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COMPUTER CONTROL SYSTEM FOR SUPERVISORY CONTROL CENTER, THE KANSAI ELECTRIC POWER CO., INC.

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I. FOREWORD

Total automation to secure a stable supply of power is being promoted to cope with the increasing complexity, sophistication, and volume of system operation business accompanying the increase in the number of substations, introduction of 500 kV systems, and other advances in power systems.

In particular, computers have been extensively introduced to widen the range and scale of automation, and efficient, reliable system operating systems that connect these by means of a data transmission system have been constructed. The automatic transfer system of distributing line's information shown in *Fig. 1* is an example.

The following describes the automatic processing system applied to a load control station that groups 20 ~ 30 unmanned substations and centrally supervises and controls the group.

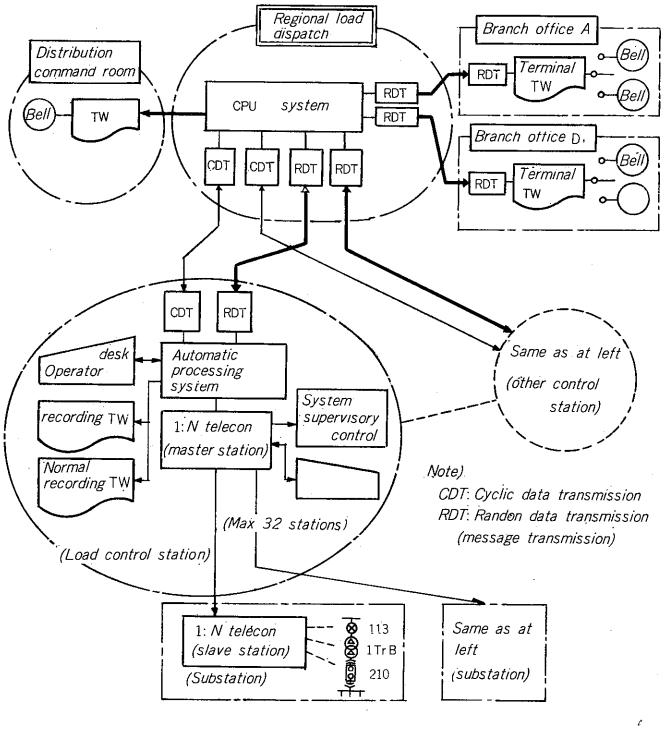

Fig. 1 Automatic transfer system of distributing line's information

II. DELIVERY RECORD AND SYSTEM CONFIGURATION

Table 1 shows the construction of the equipment and the supply list.

III. SYSTEM FEATURES

1. Control and display method (See *Fig. 2*.)

Control is a 4:n system and display is a (1:1) x n system. There are four control output routes designated A thru D. These use the following transmission words:

Control from desk 1 (A control route)
. . . . . Transmission word 1
Control from desk 2 or CPU3 (B control route)
. . . . . Transmission word 2

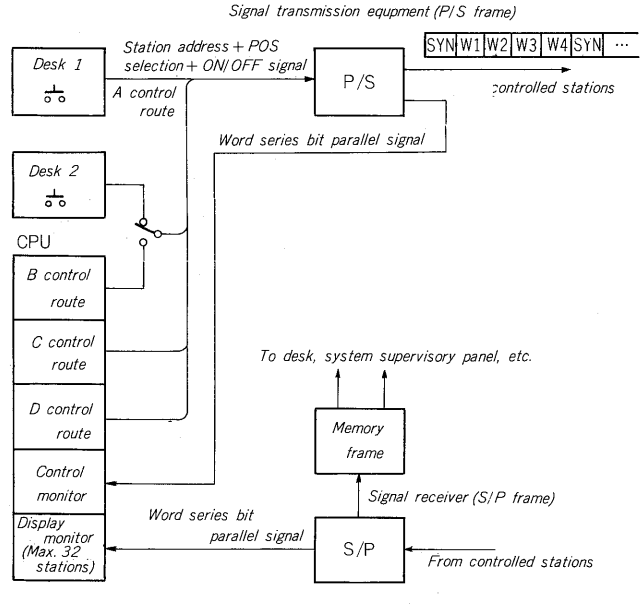

Fig. 2 Block diagram of control and display for supervisory control center

Table 1 Construction of equipment and supply list

Item		Delivery point			
		Ishitsugawa control station	Kishiwada control station	Wakayama control station	Sano control station
Year computer control system delivered		1976	1975	1974	1977
Applied computer		U-200	Same as at left	Same as at left	Same as at left
Core capacity		32 kW	Same as at left	Same as at left	Same as at left
Auxiliary memory		192 kW	Same as at left	128 kW	192 kW
System TW		F805A	Same as at left	Same as at left	F811A
Logging TW (2)		IBM735	Same as at left	Same as at left	Same as at left
PTR (PTRP)		F749C	Same as at left	Same as at left	F775C
1 : *N* telecon		Long-short code	Same as at left	Equal length code	Same as at left
Function	Trouble, operation recording	○	○	○	○
	Daily, monthly reports	○	○	○	○
	Metering	○	○	○	○
	Message function	○	○	△(1978)	○
Number of controlled stations ( ) indicates number designed		20 (32)	18 (32)	25 (32)	15 (32)
Number of position/controlled station		C/I = 70/90 position	Same as at left	Same as at left	Same as at left

Computer (C control route) . . Transmission word 3
Computer (D control route) . . Transmission word 4
Thirty-two stations can be controlled from any of these control routes. Moreover, 4 different substations can be simultaneously controlled. The B ~ D control routes are used in selective measurement from the computer. The C control route is used in short-periodic measurement, the D control route is used in long-periodic measurement, and the B control route is used by switching with desk 2.

2. Measurements

All measurements are selective measurement. Selective measurement from the desk is indicated at meter on the desk. Selective measurement from the computer is random measurement, short-periodic measurement, and long-periodic measurement.

3. Data transmission function

The data obtained at the supervisory control station are transmitted to the regional load dispatching station by CDT or message transmission.

IV. FUNCTIONS OF SOFTWARE

Besides load system supervision and measurement, and daily and monthly report recording functions, the main business of the supervisory control station, this system has

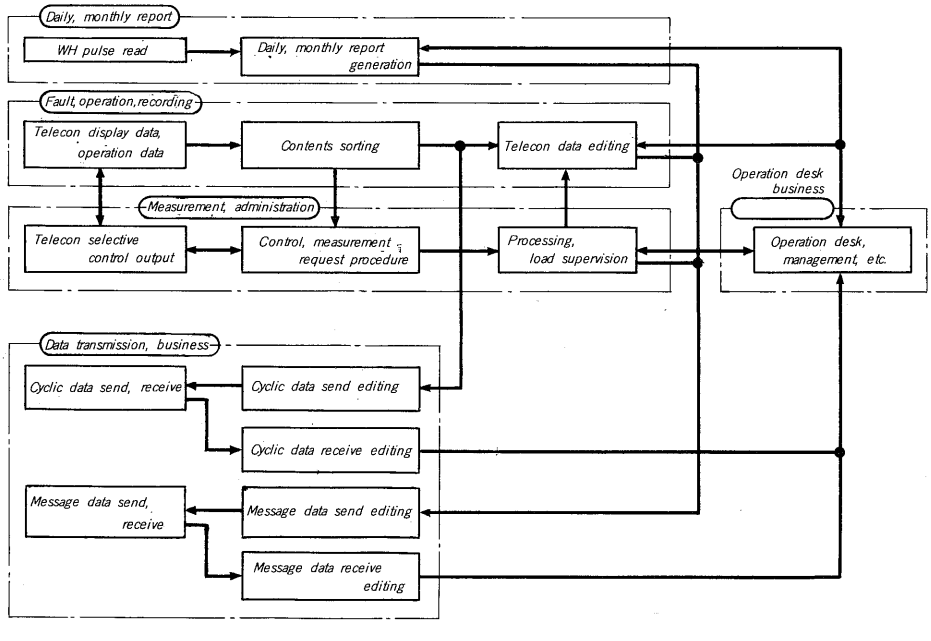

Fig. 3 Construction of software system

the distribution recording data and other data transmission functions needed at the regional load dispatching station. *Fig. 3* shows the construction of the software system.

1. Status change recording

[Operation recording (black printing)] and [fault, automatic status change recording (red)] are performed by means of the display data from the 1:*N* telecon and the control monitor. The status change positions are collected and edited by telecon set station and telecon 1 cycle. When simultaneous changes occur, up to 450 status changes can be processed within a telecon 3 cycle time. The load value immediately before the fault occured specified for each position can be added and printed. *Fig. 4* is a printing example.

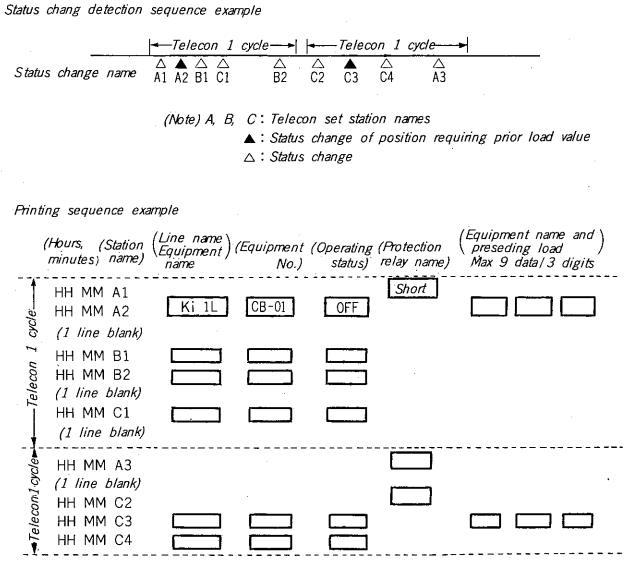

Fig. 4 Example of operational logging

2. Daily, monthly report recording

The active power of transformers, lines, etc. is journalized and sorted by time, and the daily and monthly reports are prepared.

1) Electric power

The telecon measured wattage, or the active power pulse input sent through a direct cable, are scanned every 10 seconds and integrated every hour. The data weight of one pulse may be 0.1 MWh or 1 MWh.

2) Printing

There are two printing methods; automatic periodic recording, and operation desk daily report request recording and monthly report request recording. In both cases, printing is performed at a periodic recording typewriter in a printed fixed format.

3) Active power data memory and storage

Table 2 shows the memory and storage of WH data. There are two kinds of data. These are individual input data and composite data compiled by transformer, distribution

Table 2 Memory and storage of WH data

	Active energy data name	Preparation	Memorized quantity	Erase
Daily report data	(a) Hourly value	Each o'clock	• Individual 128 quantities x 6 hours • Total 48 quantities x 6 hours	0100, 0700, 1300, 1900 daily
	(b) Daily maximum value, when maximum value generated	Each o'clock	• Daily maximum value 176 quantities • When daily maximum generated 176 quantities (individual + composite)	0100 daily
	(c) 6 hour total value	0600, 1200, 1800, 2400 daily	• 176 quantities x 4 (individual + composite) (0100~0600, 0700 ~1200, 1300~1800, 1900~ 2400)	0100 daily
	(d) 24 hour total value	2400 daily	• Individual 128 quantities • Total 48 quantities	0100 daily
Monthly report data	(a) Manthly amount	2400 daily	• 176 quantities (individual + composite)(double precision integer data)	2400 the 1st of each month
	(b) • Day monthly maximum generated • Monthly maximum 1st, 2nd, 3rd	2400 daily	• When monthly maximum generated (individual + composite) 176 quantities • Monthly maximum 1st, 2nd, 3rd (individual + composite) 176 quantities x 3	2400 the 1st of each month
	(c) Monthly maximum total		176 quantities (individual + composite)	2400 or 1st of each month
	(d) Monthly amount	2400 daily	176 quantities (individual + composite)	Not erased (carried over to next month)

substation (6.6 kV system), connection substation (33 ~ 22 kV system), and customer from the individual input data.

3. Measurement

The analog inputs sent by cable or carrier wave by selective measurement are fetched and a data bank is created. Processing data preparation and load system upper limit supervision are performed. The selection signal to the telecon employs a system is one motion selecting system and one measurement is completed in 10 seconds (selection signal transmission 8 seconds, resetting time 2 seconds).

1) Selective measurement

Selective measurement is listed in measurement priority order.

(1) Fault zone measurement (random measurement)
when a distribution line circuit breaker trips, the fault zone of that distribution line is selected two minutes later by using telecon control word 3.

(2) Voltage measurement (random measurement)
This measurement is provided to quickly measure the transformer secondary winding voltage after LR automatic control and is selected with word 3.

(3) Short-periodic measurement
Of the long-periodic measurement items of the next item, those considered to be of most importance can be measured comparatively quickly by item setting from the operation desk. This measurement processing is started at 10 minutes intervals and is selected with word 3.

(4) Long-periodic measurement
The specified measurement positions of all the controlled stations are measured endlessly. The time required for one cycle is about 30 minutes/32 stations and is selected with word 4.

2) Processing data preparation

(1) Load power (VA) preparation
This data is prepared by means of the equation VA(i) = $\sqrt{3}$ x current A(i) x pertinent voltage V(i).

(2) Load ratio (L) preparation
This data is prepared by means of the equation L(i) = current A(I)/set current A°(i).

(3) Load upper limit
The load ratio (L) and preset load ratio (L°) are compared at each measurement processing and alarm processing is performed for the data that exceed the set ratio.

4. Data transmission

Of the data obtained at the supervisory control center, that required comparatively quickly is sent by CDT transmission and the data to be printed at the recording and periodic recording typewriters is sent by RDT at the regional load dispatching station, etc. as required. Of the RDT send functions, thos for the distribution line information automatic transmission system are described below.

1) System construction and features

Fig. 1 shows the system construction. The control center and regional load dispatching station computer systems are connected and the regional load dispatching station computer system and the terminal typewriter of each business office are connected, and the distribution line data frome the control station are sent to the specified business offices.

Fig. 5 shows the format when data are sent from the control station. Since the management range of the control station and business offices does not coincide, the data are

Table 3 Automatic transferring of data regarding distributing lines

Transfer data			Receiving point		Starting method
Classification	Item contents	Business code	Area load dispatching station	Business office	
Trouble, operation data	Equipment operation (automatic, manual) recording	A01	○ (except distribution line CB)	○ (distribution lines CB)	Automatic
	Distribution line fault zone recording	A02		○	Automatic
Status data	Batch recording for slave substations	T01	○		Manual
	All slave substations voltage recordings	T02	○	○	Manual
	All slave distribution lines CB status recording	T03		○	Manual
	All slave substations current recording	T04	○	○	Manual
Others	RDT send lock, release message	Special A01	○	○	Automatic
	Test message	T06	○	○ (Note 1)	Automatic and manual
	Communication message	T09		○ (Note 2)	Automatic

(Note 1) Since data are not transferred between area load dispatching station → business office, test messages (test use fixed format) are automatically transmitted from the area load dispatching station to the business offices at 0850 daily to confirm that the system is normal.

(Note 2) RDT line faults are reported to the specified associated stations as a cover function from the standpoint of operation.

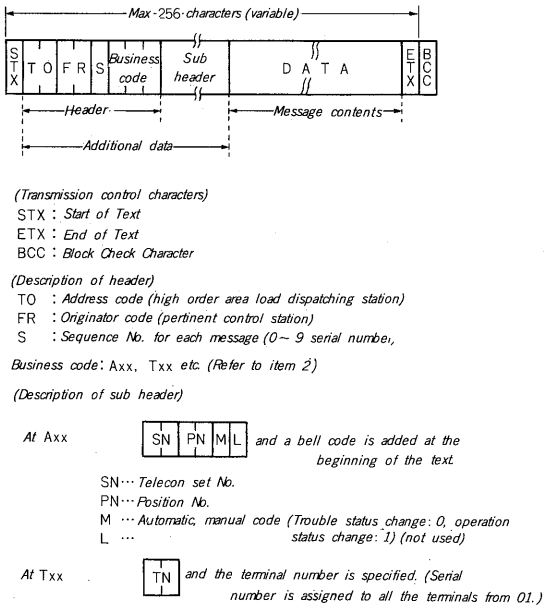

Fig. 5 Example of format for data transfer

not sent directly to the business offices, but the message type, terminal business office number, etc. are added and the data are edited to the specified format at the control station and sent to the area load dispatching station. At the load dispatching station, the data are sorted by business office by means of this additional data and predetermined destination judgement table and sent to the pertinent business office.

2) Kinds of transmission data (See *Table 3* and *Table 4*.)

In the case of transmission, the items transmitted by RDT as the supervisory control center are the monthly report periodic recording data (automatic start) and daily report request recording data, in addition to the distribution line automatic transmission items.

Table 4 Automatic transferring of troubles to business office

Contents of transferred relay data	Printing example
Line short	Short
Short in compound	Compound-S
Line ground	Ground
Ground in compound	Compound-G
Final tripping	86, 86F86
6 kV bus voltage abnormal	F84
6 kV bus ground	F64
Continuous ground relay operation	10G
22 kV bus voltage abnormal	K84
22 kV bus no voltage	B27 – 22

In the case of receiving test messages and communication messages are transmitted.

3) Transfer items priority order

Of the transfer data shown in *Table 3*, the trouble operation data (Axx business) are transferred before the status data (Txx business). For example, when a trouble occurs during transfer of Txx business, and Axx business must be sent, Txx business transfer is restarted at the end of transfer of Axx business.

V. CONCLUSION

Of system operation total automation, business processing based on example of 4 stations applying a minicomputer to the supervisory control center was outlined above.

The previously mentioned 4 systems are all currently operating and substation expansion, bank expansion, etc. are being implement yearly. On the other hand, upgrading of functions, etc. for automatic processing business contents are also being studied.