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FOREIGN TECHNOLOGY DIVISION

POWER BALANCE

By

J. Grubalska, A. Kurleto, K. Lesniak

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"POWER BALANCE" - a program system for the ODRA 1325 digital computer

Jadwiga Grubalska, Anna Kurleto, Krystyna Lesniak

As the computer application in the regional power capabilities as well as in perfectioning the systems of the information transformation in the real time is being developed, the necessity of elaboration of algorithms and programs for many statistical problems is also rising. One of these problems is current preparation of the actual power by means of the program system called "POWER BALANCE" on the ODRA 1300 digital computer.

This system consists of several utilizable programs and is employed for the present way of the electric power system management. The computation system task is to organize the automatic recording of measuring values in the half-an-hour cycle(the actual power measurements), this of the values of the sygnals of the power automatic control (ARC), the preparation of of the specifications concerning individual loads of a regional electric power plant as well as the calculation of the demand for the actual power in the area.

The POWER BALANCE system functions under the control of the operational real time system (SOSAPI-ODM) and uses the telemetric and initially transformed actual power valus obtained from the area individual power plants as well as from the line serving for the power exchange with the neighboring areas. At present, not from all objects in the area the measurements are being sent automatically. Therefore, it is indespensable to supplement the actual power measurements by means of the alphanumeric keyboard, display monitor which is the input-output equipment in the above mentioned system.

The POWER BALANCE system helps a dispatcher to control the set of the current changed values which are memorized in the system data collection. The questions put to the system and expressed as a message outgoing from the display monitor keyboard brings into life a picture on the screen. This picture comprises specifications of loads of individual groups of power plants or the area power balance.

POWER BALANCE system discription

The system consists of four real time programs and an input program. All

programs are related to each other through the BILANS$_{\nabla}$ DSØ1 data joint collection. This collection is composed and brought up to date on the grounds of the power momentary measurements as well as the magnitudes of the signals of the automatic power control (ARC) and the telecommand system of the power manual control (RRC) /All these data are being taken every 10 seconds (they are provided automatically by means of telemetric systems)/ after their averaging and memorization by the SOSAPI system in the 2-minute cycle.

In the BILANS$_{\nabla}$ DSØ1 collection, the set of the averaged and verified measuring data from two minutes following every full clock hour or half an hour of the day. A part of the data (the values of the measurements of the power which are obtained in a non-automatical way, the frequency measurements as well as consumed power limits) is introduced into the system data set on the periodic basis by the dispatcher from the alphanumeric keyboard of the display monitor. These data are introduced only for the full clock hours of the day. On the other hand, for half-an-hour periods they are calculated as the arithmetical averages from the measurements made at full hours (the preceeding hour and the following one).

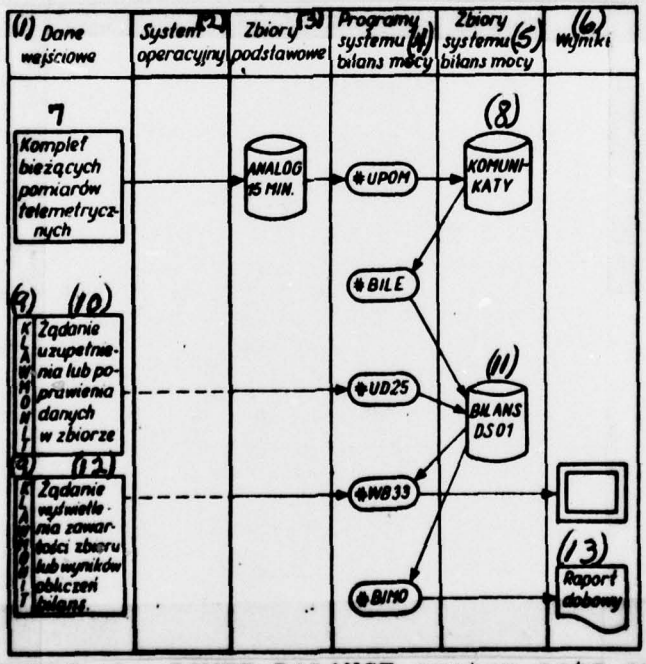

Fig.1. Diagram of the POWER BALANCE system sets and programs. Key: (1) Input data; (2) Operational System; (3) Basic sets; (4) Programs of power balance system; (5) Sets of power balance system; (6) Results; (7) Group of actual telemetric measurements; (8) Messages; (9) Keyboard monitor; (10) Requirement to complete or correct data in set; (11) Balance; (12) Requirement to show the contents of set or calculation results balance; (13) Around O'clock report.

The system comprises the following programs:

UPOM - the program of the preparation of verified and averaged telemetric measurements in the 2-minute cycle;

BILE - the program introducing the averaged telemetric measurements (prepared by means of the UPOM program) into the **BILANS$_V$ DSØ1**; set in a half-an-hour cycle;

UD25 - the program which is activated on demand introduces data into the **BILANS$_V$ DSØ1** set from the alphanumeric keyboard of the display monitor;

WB33 - the program which is activated on demand. In this program individual procedures edit the pictures designated to be shown on the monitor screen.

BIMO - the input program of the around o'clock reports preparation and feeding with it the ~~verso size typewriter~~ line-PRINTER. The around o'clock report includes also lists of particular groups of power plants as well as the actual power balance of the area.

The diagram of the data sets and system programs relations is shown on Fig.1. The real time programs are located in the program library of the operational system in a binary form. These programs are activated in an introduced working cycle.

The non-cyclic program names (UD25 and WB33) are written in the tables of the interpretation program of messages from the keyboard of the INTE display monitor /3/. Writing the message on the display monitor alphanumeric keyboard introduces one of the programs interpreting the message contents and realizing a proper procedure into the operational memory.

The principles of preparation of the actual power balance of the area.

The lists concerning the area actual power production along with the computed power balance represent a significant fragment of the dispatcher's sheet. The dispatcher calculates on the basis of the data relating to the actual power production the following:

- the total of the actual power of steam electric stations P_z,
- the total of the actual power of the industrial power stations P_p,
- total of the actual power of hydroelectric power stations P_w,

actual power produced in the area

$$P_{wt} = P_z + P_w + P_p$$

exchange of the actual power with another area or region

$$P_{wym.z} = \sum_{i=1}^{r} P_i$$

(P_i is an exchanged power through the i-line with the z area; r is the amount of lines, through which the exchange with the z area takes place).

the area's exchange balance

$$P_s = \sum_{z=1}^{W} P_{wym.z}$$

(W is the amount of areas involved in the exchange);
the power plant load with the actual power:

$$P_{ob} = P_{wt} + P_s$$

the load correction depending on the frequency changes:

$$\Delta P = 2{,}2 \frac{f_n - f}{f_n} P_{ob}$$

(f_n - characteristic frequency; f - the frequency in the electric energy system));

the demand for the actual power

$$P_{zap} = P_{ob} + \Delta P + P_{og}$$

P_{og} - limitation of the actual power supplied to customers)

the variation coefficient of the factory power plant load:

$$K_o = \frac{\min P_z}{\max P_z}$$

the variation coefficient of the actual power demand of the area

$$K_z = \frac{\min P_{zap}}{\max P_{zap}}$$

In order to perform the above mentioned calculations, in the POWER BALANCE system there is a special procedure designated for two programs of the system, namely - WB33 and BIMO. The first one calculates all balance positions for

six full hours back, beginning with the hour introduced in the message written on the alphanumeric keyboard of the display monitor. However, the 2nd program is being calculated for every hour and a half an hour of the day with a complete data set.

Preparation of the lists of verified and averaged values of the telemetric measurements

The lists of verified and averaged telemetric measurements are being made through the UPOM program which is activated autamatically through the operational system in the 2-minute cycle. The program input data are the telemetric measurements presented in the tables accumulated in the ANALOG 15 MIN collection which are prepared by the SOSAPI. The averaged value is memorized in the measuring word. This part of the word is being transferred to the MESSAGES collection.

The averaged measurements (after the elimination of incorrect measurements) are arranged in a given sequence according to the requirements of utilizable programs. In the POWER BALANCE system this function is being performed by the BILE program.

Data actualization in the BILANS$_{\nabla}$ DSØ1 collection

The BILANS$_{\nabla}$ DSØ1 collection comprises the lists of measurements of the actual power, values of the ARC and RRC signals as well as the customers' limitations from every half an hour of the i, (i-1) as well as the (i-2) period, where the i-index is related to the actual period (24-hour period).

The BILE program activated automatically by the SOSAPI in a half-an-hour cycle actualizes a part of the BILANS$_{\nabla}$ DSØ1 collection comprising the telemetric data from the actual 24-hour period and inserts the averaged measurements from the first two minutes after the full o'clock hour or after half an hour of the day. The part of the collection, which is not provided with measuring values by means of telemetry, is being actualized on the basis of the data taken from the display monitor keyboard. The data obtained from half-an-hour periods are not memorized and calculated as the arithmetical average of the measurements made in two succeeding o'clock hours (in the preceeding and following one).

After the midnight of every 24-hour period a part of the collection related to the (i-2) is being transferred to the archives collection and the remaining data are moving in order to find place for the data from the current 24-hour period.

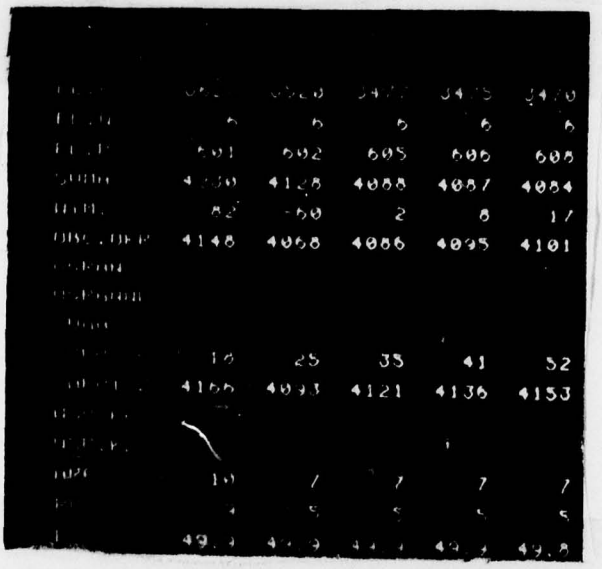

Fig.2. Example of a fragment of the picture on the monitor with the current actual power balance.

Display monitor employment in the POWER BALANCE system

The display monitor is an input-output equipment through which the information about the required changes of optional values in collections are being delivered or the demand to show the picture on the screen is also being delivered. Ani information or demand must become a an appropriate message which consists of the following: PROGRAM NAME, PROCEDURE NAME, MESSAGE PARAMETERS.

The programs realizing messages perform the following functions:

they complete and correct optional values in collections (the UD25 program);
they edit the pictures which are to be shown on the monitor screen (the WB33 program).

Both programs consist of a number of procedures which realize the presented tasks. The UD25 program individual procedures realize the following tasks:

ZZ - writing into the collection of the full set of the values of the measurements which are not being delivered automatically;

ZG - the completion of the lacking measurements in the collection or correction of the earlier memorized measurements from one or several objects of the area for the given hour of the day;

ZO - the introduction of the values of measurements from one object in the area or from several succeding hours of the day;

LI - the introduction into the proper portion of the collection of the initial values of the counter of half-an-hour periods of the 24-hour period of the day.

All procedures of the WB33 program edit the lists in the form of the picture to be shown on the screen of the monitor for a given hour of the 24-hour period.

Procedures of the WB33 program realize the following tasks:

BO - the calculation of the actual power balance according to the principles of ~~the~~ preparation of the balance of the area actual power;

EZ - the preparations of lists of the condition of the principal power station load;

OE - the calculation of the total of load of the principal.power station, hydroelectric ones and industrial ones as well as the preparation of of the list of the load condition for the area power station;

WM - the calculation of the balance of the exchange with an area or a region;

DO - the calculation of the 24-hour period of the load course;

DZ - the calculation of the 24-hour period demand for the actual power of the

area as well as the preparation of the lists to be shown on the monitor screen. Besides the above-mentioned, this procedure enables to print the daily demand on a paper tape (to be used by the forecasting program).

All procedures may realize their functions depending on the introduced parameters for the data from three succeeding 24-hour periods: i, (i- 1) as well as (i-2) where i is a succeeding number of the current 24-hour period.

When realizing the WB33 program, the edited picture is sent to the buffer and shown on the monitor screen through the operational system /2/. The fragment of one of the suggested pictures is shown on Fig.2. An entire picture here comprises the area power balance for 6 different hours and 6 half-an-hour periods of the 24-hour period of the day (columns). The power values are given in megawatts and the control sygnals and frequency in hertzes

Preparation of the 24-hour period report on the balance of the area actual power

The calculation of the area actual balance is being performed through the BIMO program in the input way. The data related to the actual power load of particular principal power stations, as well as hydroelectric stations and industrial ones, the data related to the power in the exchange power lines, those related to the ARC and RRC signals, as well as to the frequency and limitations which are being collected during the entire 24-hour period and memorized in the **BILANS, DSØ1.** collection. On the basis of these data, the BIMO program computes the power balance and sends a 24-hour period report with the list of the power station loads and the area actual power balance to the line printer. This program makes possible printing the report (Fig.3) for the last 24-hour period or for the next to the last one, - (i-1) or (i-2). One side of the print includes the results for 6 hours and 6 half-an-hour perperiods of the day (succeeding columns of the print). The whole print consists of 12 pages.

Final remarks

The current recording and holding the statistics on the actual and passive power /1/ is a part of the OBSTA system which comprises the statistical data indispensable for the ODM.

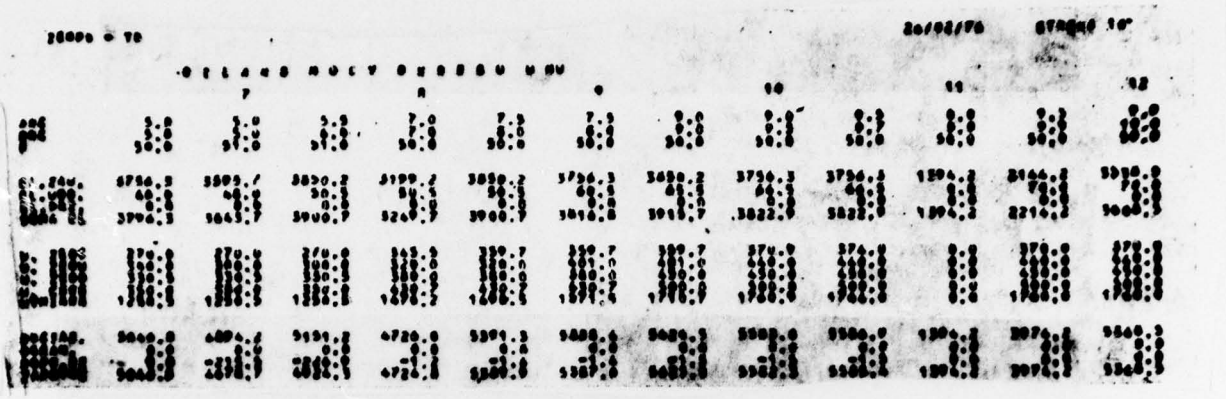

Fig.3. Fragment of the 24-hour period report print.

On the basis of the OBSTA system project, after taking into consideration the users' demands and technical possibilities, the POWER BALANCE system has been worked out. This system comprises the actual power statistics and makes possible the classification of the data into collections as well as rendering them accessible to the dispatcher in the form of lists transferred to the display monitor and line printer.

There is a possibility to employ the system in the current recording of the passive power (afrer proper telemetric measurements were introduced into the ODM).

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