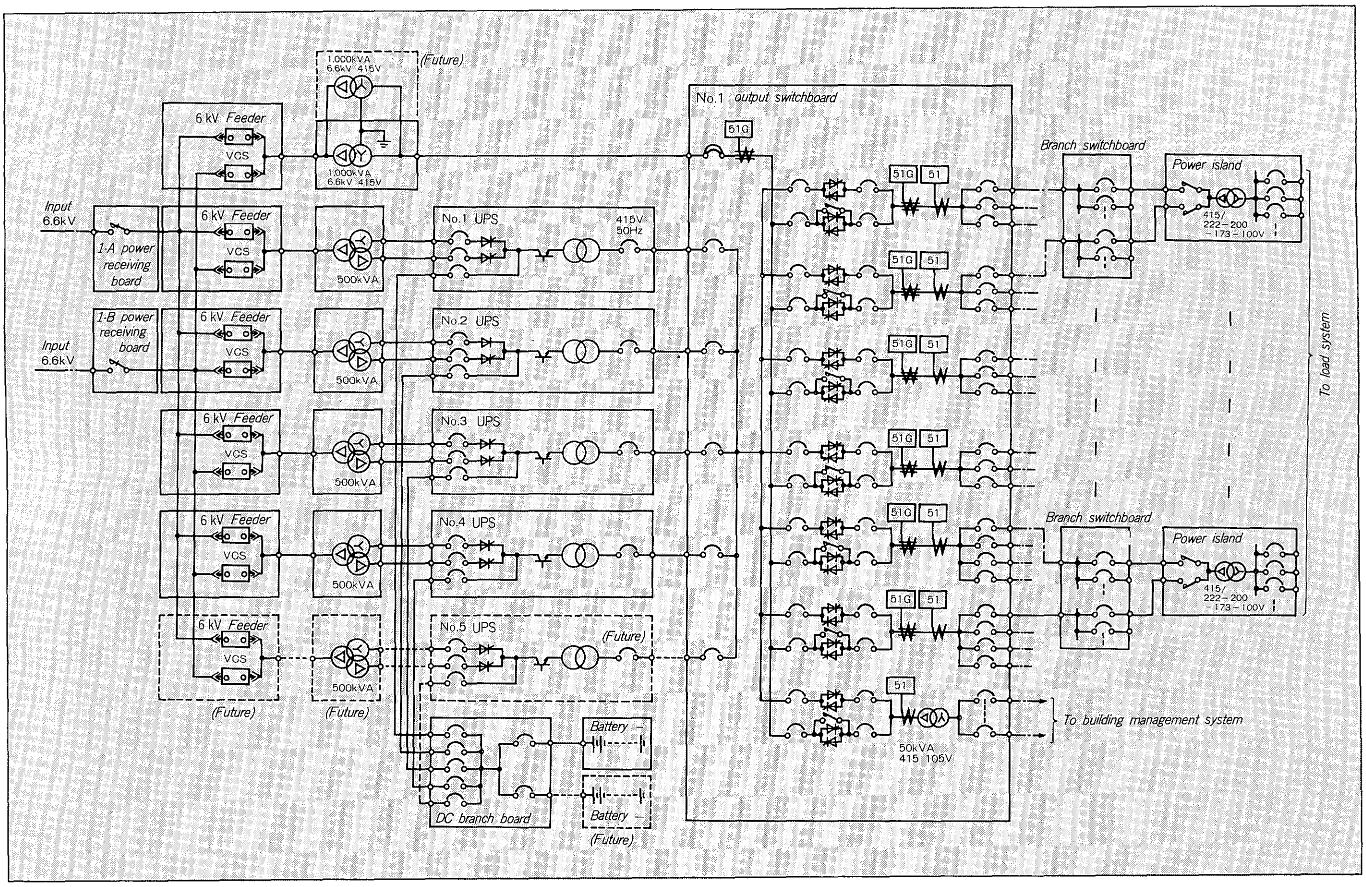


Fig. 3 UPS installation state

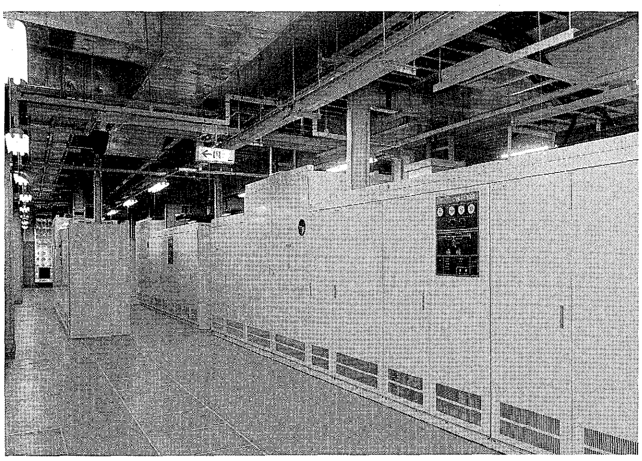


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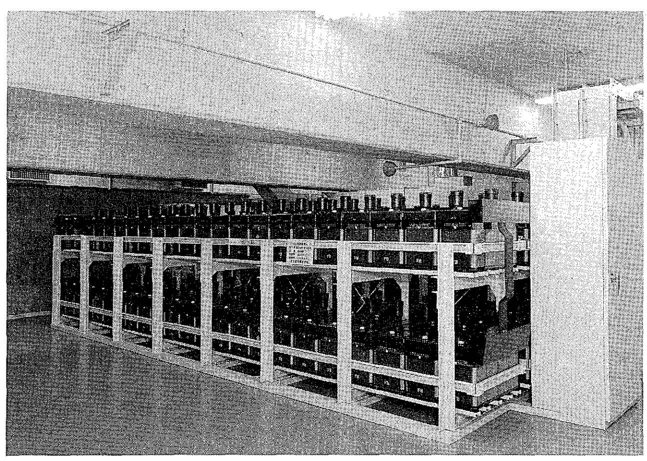
Fig. 4 Battery



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input 6kV power supply circuit and bus. Since it is duplicated so that power can be supplied to one load system from different branch circuits, the load system does not have to be stopped during load system expansion work. In this way, non-stop power can be supplied even during expansion and maintenance. The UPS room equipment layout is shown in *Fig. 5*.

2.2 Output switchboard

The static transfer switch consists of six sets of 1,200A and one set of 100A switches. The mounting state of noe set shown in *Fig. 6*. The UPS side static switch has a continuous rating with force quenching. The bypass side static switch takes a hybrid form with magnetic contactors connected in parallel.

The static transfer switch operation modes are manual switching mode and automatic switching mode. Manual switching can be performed arbitrarily, but is interlocked so that switching is performed only when the UPS power supply and bypass power supply are synchronized. Auto-

Fig. 5 UPS room equipment layout

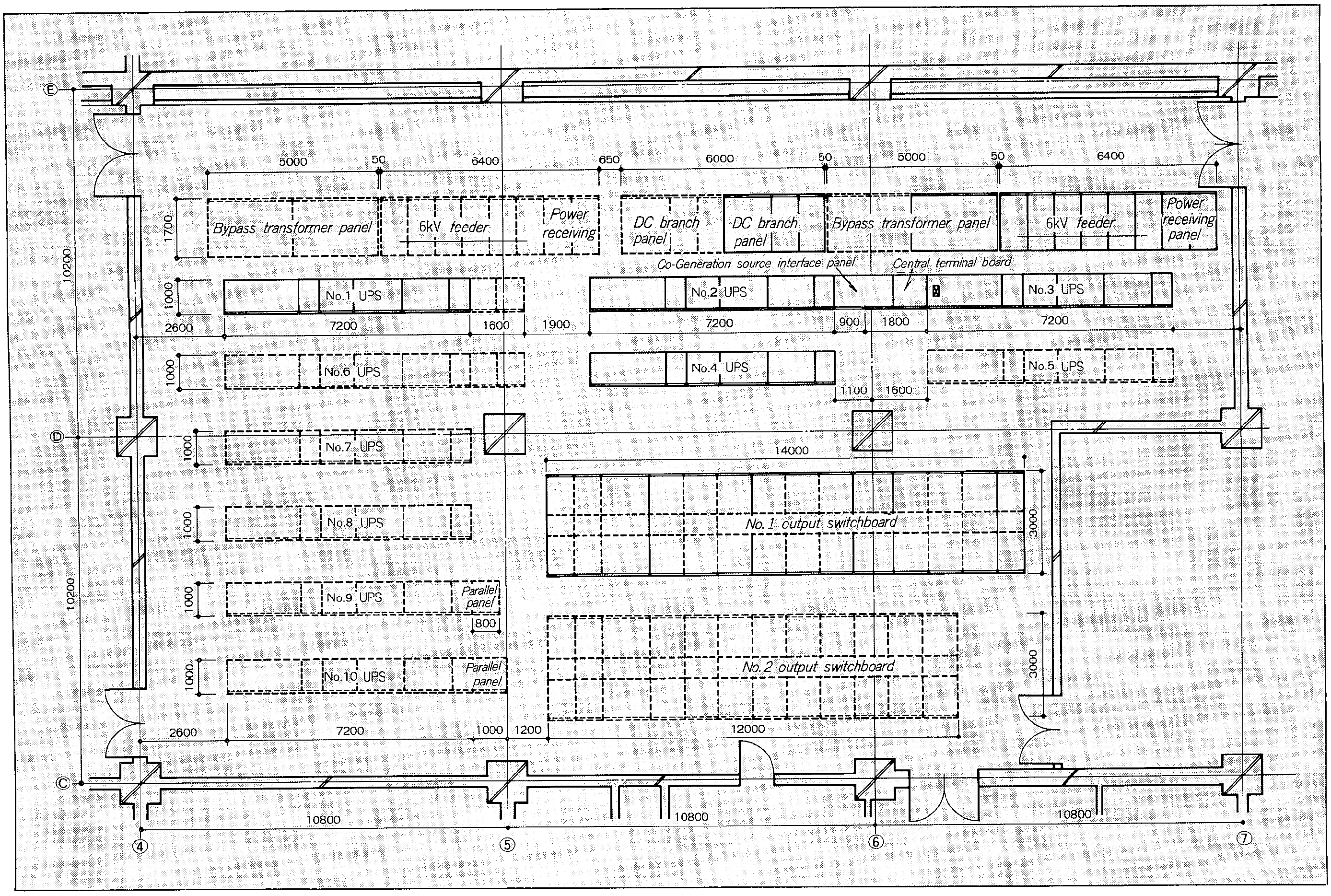
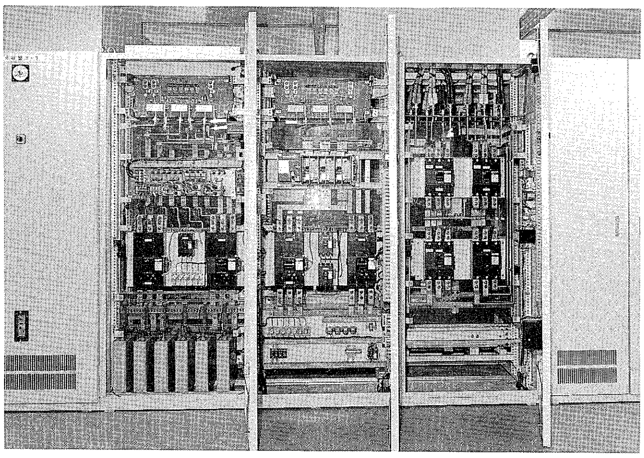


Fig. 6 Static transfer switch



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matic switching has the following three modes:

(1) Overcurrent

When an overcurrent was detected at the output feeder, UPS → bypass switching is performed and when the current returns to normal, bypass → UPS switching is performed automatically. Therefore, even if part of the load is shorted, only the faulty system becomes bypass power supply and UPS power continues to be supplied to the healthy systems.

(2) Ground fault

When a ground fault is detected at the output feeder, UPS → bypass switching is performed. When the bypass bus ground fault relay operated at the same time, the pertinent feeder stops supplying power.

(3) Stopping of two or more UPS

When two or more UPS stopped and an overload occurred, switching to bypass is performed sequentially up to the UPS supply capability in accordance with the priority of the output feeders.

2.3 Co-generation control

With a co-generation system, stable power load and stable exhaust heat are recovered and efficiency increases and introduction advantages are produced. Therefore, use of system linked operation with utility power is increasing, but this time, a method which provides stable power and load was considered and is introduced.

(1) Number of UPS control

As shown in *Fig. 7*, one of the inputs of two systems is connected to the co-generation source and the other is connected to the utility power source and the number of UPS which are connected to the co-generation power source is controlled by switches SW1 to SW3. Since the UPS is supported by a battery even when a momentary power failure is produced by input switching, the supply of

Fig. 7 Control system concept diagram

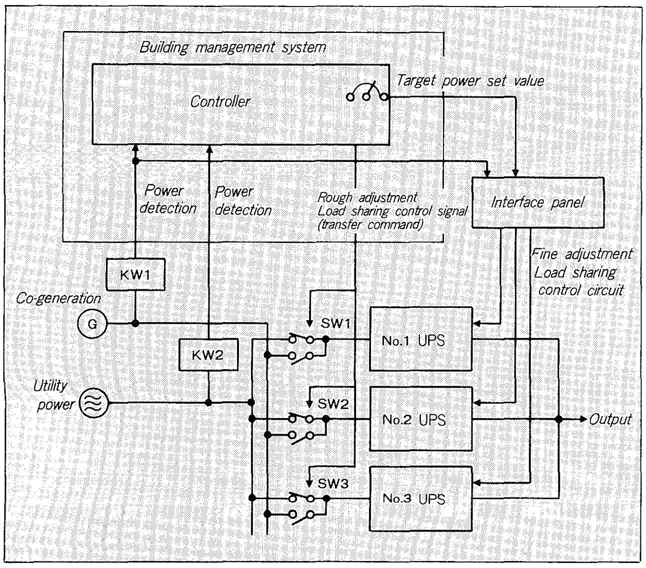


Fig. 8 UPS input power control

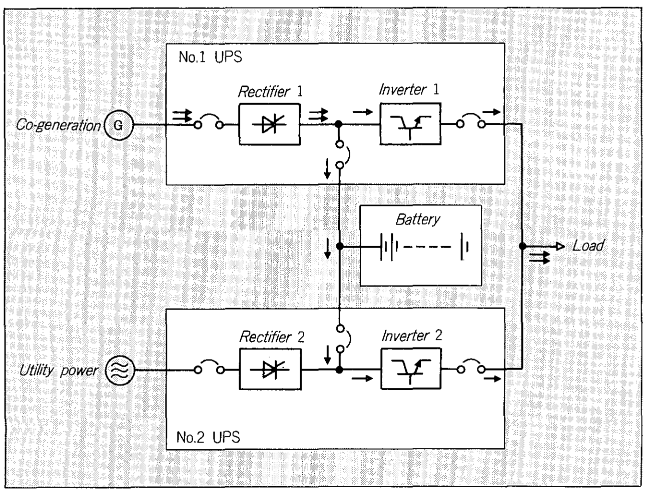


Fig. 9 UPS input power adjustment amount

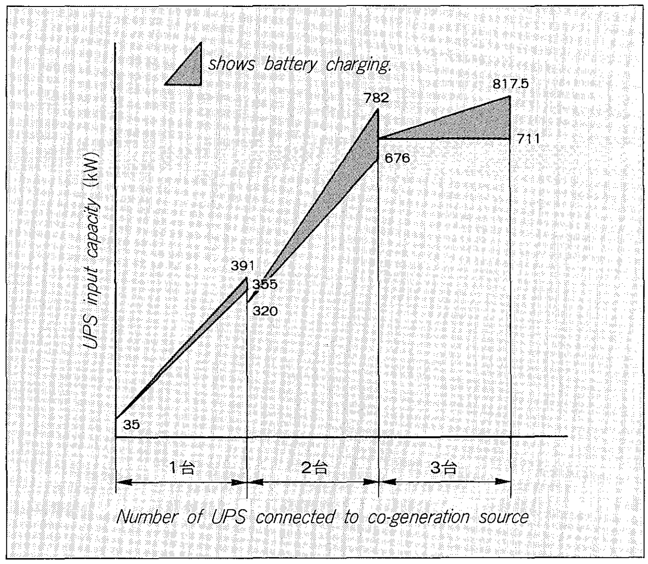
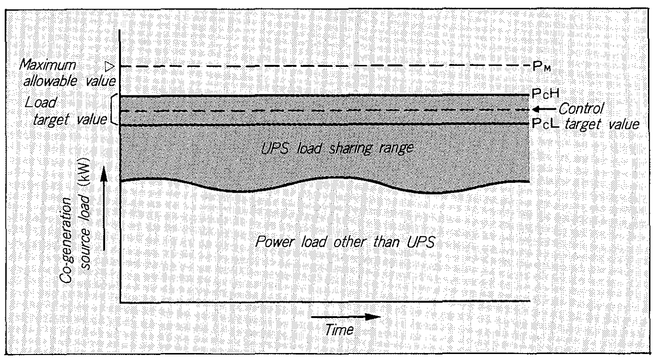


Fig. 10 Target power and load sharing



power to the load does not stop and switching can be performed arbitrarily.

(2) UPS input power control

UPS input power control is described with an example in which a battery is installed in common with the UPS as shown in *Fig. 8*. During normal operation, input is controlled so that the No.1 UPS and No.2 UPS share ½ of the load, each. Therefore, the rectifiers also share a corresponding ½ of the load. The input power control adopted this time uses the surplus of the rectifier at parallel redundant operation and controls the co-generation load sharing by controlling the load share of each rectifier.

When the number of UPS control and input power control described above are combined, wide range continuous power control is possible. The capacity adjustment concept when one to the UPS was connected to one to three co-generation power supplies is shown in *Fig. 9*.

As shown in *Fig. 10*, the co-generation power can approach the target value even when the general power changes.

3. POWER RECEIVING FACILITY

The power receiving facility receives power over two lines of main and spare at a special high voltage of 66kV and steps this down to 6kV and uses by two 4,500kVA transformers. The power receiving single line connection diagram is shown in *Fig. 11*. The special high voltage receiving facility is made compact by leading in the cable at basement 1 and receiving the power at cubicle type gas insulated switchgear (C-GIS) and connecting it directly to the transformer. The installation state is shown in *Fig. 12*. The transformer capacity anticipated future load increases and was made so that power receiving renovation are unnecessary and power failures areavoided. The 6kV circuit of the secondary side was made a double bus 4 booster system and the feeder panel was made a circuit configuration which can supply power from an arbitrary bus by double stacked circuit breakers. This was done for supply flexibility and the circuit and construction were made such that the load does not have to be stopped even during expansion work, maintenance, etc.

4. CO-GENERATION SYSTEM

4.1 System composition

In the beginning, three 1,500kVA (1,200kW) diesel

Fig. 11 Power receiving single line connection diagram

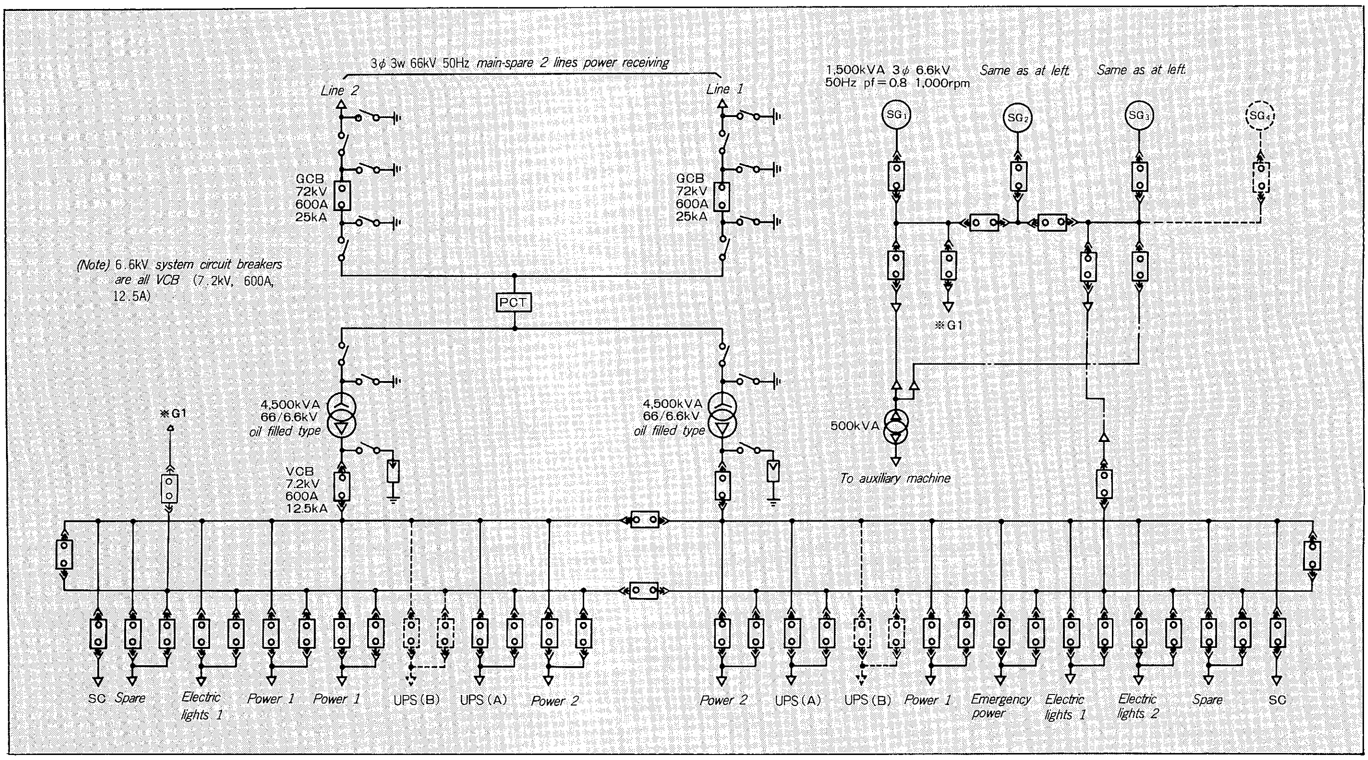


Fig. 12 Special high voltage power receiving facility

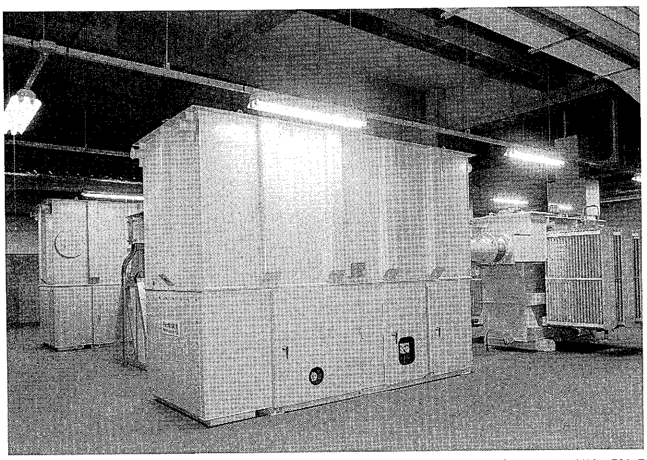


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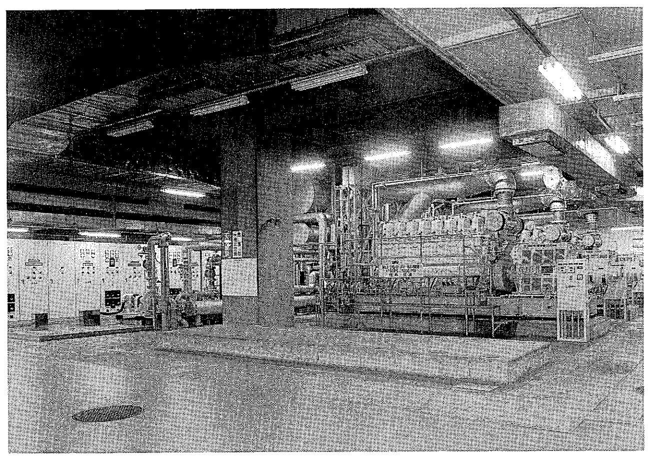
Fig. 13 Co-generation system



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generators were installed. The system is planned so that one more generator can be added in the future. One of the three generators is normally operated as the co-generation system and supplies power to the UPS and general power. The remaining two generators are used as emergency generators at a power failure.

The installation state is shown in *Fig. 13*.

4.2 Waste heat recovery and use

The waste heat recovery flow is shown in *Fig. 14*. The waste heat is recovered from the jacket and waste gas as hot water. In addition usingthe recovered heat in cooling by obtaining cold water by means of a single use absorption type refrigerating machine (capacity: 180USRT), the remaining waste heat can also be used through a heat exchanger for hot water supply (250,000kcal/h). Since co-generation operation is possible by any of the three generators, a jacket water heat reclaimer is added to each. Since there is only one co-generation operation generator, a single common waste gas heat reclaimer is installed.

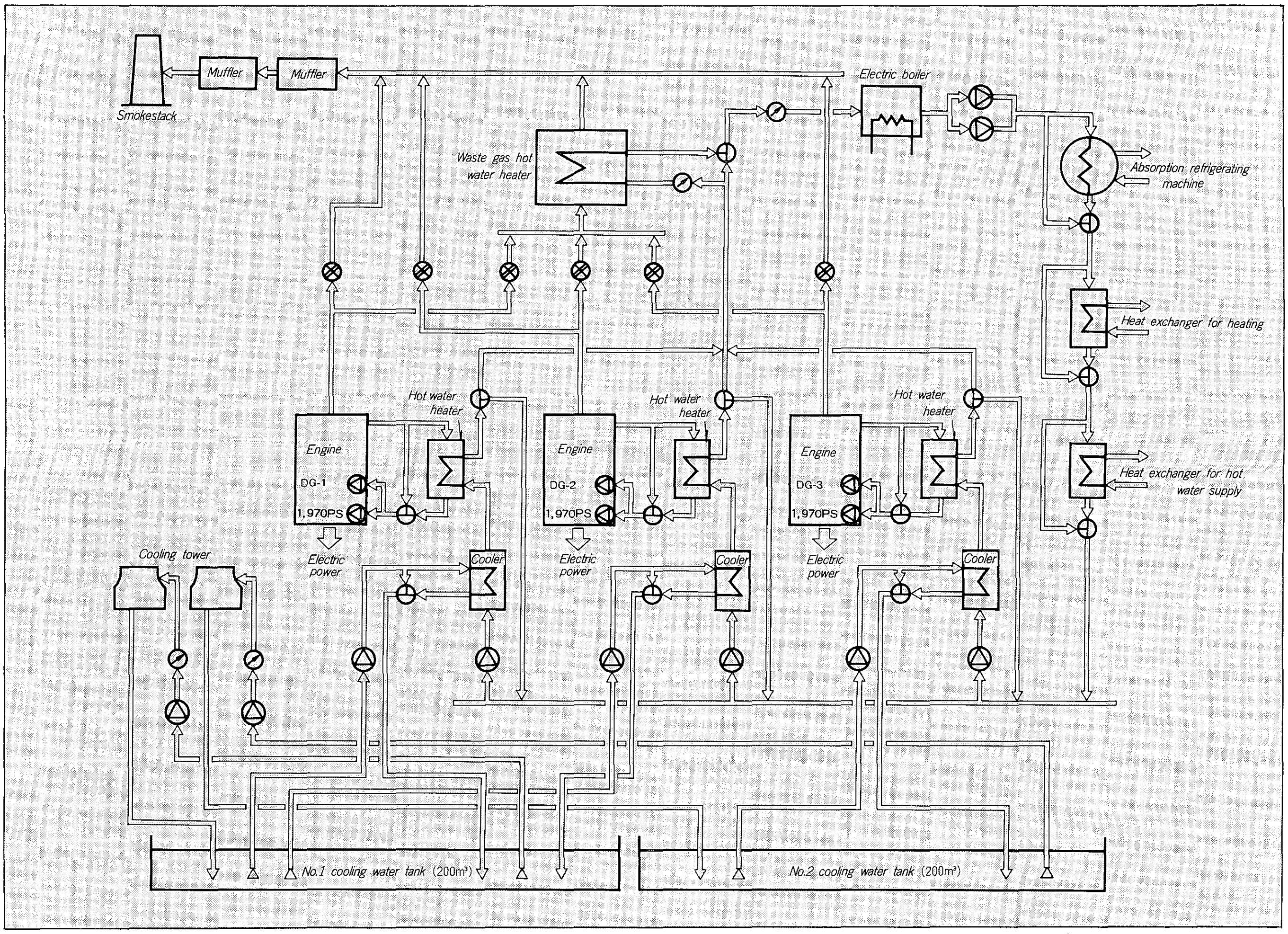
4.3 Waste gas countermeasures

A value of 900ppm (13%, O_2 density) was planned as nitrogen oxide countermeasures and was reached by engine unit countermeasures. As sulfur oxide countermeasures, kerosene with almost no sulfur content is used and the countermeasures necessary for the kerosene use are taken at the diesel engine.

5. CENTRAL MONITORING FACILITY

CRT, graphic board, and other displays, keyboard and

Fig. 14 Waste heat recovery flow



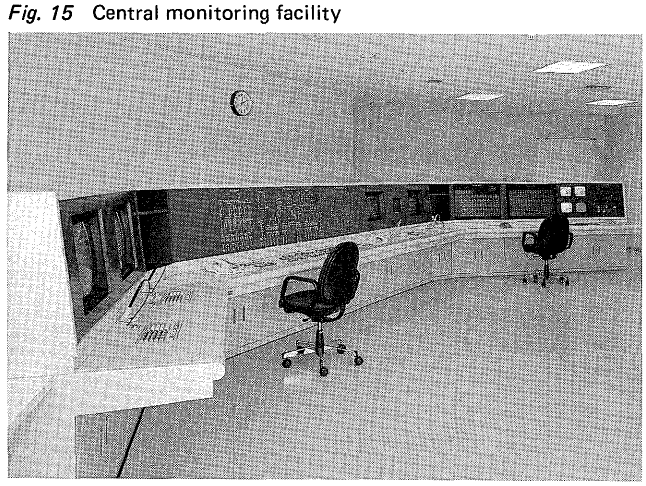
other operating sections, recording section by printer, etc. are installed in the monitoring room as shown in *Fig. 15*. The monitoring room is a system which allows overall central monitoring of electricity, heat, air conditioning, elevators, etc. A building management system interfaced with the central monitoring system (building management system) was introduced. The current day's optimum energy source (oil, gas, etc.), kind of heat source which is operating (absorption type, electric type, etc.) and other guidance is provided from the actual data collected from the building management system, operation date, kerosene storage amount, gas consumption, heat source rating, etc. and current day's heat use transition forecast, etc. can be performed from the actual data. This provides optimum operation technical support to the facility operator and saves energy and improves economy.

6. CONCLUSION

The power supply was mainly described. Besides the above, feed forward control and various other control considering outside air intake, and other energy-saving and comfort were also incorporated into air conditioning control and is currently operating favorably.

A system using cards was also introduced into important in-out checkoff system as a computer center. Regarding planning, we intended to also challenge maintenance of computer building operation without restrictions for expansion work and maintenance, etc. after the start of operation and minimization of operating cost which takes in advanced analysis capacity also while being friendly to the operator and to accumulate an operation record. The authors will be happy if this article is of even little reference when planning a computer building.

Fig. 15 Central monitoring facility



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