ACTINOMETRIC INSTRUMENTS FOR AUTOMATED SYSTEMS

Skuratovich I.M., Lutsko L.V., Klivantsova V.A., Kazeyeu Y.I.
(Belarus)

In the CIS and in some other countries there are under exploitation actinometric instruments, which were manufactured earlier, in the former USSR at the "Gidrometpribor" factory (Tbilisi).

The instrument types are as follows: the M-80 pyranometer, M-10 radiation balance gauge and M-3 actinometer.

At present these instruments production has been ceased and consequently the market is suffering from their shortage.

Replacement of the available equipment by the instruments from other manufacturers evoke some undesirable consequences, the main of them being violation of observation files and the necessity to reorganize the meteorological base on the network.

The Belarus and Russia united State, taking into account the situation, by its Program within the field of hydro meteorology and environmental monitoring foresees resumption of actinometric instruments production, similar to the enumerated ones by their characteristics, capable to operate in automated systems.

The main geophysical laboratory after A.I. Voyeikov (Russia) having large experience in the field of actinometric instrument-making and the JSC PELENG company were charged to solve this task.

The first development under this cooperation appeared to be the "Peleng СФ-06" pyranometer (hereinafter - pyranometer СФ), with its finish in 2003. This instrument is designed to measure total, scattered and reflected radiation at meteorological stations instead of the M-80 pyranometer manufactured earlier.

The СФ pyranometer is granted with the Gosstandard Certificates of Russia and Belarus and also with a Roshydromet lisence for the right to perform works within the sphere of hydrometeorology and overlapping sciences.

The instrument production started from 2004.

Figure 1. Pyranometer with unit and information board. External View.

Explanatory notes:

- *thermal battery, BW, staggered, similar to that of M-80,*
- *the body is slightly thickened and air-tight,*
- *the level, aimed to control the pyranometer horisontal position may be directed downwards during non-stop measuring of reflected radiation.*

Due to the used BW thermal battery, like the M-80 pyranometer, the СФ pyranometer provides for storage of observation files, accumulated by the M-80 pyranometer measurements. This is confirmed by the results of comparing both the pyranometers under the natural conditions.

Meteorological equipment of the СФ pyranometer (as well as the one of the M-80 pyranometer) is based on adjustment with the standard actinometer, and is executed as per the same schedule and with the help of the same control means (as well as for the M-80 pyranometer). The dicrepancy lies within the standard pyranometer type: the СФ instrument is taken as the standard one and is certified like the M-80 pyranometer, that is in the result of test trial under natural conditions according to the standard actinometer.

Preparing and certifying standard pyranometers are executed by the Main geophysical observatory. Due to yearly certifying of pyranometers belonging to any type this discrepance in practice will not cause extra difficulties.

Note: In case the working pyranometers are calibrated relative to the sun, then the necessity in a standard pyranometer no longer arises.

The СФ pyranometer head preserves external attachment dimensions of the M-80 pyranometer, due to which it may be installed on every device, used with the M-80 pyranometer.

This means no necessity to install new extra equipment for commissioning the СФ pyranometer in the countries, where the pyranometer M-80 is used on the network.

Input parameters of the СФ pyranometer head are similar to those of the M-80M instrument, that is why in principle it may be switched to the same electric measuring instrument: to the ГАС galvanometer, to the self-recording potentiometer, the X-607 electrolytic intergrator.

However, during exploitation of pyranometer СФ these instruments are not necessary, because the pyranometer СФ complete set comprises specially developed electronic measuring unit with a LED indicator information board and with their help are taken all the necessary parameters.

The unit is installed at the meteorological site, for example in a box for galvanometers. The unit has a light indicator, showing current instantaneous values and is used instead of the ГАС galvanometer during urgent observations.

The pyranometer and the unit are designed for operation under natural conditions (by temperature from minus 50 to plus 50°C and the upper value of the air relative humidity equal to 98% at 25°C). Power supply – 36 VAC. The limit of extra error by measuring the voltages $\pm$ (0,08% Umeas + 20 μV). The electronic unit is equipped with an RS 485 output interface and an V23 modem.

The information board is installed in premises, for example on the operator's table.

From the information board are taken the parameters, necessary as per programs of non-stop registration and integration: the values, averaged per each hour of the current and terminated day, average daily per each day of the current month, average monthly for the terminated month.

The information board power supply is delivered from the mains of 220V. The information board also shows current instantaneous values.

The board is equipped with an interface RS 232. Instead of the board there may be used PC capabilities with corresponding software.

On the customer's request the unit with the board may be delivered in single channel and three-channels versions, that is with three heads being connected simultaneously.

Note: The sensor output voltage is not converted into radiation values by means of the unit with the board, because the instrument has been developed for the existing on the network technology of collection and compiling monthly files with consequent processing as per the program, adopted on the network.

The executed investigations of the main СФ pyranometer errors, indicated that they are practically the same, as those of the M-80 pyranometer.

Main technical characteristics of pyranometer

Measuring range for the radiation density, kW/ m^2	from 0,01 to 1,6
Wavelength range, μm	from 0,3 to 2,4
Head conversion ratio at standard radiation drop per receiver, mV • m^2/kW, not over	8
Time interval for setting-up the head output signal, s, not over	50
Values of correction factors at the sun altitude h=20° by azimuth 90,180,270° differ from the value in azimuth direction of 0°, %, not over	10
Limit of tolerable relative error during radiation density measurement, %	11
Relative displacement of the head reference point under the influence of thermal radiation of semi sphere black surface, heated to (75±5) °C from the value of $\sigma \{(tB + 273)^4 - (t + 273)^4\}$, %, not over	6
Limit of extra error during taking measurements of radiation density, evoked by the air temperature deviation from a standard value per each 10°C, %	

In the countries, where the M-80 pyranometer is under exploitation (today the production has stopped), it is expedient to use the “Peleng СФ-06” pyranometer. This enables the following advantages:

- to memorize the observation files,
- to have a metrological base on the network without changes,
- to exploit the available extra equipment,
- to replace the obsolete electric measuring instruments (galvanomoters, self-recording analog potentiometers, electrolyte integrators) with the up-to-date electronic equipment from the СФ pyranometer complete set.

In 2004 there was developed an automated meter for the sun radiation duration (hereinafter - the IPSS), aimed for operation instead of the Kempbell-Stocks geliograph.

The IPSS sensor unit has 16 photo sensors (sections), located in such a manner which provides the angle of observation within a semi sphere equal to 180°. Sections, located along the diagonal by azimuth are connected in pairs directed to each other, due to which the signal at the IPSS output turns to be proportional to radiation intensity, coming from the sun disk, independent from azimuth direction at the sun.

Figure 2 The IPSS external view

Explanation note:
Section, illuminated by the sun, receives radiation from the sun disk and from the sky. The opposite section receives radiation only from the sky. Thus, the difference between their signals is proportional only to the sun disk radiation.

The IPSS shows the availability of the sun radiance, the direct sun radiation being not less than 120 W/m^2. The IPSS possesses an output interface RS485 and an V23 modem and may be used as with the indication board, so with the PC.

A special program enabling on the operator's choice to call on a display the current data about the sun, radiance, its duration within the chosen time intervals (5,10,30 min, hour, day and etc.), as for current, so for the terminated days. The information is memorized.

The sun radiance availability relative to time may be plotted at a display.

The body design provides the capability of fastening the IPSS to the tripod of the M-80 pyranometer.

At present the JSC PELENG company and the Main geophysical observatory have finished the radiation balance gauge of the " Peleng СФ-08" type, designed to replace the balance gauge of the M-10 type. And also they have started the " Peleng СФ-12" actinometer development.

The aim of development is similar to that of the pyranometer's:

- to memorize the observation files,
- to have a metrological base on the network without changes,
- to employ actinometric sensors within automated systems.