Monitoring and Control Systems
for Industrial Processes

MIP, spol. s r. o. (Ltd.) Velká nad Veličkou

"Complex information on production and automation of its management quarantees your success!"

motto

CALORIMETER

The Calorimeter serves to the continuous (non-contact) measurement of the calorific value and ash content of coal.

Application on mines, coal separating and preparation plants, electrical power stations, heat plants, cement works and steel works.

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CALORIMETER

Dear Business Friends,

We take the pleasure to introduce one of MIP's products in the field of monitoring and control systems for industrial processes - the "Calorimeter". This equipment is a pillar programme in our company's activities and has undergone long-term development and is continuously being added to and improved not only to suit developments in the fields of computers and technology, but also to meet the ever changing customer requirements.

1. Essence of Equipment

The Calorimeter serves to the continuous (non-contact) measurement of the calorific value and ash content of coal. Measuring is done on the coal conveyer belts and is not dependent on volume and changes in the layers of coal and is not affected by the irregularity of the surface of the measured coal flows. It is intended for

- coal granulity of up to 300 mm,
- transported layer of coal of height range of 50 to 300 mm.

The Calorimeter operates on the weakening gamma ray principle using two different intensities of energy. This method is to a given extent dependent upon the chemical composition of the coal. For purposes of eliminating such influence, the calorimeter sensor elements are calibrated to the so-called "measured type of coal". If the Calorimeter is used to measure types of coal of substantially different chemical composition from different mines, the sensor elements are calibrated to suit such types of coal and the Calorimeter operators simply adjust the calibration curves by type of coal being measured. The Calorimeter sensor elements are calibrated to the type of transported coal at the time that the Calorimeter is put into operation and the customer only performs a check. Such check is based on the verification of trends in the Calorimeter readings using a set of laboratory samples over a long period of time. Where necessary the customer adjusts the calibration himself, i.e. he sets the calibration for a new type of coal (coal from a new supplier or another mine). The calibration of the Calorimeter sensor elements is very easy and can be done by the customer's trained employees (Calorimeter operators, technicians or laboratory workers). This is based on the collection of samples and their evaluation using classical laboratory methods. The obtained results are entered into the Calorimeter's calculator programme, which calculates the new calibration constants for the calibrated type of coal.

The operators counter the influence of free water in coal on the Calorimeter readings by entering the average water content for the given period of year or month.

The precision of the Calorimeter readings is based on the radiometric principle of measurement and its statistical evaluation. It is supported by the correct calibration of the sensor elements and correct operation of the equipment. For coal with a calorific value of more than 1430 kcal (6 MJ) the error of measurement is 3 to 5 % of the maximum measured calorific value. For coal with a calorific value of less than 1430 kcal (6 MJ) the error of measurement is 8 % of the maximum measured calorific value.

The Calorimeter as against similar equipment and methods offers the following advantages:

a) **instantaneous information** on the calorific value and ash content of coal, orientation volume of the passing coal. Eliminates delay in measurement evaluation as arises in the use of classic laboratory samples, where the results are known only after the measured coal has been deposited on the dump, after expedition from the mine or the coal processing plant, in worse cases only during the combustion process.

b) **continuous information**, which differentiates the use of the Calorimeter method from classic laboratory measurement. Continuous information from the Calorimeter replaces the non-representative character of laboratory samples with regard to the total volume of transported coal. The volume of transported coal, not measured between the individual collection points of the sampling equipment is quite large. The norms, which lay down the methodological procedures for laboratory sampling are based on the statistical processing of individual coal samples from various points. Such a sample gives the total volume of coal transported, thus giving the representative accuracy of the laboratory. The processing and evaluation of the sample is also influenced by the worker who also makes a lesser or greater error of measurement. These methods are based on the possibilities of the sampling equipment, laboratory evaluator equipment and the capacity of the laboratory in general. The Calorimeter is also based on statistical processing, and as the information is processed in a continuous flow, it therefore has a greater

representative capability. The individual Calorimeter readings are presented as weighted averages of ash content and calorific value of coal per minute. The measurement therefore shows the volume of flow for a given quality of coal below the sensor element. It therefore eliminates the peaks in measurement on the upper or lower limits arising from the radiometric method for the measurement of chemical non-homogenity in coal as well as large deviations in coal granulality.

c) for the Calorimeter it is not necessary to build complicated **collector equipment** (as is the case with some similar equipment), it is possible to mount it at any point of the technology as per requirements (even on heavy mining machinery and excavators, where information on the quality and quantity of extracted coal is of paramount importance to the further control of mining operations).

2. Application

The given advantages and further characteristics of the Calorimeter characterize its use.

2.1. Mines

The control of mining, processing and homogenization of coal. Based on information from the Calorimeter, geological research of the locality and quality and volume requirements with regard to the final product, the following are determined

- position of excavators on the mine location and coal production volume requirements,
- setting of the feeder heads on the conveyer belts, setting at dumps or coal bins.

During the course of operation the accuracy of the geological research is checked by Calorimeter measurement and the mining requirements on the excavators and the technological settings are automatically changed as per requirements.

The operator is informed of the instantaneous state of the dump and expedited coal. He adds to or reduces the dump as per requirements on the output quality of the coal on exit from the technology.

2.2. Coal separating and preparation plants

By location of the Calorimeter sensors at the coal inlet and outlet points to and from the technological process and the dump (monitors the blending of coal at the dump), increased coal production is achieved as per desired parameters, reduction in losses arising from unseparated coal as well as in deviations from desired quality standards to a minimum. Combination of the Calorimeter information and the operational equipment in the technology, leads to the automatic removal of poor quality coal as well as the initiation of further processing of the coal by the technology are achieved.

2.3. Electrical power stations, heat plants and cement works

Information from the Calorimeter is used in the control of coaling, thus leading to more efficient production of electrical energy, heat as well as coal quality control from the ecological point of view. The Calorimeter readings may be used as an input for further automatic control systems, such as control of combustion processes and the desulphurization of the combustion products.

It seems to be more suitable to locate the Calorimeter sensors before the access point to the fuel dump. The coaling operator then has instantaneous information on the incoming coal. He can guide its dumping in sectors by its quality. In this way the operators are always informed about the actual state of the dump and the coal reserves. At the same time it is possible to check contracted quality limits for the coal from suppliers.

A further place for the application of sensors is the point of exit from the dump, respectively, inlet to the boiler coal bin. The importance of the application lies in the fact that the content of the boiler bins is known and thus also the quality of the fuel fed to the boiler. This information is fed to the control system for the combustion process and the desulphurization of waste gases. The operator may in accordance with the instantaneous quality of the incoming coal opt for a mixture from different sectors of the dump or add coal from the dump to directly to coal which is coming in from the supplier. In this way coal within the desired quality limits is fed to the boiler, which play a very great role in the economy of the combustion process.

In cement works, information on the ash content of the fuel may be used in the further processing of such ash.

2.4. Steel works

Information from the Calorimeter is used in the management of operations from the point of view of ash content in coke.

3. Description of Equipment

3.1. Information from the technological process

3.1.1. Sensors (Type GE 1100 S)

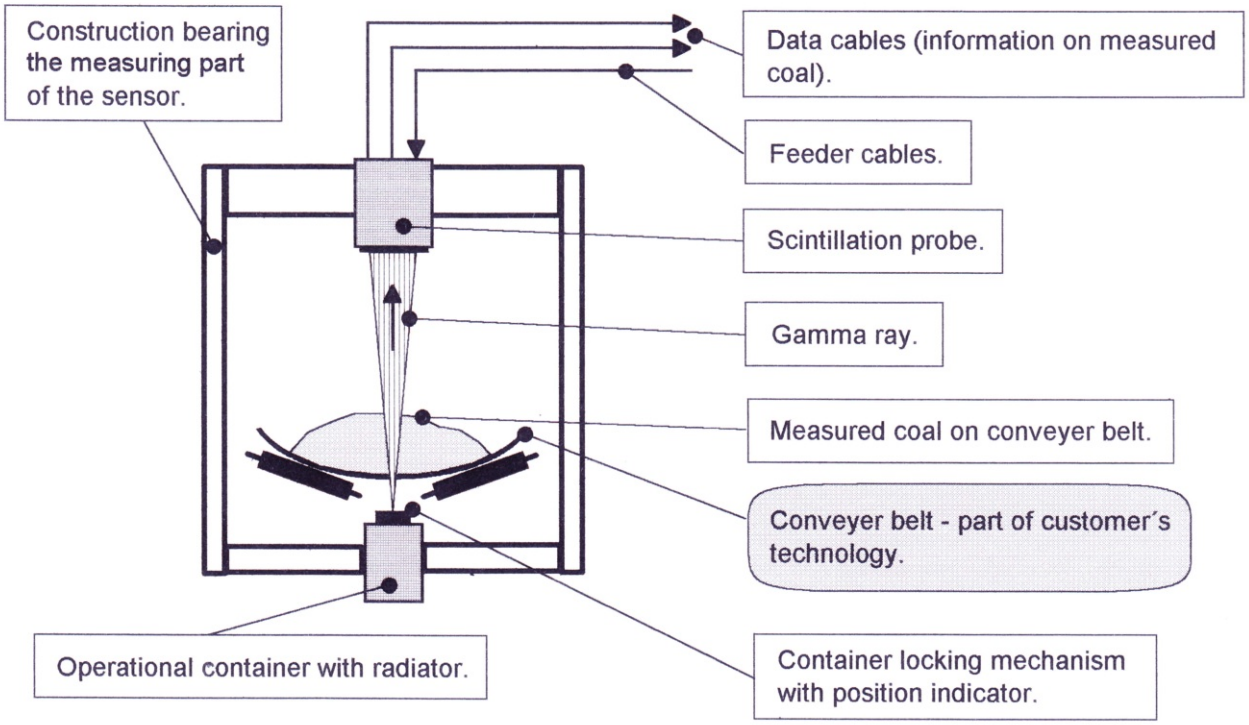
Coal quality sensors are positioned on the conveyer belts, which transport the coal. The number of sensors depends upon customer requirements with regard to the volume of desired information, especially the arrangement of the transport lines and coal storage. The sensors operate on the weakening gamma ray principle using of two different energy intensities. The gamma ray comes from two sources (elements Am241 and Cs137), which are positioned below the belt in the operation container (weakened Uranium CsAm13). The thin ray passes upwards through the conveyer belt bearing the coal and is captured by a scintillation probe above the conveyer belt (Type NKG 301 A). The signal from this probe which is further processed in the sensor control unit bears information on the ash content in the coal and the volume of the passing coal.

The container containing gamma radiators ensuring the generation of the necessary band to radiate through the coal layers and at the same time protects the surrounding areas from radiation. The operators and maintenance personnel can work in close proximity to the sensors without any danger of exposure. At the same time, manipulation of the radiator container, for instance, during belt exchange, repair of the construction or modification of the transport route, is very easy. Its based on the release of the locking mechanism on the container, adjustment to the position where the container is impermeably closed and does not even release the measuring ray, and the locking mechanism reset. A container so secured can be removed and stored in a suitable place and be replaced at the desired moment. The locking position is indicated on the container.

Control of radiation intensity and stability (interference) of signal transfer lines from the sensors to the control unit are carried out by the customer's employees by measuring the etalon (standard measure) below the sensor. As the medium period for the deterioration of the radiators is 30 years, the depreciation of radiation intensity is very low and is eliminated during sensor calibration.

The containers are checked by the highest authorized Working Hygiene Institute of the Czech Republic and a certificate issued stating the radiation intensity in the container's surroundings both in unlocked and locked state.

Diagram No. 1 - Measuring Scheme usins the GE 1100.S sensor.



3.1.2. State of technological equipment

This involves

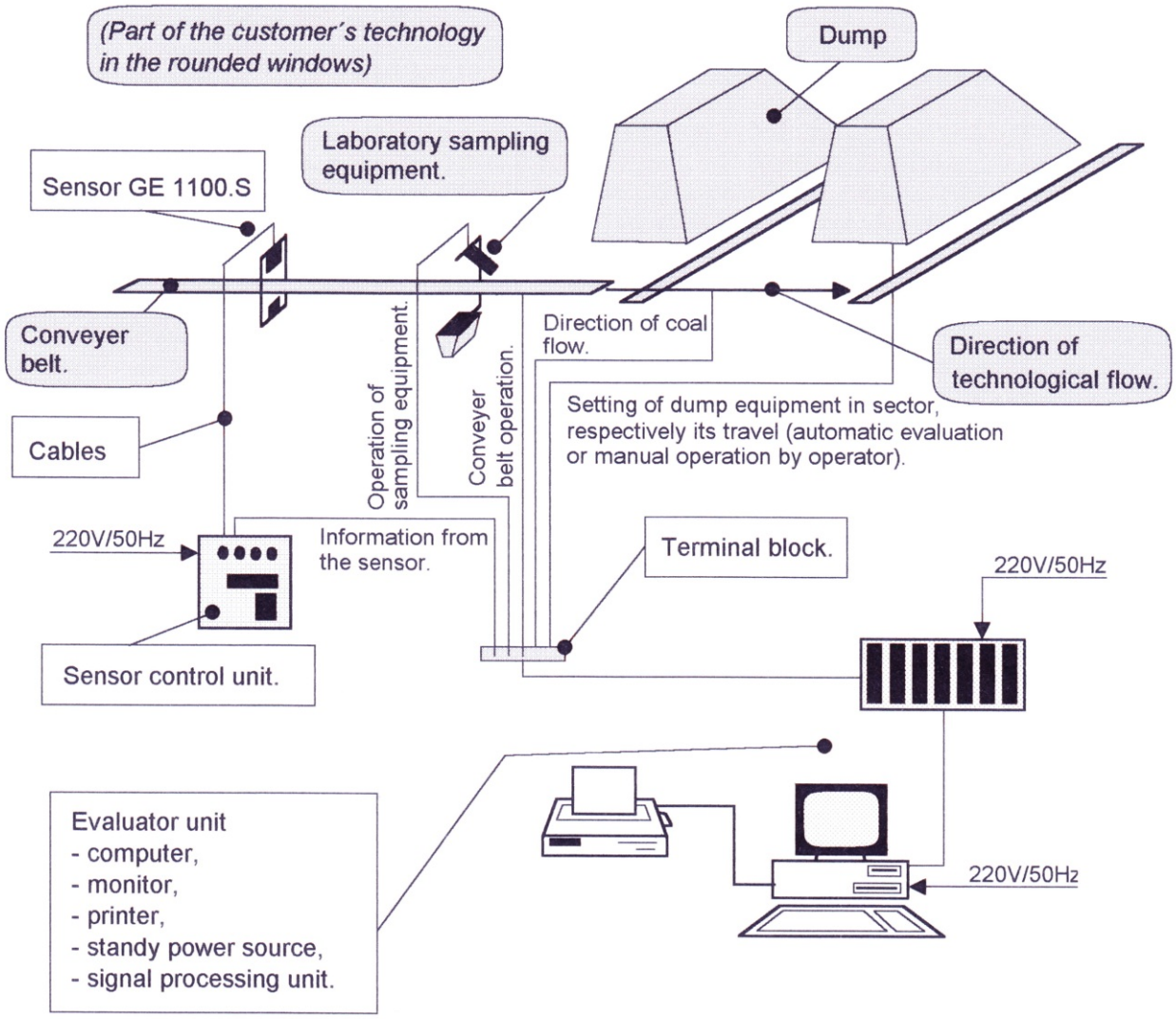
- operation of the equipment, on which the sensors are mounted (this involves the operation of the conveyer belts, these signals are continuously registered),
- resetting of equipment (trasversing and draw-out heads), which guide the coal flow in the technology, thus determine the dump, dumping sector, bin or boiler coal bin to which the coal will be fed or from the which the coal will be drawn (these signals are registered according to customer requirements on the overall solution of the system),
- travel of dumping machinery or stoppage at dump sector (automatic sensory system or manual selection by the operator according to customer requirements with regard to dump evaluation),
- measurement of the level in the bin (where the customer desires the evaluation of the bin level),
- operation of the laboratory sampling equipment (for the calibration of the Calorimeter sensors).

3.2. Transmission of information from technology

Solved according to the distribution of the technology and other local conditions on the customer's premises

- by wire,
- by optic cable,
- radio wireless transmission from mobile technology (where wire lines cannot be installed).

Diagram No. 2 - Scheme of the structure of the Calorimeter and the signals picked up from technology.



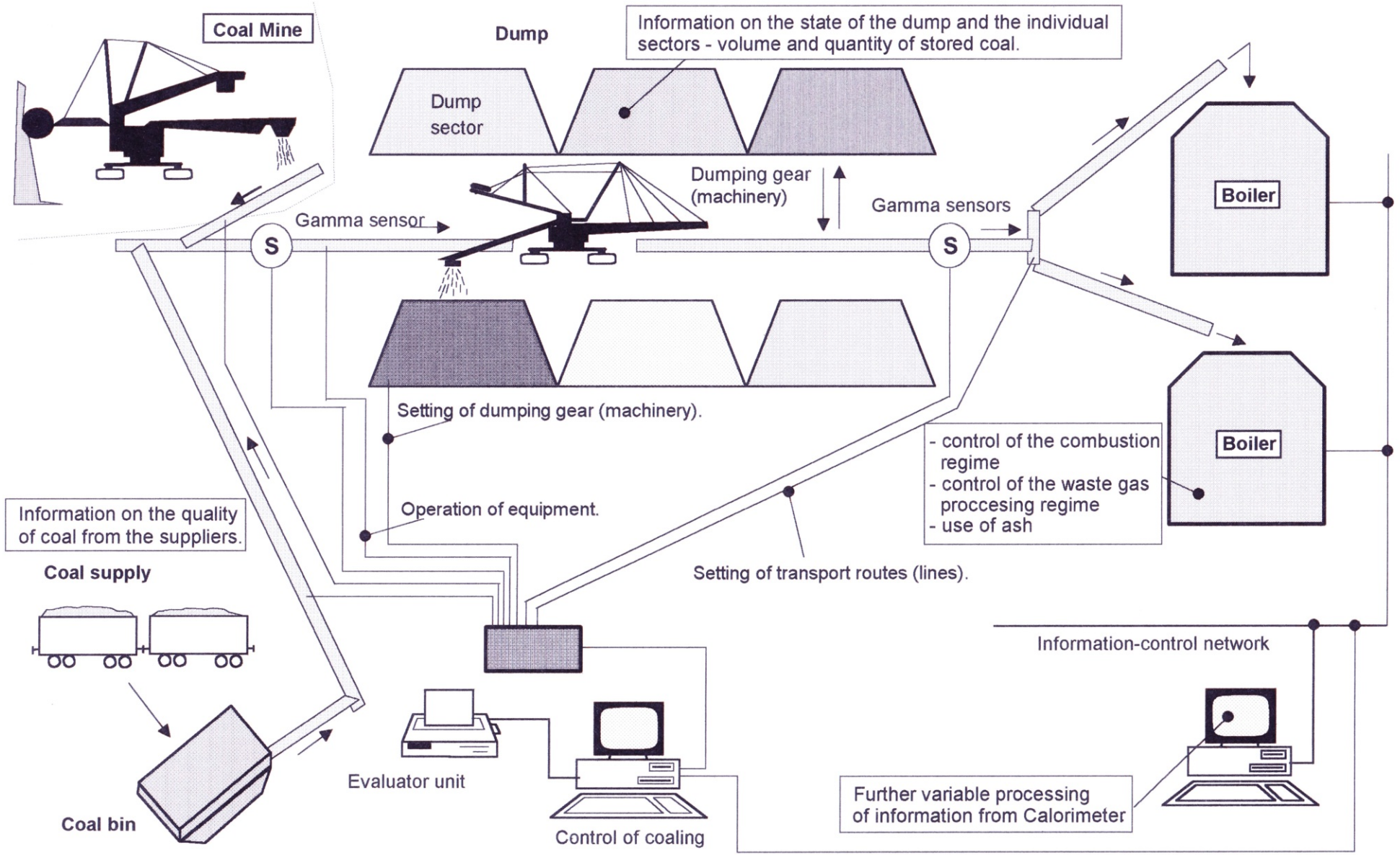


Diagram No. 3 - Example of Calorimeter application in the coaling of electrical power stations, heat plants, cement works.

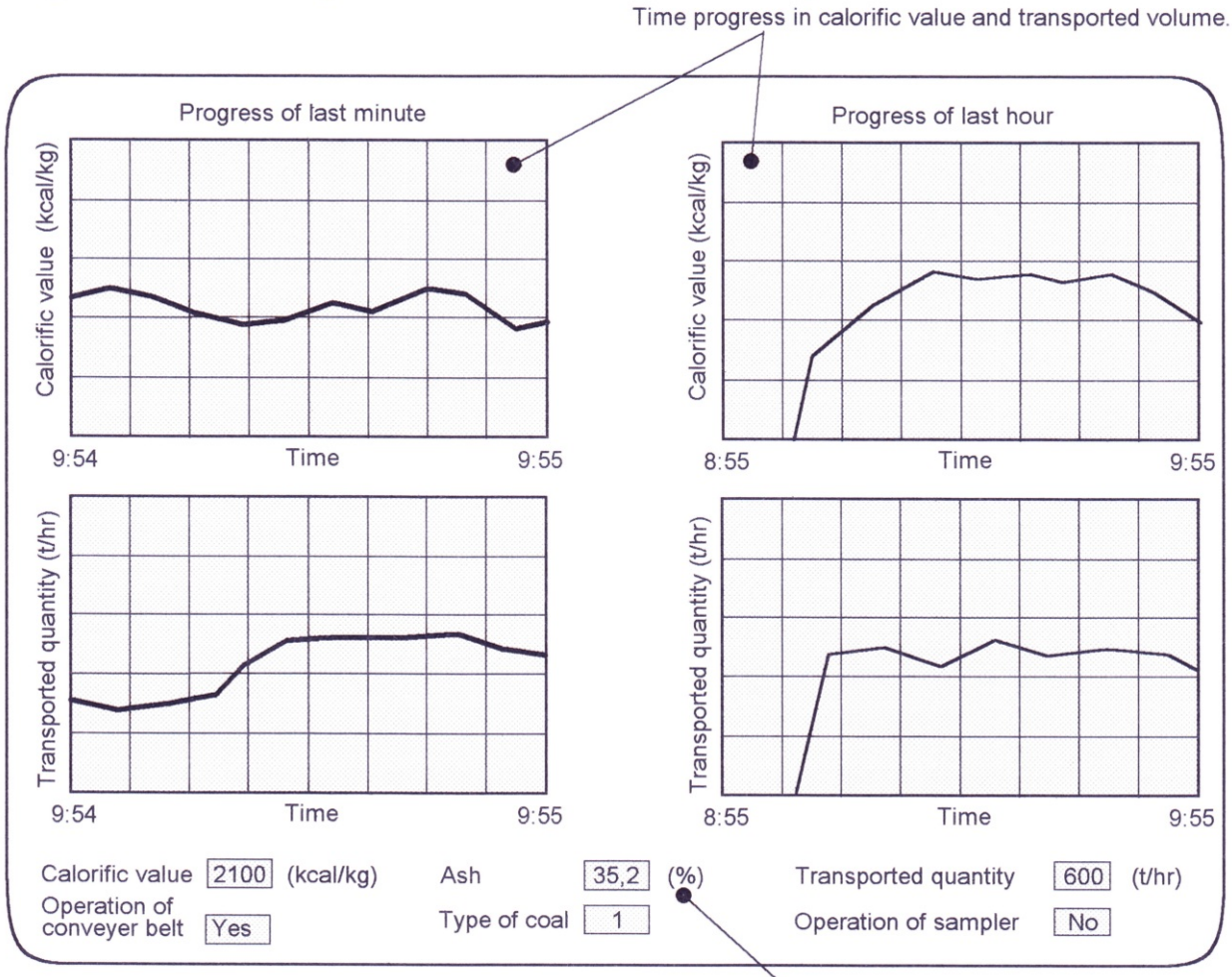
3.3. Sensor control unit

Processes the signal from the sensor and feeds it to the evaluator unit. Its operation comprises only the time to time check, check of sensor operation and setting of system constants.

3.4. Evaluator unit

The evaluator unit processes the information obtained from the technology. Information is transferred to the operator, archived and makes it possible for the operators to view and process the archived data, supports control and calibration of the sensors.

Diagram No. 4 - Screening of instantaneous values measured by the Calorimeter.



Instantaneous number value of quality and quantity of coal during the course of the last minute and last hour.

Progress of last minute

Time	Calorific val. (kcal/kg)	Ash (%)	Volume (t/hr)
9:55:50	2100	35,2	600
9:55:45	1950	35,5	610
9:55:40	2000	35,3	600
9:55:35	2000	35,3	590

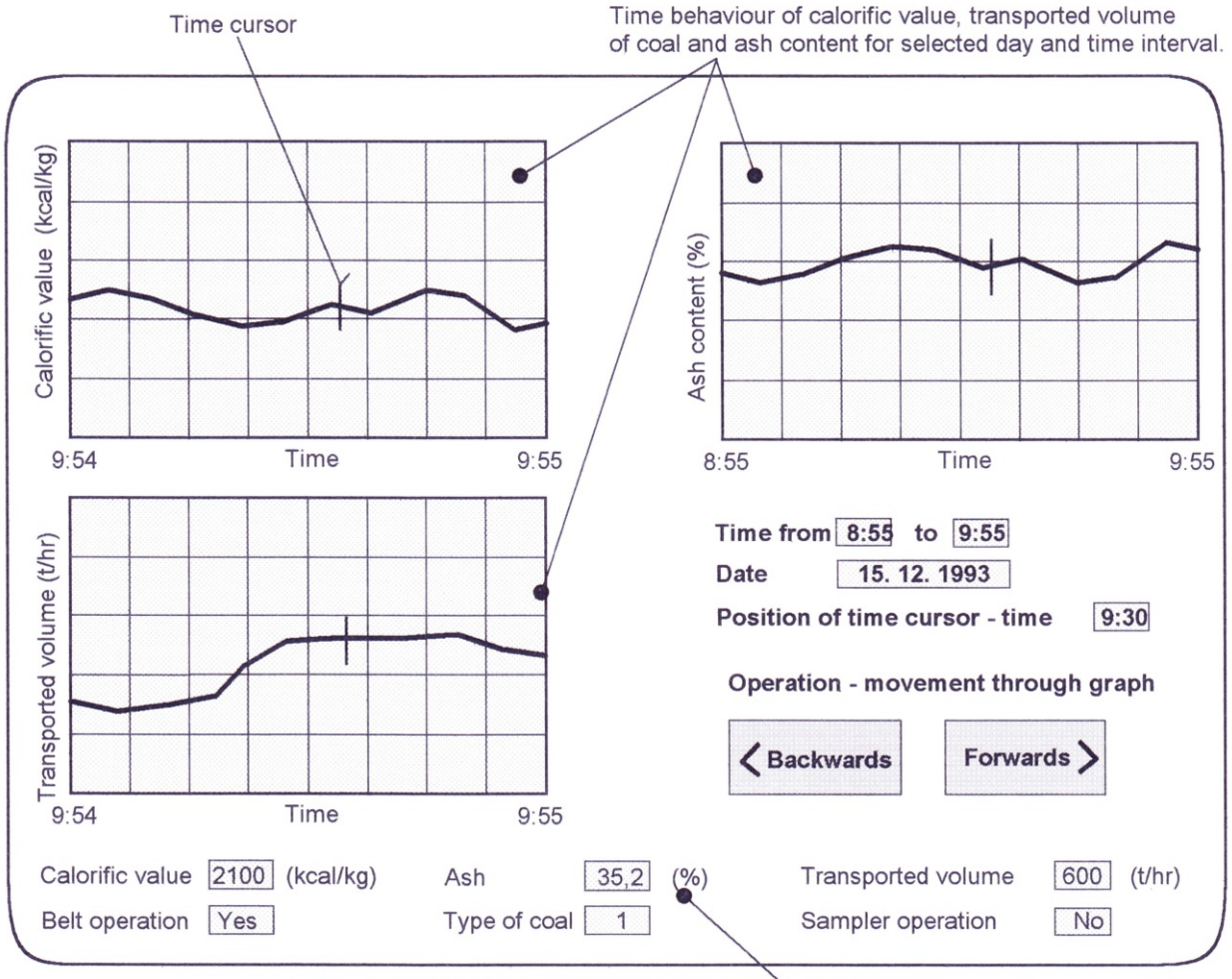
Progress of last hour

Time	Calorific val. (kcal/kg)	Ash (%)	Volume (t/hr)
9:55:00	2100	35,2	600
9:54:00	1950	35,5	610
9:53:00	1850	36,0	600
9:52:00	2000	35,3	590

It comprises

- signal processing units (according to the concrete situation of the processing station or supplementary card inside the computer),
- computer (according to the working environment, either industrial or office design),
- monitor,
- printer,
- standby power source (according to the local conditions at the customer's).

Diagram No. 5 - Viewing of archived Calorimeter values.



Numerical printout of archivated data for samples at 1 minute intervals for selected day and time interval.

Listing of measured samples

Time	Calorific val. (kcal/kg)	Ash (%)	Volume (t/hr)	Type of coal	Belt oper.	Sampler oper.
9:55:00	2100	35,2	600	1	YES	NO
9:54:00	1950	35,5	610	1	YES	NO
9:53:00	2000	35,3	600	1	YES	NO
9:52:00	2000	35,3	590	1	YES	NO

Time from 8:55 to 9:55

Date 15. 12. 1993

4. Instantaneous information from Calorimeter readings

The operator receives the following information from the computer screen

- instantaneous calorific value, ash content and orientation volume of incoming coal,
- progress of calorific value and transported volume of coal during the course of the last minute (number and graphic in samples at 5 second intervals),
- progress of calorific value and transported volume of coal during the course of the last hour (number and graphic in samples at 1 minute intervals),
- state of input signals - diagnosis of inputs from the technology, for the evaluation of eventual failure.

Operation of the programme is very simple and the operators master it after short training.

Instantaneous information from the Calorimeter may be used as input data for further automatic control systems (for instance, control of combustion processes).

5. Archivation of information from Calorimeter readings

The individual Calorimeter readings are archived and saved to the computer's HD. The programme for viewing the saved data makes it possible for the operators to view or print data for the desired day and time intervals as per requirements:

- listing of the individual minute samples for detailed information on the transported coal. The sample shows time of measurement, calorific value, ash content, transported volume, type of coal, state of technological equipment (conveyer belt, draw-out heads, laboratory sampling equipment),
- printout of sum information on the transported coal. The printout shows average calorific value, ash content, transported volume of coal, for the individual types and overall,
- graph of the time behaviour of calorific value, average ash content and the transported volume of coal, with a possibility for movement through the graph according to the individual measured samples,
- time behaviour of the operation of the programme equipment (programme access and sign-off, incorrect work with the programme), which serves to check the work of the operators as well as to detect mistakes in the event of damage to the programme installations on the part of the operators.

The Calorimeter processes archived information in protocol form (shift and daily production and coaling protocols, dump maps as per customer requirements using automatic or manual evaluation).

The given information may be by means of computer network transmission or using diskettes be made available to other specialist or control workers (laboratory, coaling control, marketing, production management and planning, production quality control, etc.). Easy interactive operation of the programme for the display of the above mentioned archived information ensures that a worker who is not acquainted with work on personal computer handles its easily.

The Calorimeter transforms the archived information to standard database format *.DBF for purposes of further specific use in table processors (table calculus programmes such as Quattro Pro, Lotus, etc.) and database programmes (for instance, Dbase, FoxPro, etc.).

Diagram No. 6 - Viewing of archived Calorimeter values - Accumulated values

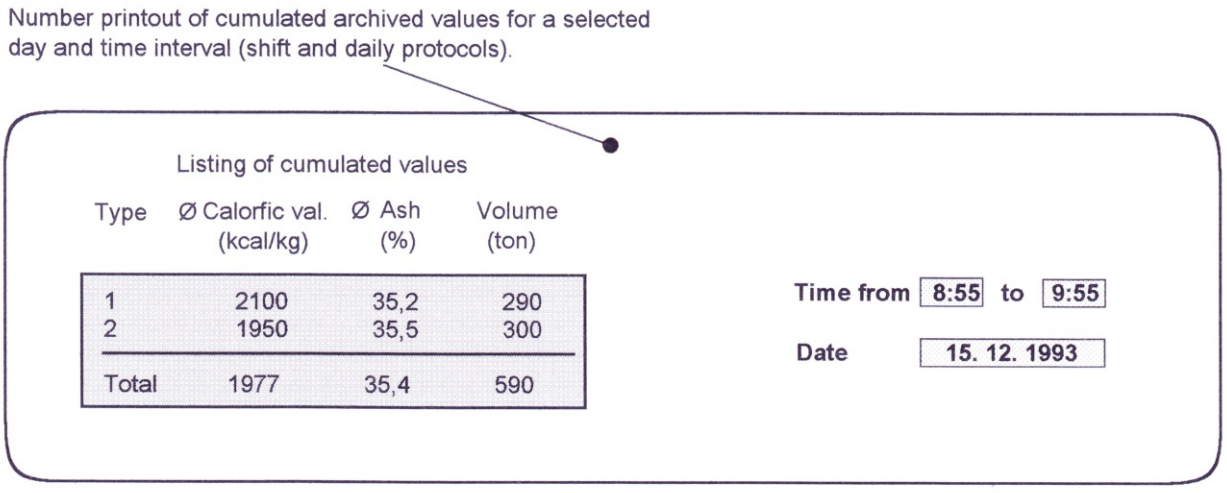
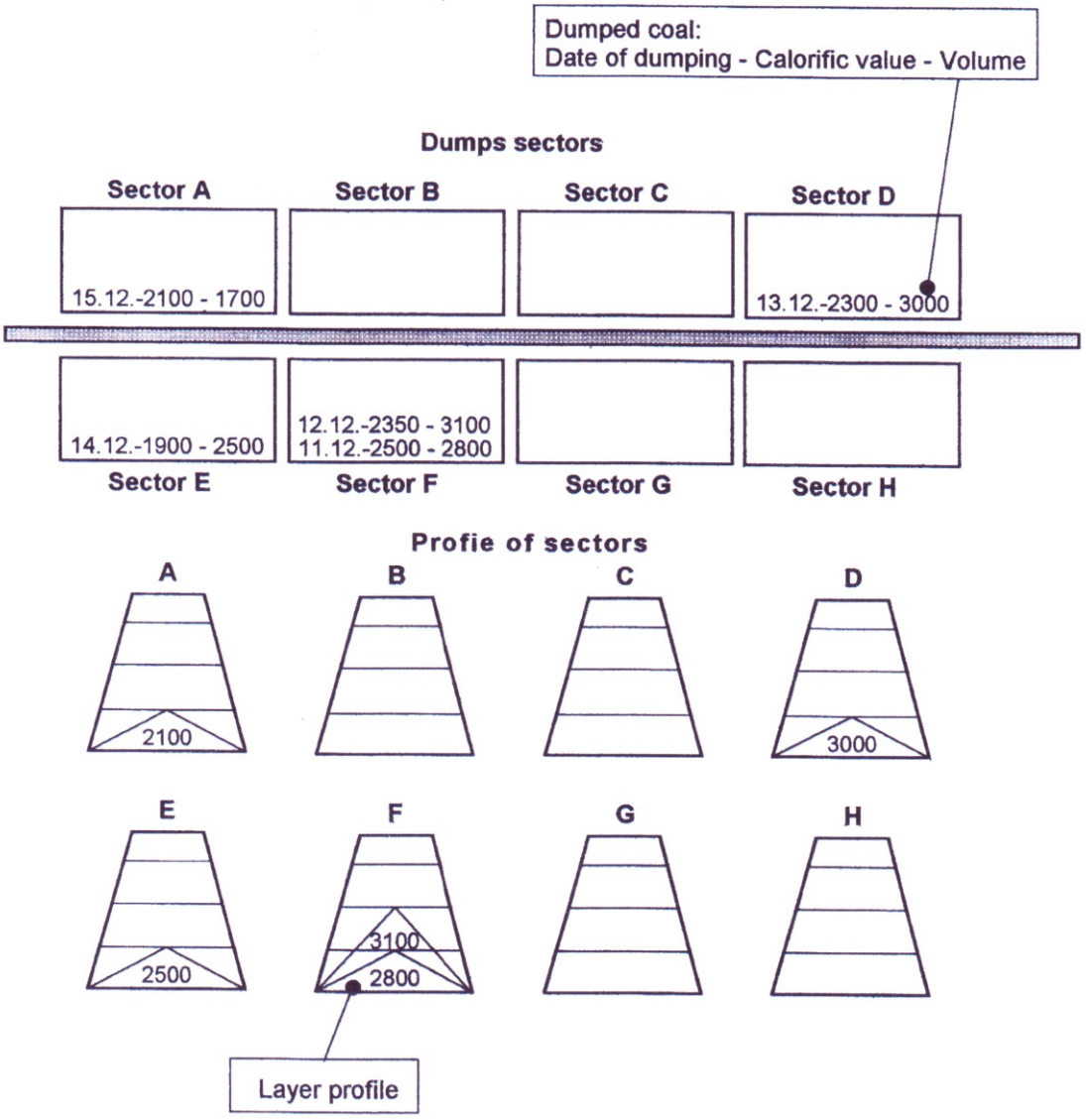


Diagram No. 7 - Example of archivation of quality values of coal stored in dumps - (the Calorimeter is edited manually by the operator).



Contact

If you have the feeling, that it would be suitable to consult your feelings, problems and requirements with regard to offer, please feel free to contact us. We look forward to mutual cooperation.

MIP, spol, s r.o. (Ltd.),
Velká nad Veličkou 628, 696 74 Velká nad Veličkou, Czech Republic

GPS: 48°52'51.879"N, 17°31'30.614"E
Phone: +420 518 329 631
GSM: +420 602 336 695
fax: +420 461 541 108
e-mail: mipvnv@mipsro.cz
web: www.mipsro.cz