INSTRUMENTATION FOR THE MEASUREMENT OF THE
COMPONENTS OF SOLAR AND TERRESTRIAL RADIATION

1. General

Short-wave solar radiation is comprised of the direct component of sunlight and the diffuse component of skylight. When measured together, as the total short-wave flux on a horizontal surface, this integral is referred to as the global radiation. The other short-wave component of the radiation budget is that reflected from natural surfaces. The wavelength range of these components is usually taken to be 0.3-5 um but about 0.3-3 um in practice.

Long-wave terrestrial radiation is comprised of the incoming atmospheric component (i.e. downward emission by the gases of the atmosphere, especially water vapor and carbon dioxide) and the outgoing terrestrial component (i.e. upward emission and reflection by natural surfaces and atmospheric gases). The wavelength range of these components is usually taken to be 3-100 um ideally but about 4-50 in practice.

When the two long-wave components (there are strictly three, but it is impracticable to attempt to separate long-wave emission and reflection) are measured together, differentially, this flux is termed the net long-wave radiation. When the four components (global and reflected short-wave radiation and incoming and outgoing long-wave radiation) are combined, as a single measurement of the difference between long and short-wave incoming and similarly outgoing, this flux is termed the net total radiation. However, there is presently strong support for separate measurement of each of these four components, as a more accurate approach to the determination of the radiation budget. Eppley Laboratory policy is, therefore, along these lines.

2. Short-wave Radiation Sensing

Two improved Eppley pyranometers are available.
(a) The Precision Spectral Pyranometer - which is believed to be the most accurate radiometer produced commercially for the measurement of global sun and sky radiation, totally or in defined wavelength bands. It is equally suitable for the measurement of reflected short-wave radiation (albedo) or, with the incorporation of a shading arrangement to screen off the sun, the diffuse sky component separately. Such a special stand is available from the Eppley Laboratory.

This radiometer (pyranometer) is an improved smaller model of the earlier Eppley instrument introduced in 1957. It comprises a circular multi-junction Eppley thermopile of the plated (copper-constantan), wirewound type which, when necessary, is temperature compensated to render the response essentially independent of ambient temperature. The thermopile has the added advantage of withstanding severe mechanical vibration and shock. Its receiver is coated with Parsons' black lacquer (nonwavelength-selective absorption). This instrument is supplied with a pair of removable precision ground and polished concentric hemispheres of Schott optical glass (the inner of clear WG7 glass and the outer of WG7 glass or yellow GG14, orange OG1, red RG2 or dark red RG8 filter glass, as preferred). Also supplied is a desiccator which can readily be inspected. The instrument has a painted cast bronze stand carrying a white enameled guard disc. It is shown in Fig. 1.

The WG7 clear glass is transparent from a wavelength of about 285 to 2800 nm. The centers of lower sharp cutoff of the hemispherical filters are as follows: GG14, approximately, 500 nm; OG1, 530 nm; RG2, 630 nm; and RG8, 700 nm. For solar ultraviolet measurements, hemispheres of quartz are available.

(b) The Black and White Pyranometer - also for the measurement of global, reflected and diffuse short-wave radiation is a more economic development of the well-known Eppley 10- and 50- junction 180° pyrheliometer originally introduced by Kimball and Hobbs in 1923. The detector is a differential electroplated (copper-constantan) thermopile with the hot-junction receivers blackened and the cold-junction receivers whitened.

The innovations are:

(a) replacement of the two concentric-ring detector, of gold-palladium: platinum-rhodium alloys, by one of radial wirewound-plated construction;
EPPELEY PRECISION PYRANOMETER

Model PSP

INSTRUMENT CHARACTERISTICS

Sensitivity
Impedance
Receiver
Temperature dependance
Linearity
Response time
Cosine
Orientation
Mechanical vibration
Calibration
Readout

9 microvolts per watt meter\(^{-2}\) approx.
650 ohms approx.
circular 1 cm\(^{-2}\), coated with Parsons' black optical lacquer
+ 1 per cent over ambient temperature range -20 to +40°C (temperature compensation of sensitivity can be supplied over other ranges at additional charge)
+ 0.5 per cent from 0 to 2800 watts m\(^{-2}\)
1 second (i/e signal)
+ 1 per cent from normalization 0-70\(^°\) zenith angle
+ 3 per cent 70-80\(^°\) zenith angle
no effect on instrument performance
tested up to 20g's without damage
integrating hemisphere (approx. 700 watts/meter, ambient temperature +25°C): calibration reference Eppley primary standards reproducing the World Radiation Reference

Fig. 1
EPPELEY BLACK AND WHITE PYRANOMETER

Model 8-48

INSTRUMENT CHARACTERISTICS

Sensitivity
Impedance
Temperature dependence
Linearity
Response time
Cosine response
Orientation
Mechanical vibration
Calibration
Readout

11 microvolts/watt meter$^{-2}$ approx.
350 ohms approx.
+ 1.5 per cent constancy from -20 to +40°C
+ 1 per cent from 0 to 1400 watts meter$^{-2}$
3 to 4 seconds (i/e signal)
+ 2 per cent from normalization 0-70° zenith angle, + 5 per cent 70-80° zenith angle
no effect on instrument performance

capable of withstanding up to 20g's
integrating hemisphere (approx. 700 watts/meter, ambient temperature +25°C): calibration
reference Eppley primary standards
reproducing the World Radiation Reference

Fig. 2
EPPLEY PRECISION INFRARED
RADIOMETER (PYRGEOMETER)

Model PIR

INSTRUMENT CHARACTERISTICS

Sensitivity
Impedance
Temperature dependance
Linearity
Response time
Cosine response
Orientation
Mechanical vibration
Calibration

5 microvolts/watt meter\(^{-2}\) approx.
700 ohms approx.
+ 2 per cent, -20 to 40°C (nominal)
+ 1 per cent, 0 to 700 watts m\(^{-2}\)
\(\frac{1}{2}\) seconds (i/e signal)
better than 5 per cent from normalization,
insignificant for a diffuse source
no effect on instrument performance
capable of withstanding up to 20g's
blackbody reference

Fig. 3
use of a more stable 3M Velvet Black coating and of barium sulfate as the whitening agent (non-hygroscopic as compared with the previous hygroscopic magnesium oxide deposit);

c) precision-ground, optical glass envelope instead of the former blown-glass bulb;

d) built-in temperature compensation for instrument sensitivity dependence upon ambient temperature.

The spectral response of this new model is similar to that of the later 10- and 50-junction type pyranometers since the reflectance of BaSO$_4$ is essentially identical to that of MgO over the solar range of wavelengths. The Schott WG7 glass used is usefully transparent from about 280 to 2800 nm. This hemispherical envelope has a weather-proof seal but is readily removable for instrument repair. Fig. 2 is a photograph of the pyranometer.

3. Long-wave Radiation Sensing

All pyrgeometers (long-wave radiometers) inherently measure the exchange of radiation between a horizontal blackened surface (i.e. the detector) and the target viewed (i.e. sky or ground, etc.). In the case of a net radiometer, the instrument can be so designed to eliminate (by differential means) the radiation emitted, both upwards and downwards, by the detector. The instrument described below is believed to be the first of its type where the detector flux is automatically compensated, allowing isolation of the radiation from the target impinging on the detector.

The Precision Infrared Radiometer is, therefore, a new Eppley development intended for the measurement of (unidirectional) incoming or outgoing long-wave terrestrial radiation. It is a modification of the Eppley Precision Spectral Pyranometer.

For the measurement of long-wave radiation in general, and for the isolation of this flux from the solar short-wave radiation in daytime, the glass hemisphere system has been replaced by a (30-mm diameter) hemisphere of silicon, which is cemented into a removable collar (with an O-ring seal) on the instrument case. On the inner surface of this envelope is a vacuum-deposited interference filter. The composite envelope transmission exhibits a sharp transition between about 4
and 5 μm, from complete opaqueness to maximum transparency, and (apart from the normal waviness associated with such interference patterns) a general transmittance of about 0.50 decreasing, with increasing wavelength, to 0.30-0.40 around 50 μm. Tests have demonstrated that this coated hemisphere does not exhibit significant transmission of sunlight; absorption and re-emission effects are small and have been determined. The pyrgeometer is shown in Fig. 3.

A thermistor-battery-resistance circuit (in addition to that employed for temperature compensation of radiometer response) is incorporated to precisely compensate for detector temperature. The basis of this innovation is that since the signal out of the pyranometer (when used for the measurement of infrared radiation) is representative of net radiation flux at the receiver surface,

\[ R_{\text{net}} = (R_{\text{in}} - R_{\text{out}}), \]

then \( R_{\text{in}} \) can be directly measured if the portion of the signal due to \( R_{\text{out}} \) can be removed. And because

\[ R_{\text{in}} = R_{\text{net}} + R_{\text{out}} \]

(and \( R_{\text{out}} \) is essentially dependent on the temperature of the receiver) a voltage, controlled by a thermistor which senses receiver temperature continuously, can be introduced (added) between the thermopile output and the measuring device. The circuit is simple, although choice of the correct thermistor is essential. It consists of the thermistor, a shunt resistor, a series resistor, a variable resistor (across which the equivalent \( R_{\text{out}} \) voltage is sensed) and a 1.35V battery. The variable resistor is used to match thermopile sensitivity. The electrical circuit arrangements are shown in Fig. 4 (which also indicates the means for checking thermopile and battery outputs).

4. **Calibration of Radiation Sensors**

The radiometric references and techniques are different for the two types of radiometer. At Newport, calibration of short-wave pyranometers is with respect to the World Radiation Reference (WRR) while long-wave pyrgeometers are basically referred to blackbody sources. As of April 1, 1977, the calibration traceability of Eppley pyranometer and pyrheliometer instruments has been changed from the International Pyrheliometric Scale of 1956 (IPS 1956) to the Absolute Scale (SI). This change based on the results of IPC IV is such that instruments calibrated in SI units yield irradiance values which are 2.1% higher than values which would be obtained using Eppley instruments calibrated previously and referenced to IPS.
A through F are pin designations on both portions of the connector.

Fig. 4. Schematic for elimination the effect of detector temperature on the measurement of infrared radiation fluxes (including temperature compensation circuit and connections for checking thermopile and battery outputs)
(a) **Short-wave Pyranometers**

These are normally calibrated by exposure in an integrating hemisphere (artificial sky) where the diffuse radiation, at a flux level of approximately 1.0 cal cm\(^{-2}\) min\(^{-1}\), is produced by a series of tungsten-filament lamps totalling about 5 KVA in power. By means of water cooling the walls of the chamber and refrigerating the air inside, the ambient temperature is maintained close to \(+25^\circ\text{C}\). For a description of the system and the calibrating techniques, reference should be made to Eppley Reprint No. 30. The comparison reference is a working standard pyranometer calibrated, in sunlight, against the Eppley group of primary electrical compensation pyrheliometers which, in collaboration with similar standards in the National Weather Service (NOAA), maintain and reproduce the World Radiation Reference (WRR) for the United States. The calibration of the above-mentioned working standard pyranometer comprises a comparison between the difference in pyranometer voltage output, when alternately exposed to the global sun and sky radiation and (by shading the sun) the diffuse sky radiation alone, and one of the standard pyrheliometers sensing, simultaneously, only the direct solar radiation. In this condition, the comparison is represented through the relationship \(T - D = I \sin h\), where \(T\) and \(D\) are, respectively, the voltage equivalents of the total sun and sky (global) and the diffuse sky radiations, \(I\) is the direct solar radiation measured, in energy units, at normal incidence and \(h\) is the mean solar height. Essentially, the comparison is one of the vertical component of direct solar radiation.

In routine operation, in the field, there are two ways whereby short-wave global pyranometers can be checked for constancy of instrument sensitivity. The first is to preserve a similar (calibrated) pyranometer for this purpose and occasionally (e.g. once per year) compare it with the field instruments, side by side in sunlight, ideally on cloudless occasions. The second is to repeat the basic pyranometer type radiometric calibration using either a pyrheliometer or a thermopile-type derived standard (e.g. the Eppley normal incidence pyrheliometer.

Newport calibrations of the Precision Spectral Pyranometer reproduce the WRR to within \(\pm 1\) per cent in general. The corresponding figure for the Black and White Pyranometer is \(\pm 2\) per cent.

Whenever the radiometer is employed as a spectral pyranometer, the instrument sensitivity indicated in the relevant calibration
certificate and engraved on the name plate can be adopted for all practical purposes. This value is established by exposure of the pyranometer with both clear glass hemispheres in position during the calibration operation. However, there can be small differences in the general transmission characteristics of the several glasses (as shown by the relevant factors supplied with the filter hemispheres). Typical values are given in Table 1. If it is desired to apply such correction, the procedure is straightforward, viz. pyranometer sensitivity (for RG2 filter in position) = calibration value x 1.10/1.11.

(b) Long-wave Pyrgeometers

The fundamental calibration of detectors intended for the measurement of terrestrial long-wave radiation is based upon their exposure to an ideal blackbody radiator. However, in practice, the alternate method of comparison against a (blackbody) calibrated working standard pyrgeometer, preferably of similar type, may be employed solely or as a check on the more difficult direct blackbody calibration. In this instance, a good source of steady long-wave radiance, for pyrgeometer exposure, is a cloudless night sky. In the Eppley Laboratory, both approaches are adopted. The reference blackbody is a low-temperature (0 to 50°C) source which has a circular opening of about 10 cm in diameter and is temperature stabilized by circulating oil. Temperature is measured with a series of strategically located calibrated thermocouples. The reference detectors are (a) Eppley pyrgeometer (new thermopile model, as described in Section 3 above), (b) Ångström electrical compensation pyrgeometer (without filtering window); this working standard (a) is first calibrated basically against Eppley Laboratory blackbodies and against the Ångström pyrgeometer using either artificial or natural sources. The production model is then compared to working standard (a).

5. Installation, Operation and Maintenance of Radiation Sensors

(a) Installation

The site for an upward-looking pyranometer or pyrgeometer should be free from any significant obstructions above the plane of the sensing element and, at the same time, should be readily accessible. If it is impracticable to obtain such an exposure, the site selected must be as free from obstructions (artificial as well as natural) as possible, especially (in the N. Hemisphere) from east-northeast, through south, to west-northwest and (in the S. Hemisphere) from east-southeast, through north, to west-southwest. If
Representative values for the transmittance of Schott filter glass (2.0 mm thickness, +25°C)

| λ nm | New Old | WG295 WG7 | GG395 GG22 | GG400 | GG495 GGL4 | OG530 OGL1 | OG670 CG2 | RG610 RG1 | RG630 RG2 | RG695 RGB | RG715 RG10 | RG805+ |
|------|---------|-----------|-----------|-------|------------|---------|---------|--------|--------|--------|--------|--------|--------|
| 270  |         | 0.22      | 0.00      | 0.00  | 0.00       | 0.00    | 0.00    | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   |
| 80   |         | .41       |          |       |            |         |         |        |        |        |        |        |        |
| 90   |         | .60       |          |       |            |         |         |        |        |        |        |        |        |
| 300  |         | .74       |          |       |            |         |         |        |        |        |        |        |        |
| 40   |         | .90       | .00      |       |            |         |         |        |        |        |        |        |        |
| 20   |         | .83       |          |       |            |         |         |        |        |        |        |        |        |
| 60   |         | .91       | .01      |       |            |         |         |        |        |        |        |        |        |
| 80   |         | .91       | .31      |       |            |         |         |        |        |        |        |        |        |
| 400  |         | .91       | .68      | .52   |            |         |         |        |        |        |        |        |        |
| 20   |         | .91       | .82      | .78   |            |         |         |        |        |        |        |        |        |
| 40   |         | .91       | .87      | .88   | .00        |         |         |        |        |        |        |        |        |
| 60   |         | .92       | .88      | .87   | .01        |         |         |        |        |        |        |        |        |
| 80   |         | .92       | .88      | .89   | .27        |         |         |        |        |        |        |        |        |
| 500  |         | .92       | .89      | .90   | .80        | .00     |         |        |        |        |        |        |        |
| 20   |         | .92       | .90      | .90   | .88        | .05     |         |        |        |        |        |        |        |
| 40   |         | .92       | .90      | .90   | .90        | .76     | .33     | .00    |        |        |        |        |        |
| 60   |         | .92       | .90      | .90   | .90        | .88     | 33      |        | .00    |        |        |        |        |
| 80   |         | .92       | .90      | .90   | .91        | .90     | 83      | .33    | .00    | .00    |        |        |        |
| 600  |         | .92       | .90      | .90   | .91        | .91     | 83      | .33    | .00    | .00    |        |        |        |
| 20   |         | .92       | .90      | .90   | .91        | .91     | 83      | .33    | .00    | .00    |        |        |        |
| 40   |         | .92       | .90      | .90   | .91        | .91     | 83      | .33    | .00    | .00    |        |        |        |
| 60   |         | .92       | .90      | .91   | .91        | .91     | 83      | .33    | .00    | .00    |        |        |        |
| 80   |         | .92       | .90      | .91   | .91        | .91     | 83      | .33    | .00    | .00    |        |        |        |
| 700  | .92     | 0.90      | 0.91     | 0.91  | 0.91       | 0.91    | 0.91    | 0.91   | 0.84   | 0.25   | 0.00   |        |

+RG805 standard thickness is 4.0 mm.
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Center of cutoff (nm) | 281 | 385 | 397 | 485 | 529 | 552 | 603 | 623 | 686 | 707 | 807 |
Filter factor | 1.09 | 1.11 | 1.105 | 1.10 | 1.095 | 1.095 | 1.105 | 1.095 | 1.09 | 1.09 | 1.11 |

N.B. Variation from these values of transmittance of up to +0.01 and of center of cutoff of up to +2 nm can occur within the glass melt.
practicable, the instrument should be so located that (a) a shadow will not be cast on it at any time (e.g. by radio masts, etc.); (b) it is not close to light-colored walls or other objects likely to reflect sunlight onto it; and (c) it is not exposed to artificial radiation sources.

At most places, a flat roof provides the best location for mounting the instrument; if such a site cannot be obtained, a rigid stand with a horizontal upper surface some distance from building structures or other obstructions should be used.

On the initial installation of the instrument, or whenever its location is changed or if a significant change occurs in regard to any surrounding obstructions, the angular elevation above the plane of the receiving surface of the pyranometer (or upward-looking pyrgeometer) and the angular range in azimuth of all obstructions throughout the full 360° around it should be observed. If it is at all possible, the site should be so chosen that any obstruction over the azimuth range between earliest sunrise and latest sunset should have an elevation not exceeding 5°. It is also useful, for reference purposes, to note the altitude above M.S.L. of the detector and its geographical co-ordinates.

In the case of a downward-looking pyranometer or pyrgeometer, for the measurement of outgoing radiation fluxes, the principal requirement is similar, viz. that the lower hemisphere be viewed as fully as possible. This may entail mounting the instrument at the end of a long boom, so that the vertical support causes minimum obstruction to the instrument receiver.

The pyranometer or pyrgeometer should be securely attached to whatever mounting stand is decided upon, using the holes provided in the instrument baseplate and, at the same time, levelling it with the adjustable feet. Precautions should be taken to avoid subjecting the instrument to shocks or vibration during installation. The stand should be sufficiently rigid that severe shocks to the instrument do not occur or, throughout operation, the horizontal position of the receiving surface does not change, especially during high winds.

The cable employed to connect the pyranometer or pyrgeometer with the respective readout should be twin conductor (No. 20 wire is generally used at the Eppley Laboratory) and waterproofed. If there is the possibility of electrical interference (e.g. from power lines or radio transmissions), the cable should also be screened. It
should be firmly secured to the mounting stand to minimize breakage and intermittent contacts in windy weather. Wherever possible, the cable should be run either along or under the surface to the readout, especially if the latter is to be located at some distance. High overhead connections should be avoided, particularly in areas of severe thunderstorm activity. When potentiometric recorders are employed cable lengths of 1000 feet or more may be used without impairing the quality of the records. As with other types of thermoelectric radiometer, care must be exercised to obtain a permanent (soldered) copper-to-copper junction between instrument connector and cable. All junctions exposed out of doors must be weatherproofed. On all standard Eppley instruments, Pin B is positive and Pin A negative.

(b) **Operation**

In the case of the pyranometer, there are two main requirements: viz. (a) periodic verification of pyranometer calibration, and (b) application of corrections, where judged necessary, to take account of instrument obstruction to a free horizon.

Calibration constancy should be checked at least once per year, if the highest measurement accuracy is desired.

With regard to significant correction (see below) for general horizon obstruction (as distinct from the simpler and obvious correction for obstruction to the solar beam), the procedure is to separate out the diffuse radiation (by measurement or estimation), correct it and then adjust the total short-wave (global) radiation accordingly. In this connection, however, it must be pointed out that it is the fraction of the vertical component of the short-wave flux from the sky, lost by obstruction, which is to be computed and not the fraction of sky so obscured. It will hence be apparent that radiation incident at angles less than 5° to the horizon has only an extremely small contribution to make to the total. For example, it may be demonstrated (see below) that a horizon limited by a continuous circular obstruction with an average elevation of 5° diminishes the diffuse (vertical) flux by only about 1 per cent, and such an effect can normally be neglected. Strictly, in determining corrections of this nature, account should be taken of the variation in intensity of the diffuse radiation over the hemisphere of sky which, of course, depends upon the sky conditions at the time. The only
practical procedure is to assume isotropy. For determining these corrections for objects of finite size, the following expression is applicable.

\[
\frac{1}{2\gamma r} \sqrt{\Theta} \int \sin 2\Theta \, d\Theta \, d\gamma
\]

Here, \(\Theta\) and \(\gamma\) are the elevation and azimuth of the object, respectively; an elementary area with these co-ordinates will contribute a fraction \(\sin\Theta \cos\Theta \, d\Theta \, d\gamma / r\) to the vertical flux. The outlines of the obscuring objects should be mapped out on a \(\Theta - \gamma\) diagram and these projections then divided into suitable component areas over which a mean value of \(\sin 2\Theta\) may be assigned, and the fractional correction obtained by summation. Since the formula is exactly valid only for obstructions with a completely black surface, the effect of the albedo of lighter colored objects will be to reduce the magnitude of the correction, through inwards reflection (and may even yield a correction of opposite sign).

In the case of the pyrgeometer, there are two main requirements, viz. (a) periodic verification of pyrgeometer calibration, it is suggested this be done yearly against a blackbody or returned to Eppley, (b) periodic testing of compensation circuit (battery) stability.

To check calibration of compensation circuit, measure across pins E & D to obtain the temperature of the instruments, express it in absolute terms \(T_1^4\). Measure millivolt output across pins B & C (mv). S equals sensitivity of instrument expressed in mv/cal, cm^-2 min. Stefan-Boltzmann Constant = 8.124 x 10^-11 cal cm^-2 deg^-4 min^-1. Then \(T_1^4 (8.124 \times 10^{-11}) = \text{mv} \). The millivolt output can be adjusted with the small pot inside the instrument (take bottom off, the battery life, in this operation, is believed to be at least one year).

With regard to correcting for obstructions, this is much simpler than for the pyranometer since the radiation measured is essentially diffuse. The same error limitation and corrective computational procedure, detailed above, is theoretically applicable. But, it is not possible to separate long-wave emission from long-wave reflection by pyrgeometer obscuring objects and, therefore, it is recommended that, in general, such correction here should either be ignored or only attempted on the basis of specific experimental investigation (e.g. comparison of simultaneous results at different locations).

The foregoing also applies to both pyranometer and pyrgeometer, when they are exposed in the inverted position.
(c) Maintenance

Pyranometers and pyrgeometers in continuous operation should be inspected, ideally, at least once per day. At these inspections, the (outer) hemisphere should be wiped clean and dry with a lint-free soft cloth. In desert or arid regions, the hemisphere should be cleaned very gently in order to prevent scratching of the surface. Such abrasive action can alter appreciably the original transmission properties of the material and, hence, the radiometer calibration. If frozen snow, glazed ice, hoar frost or rime is present, an attempt should be made to remove, at least temporarily, the deposit carefully with warmed cloths.

With regard to the two models of pyranometer, should the internal surface of the (outer) hemisphere become coated with moisture, it can be cleaned by careful removal on a dry day, allowing the air to evaporate the moisture and then firmly re-securing the hemisphere. The inside of the hemisphere should not be wiped unless smears are visible. Precautions should be taken to avoid scratching the under-surface of the collar carrying this hemisphere. In the case of the precision spectral pyranometer, the external surface of the inner hemisphere can also be cleaned, if necessary, when the large one is removed. Should moisture be deposited on the inside of the small hemisphere, this can similarly be removed. However, in this instance, and also with removal of the single hemispherical envelope of the black and white model, extreme care must be exercised since the thermopile element is now unprotected and could be seriously damaged.

Occasionally, the desiccator installed in the pyranometer case should be inspected. Whenever the silica gel drying agent is pinkish or white in color, it should be replaced (N.B. silica gel can be rejuvenated by drying in an oven at about 135°C for a few hours, until the original dark blue color reappears).

The circular spirit level of the pyranometer or pyrgeometer should be inspected at regular intervals.

With regard to the pyrgeometer, the same maintenance procedures are applicable. The hemisphere should only be removed when calibration verification indicates that the results are suspect; in this instance, the interference filter (vacuum) deposited on the internal surface of the hemisphere must never be touched.