# AERI Guide for Radiometric Calibration Maintenance

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2020-09-29

## 1. Certification of New AERI Instruments

The foundation for the AERI radiometric calibration is the suite of tests performed at ABB & UW-SSEC for each new AERI instrument. These include:

- Field-of-view mapping
- Radiometric calibration
- Wavelength calibration
- NESR testing
- Blackbody temperature and emissivity testing
- Temperature measurement accuracy testing
- Detector nonlinearity determination

## 2. Confirmation of Calibration in the Field

The 3rd blackbody calibration validation is an end-to-end verification of the radiometric accuracy of the instrument, that confirms that the instrument calibration has not strayed from the original certification. This is a simple and powerful test that reveals any potential issues in the whole AERI system. We recommend that 3rd blackbody calibration validations be performed regularly and whenever the instrument configuration changes. Specifically:

- At the beginning and end of data collection periods
- Before and after the instrument is relocated
- Once a year during continuous operation

## 3. Scheduled Maintenance

The properties of certain components of the AERI system drift over time which can cause errors in radiometric calibration.

### *3.1 Blackbody Thermistors*

The blackbody thermistors can drift over time. Blackbody thermistors operated at high temperatures, or severe temperature cycles, are more prone to degradation over time. The blackbody can be sent to UW-SSEC for periodic re-calibration in the AERI Temperature Calibration Facility.

UW-SSEC recommends that blackbody thermistors get re-calibrated every 3 years. Our field experience has shown that thermistors can hold their calibration for over 5 years. Drift in blackbody thermistors could be identified in the field using a 3rd blackbody calibration. A 3rd blackbody calibration is recommended in the field before and after blackbody thermistor re-calibration.

*3.2 Resistance Meter*

The accuracy of the ohmmeter reading the blackbody thermistors can drift. The ohmmeter (Agilent / Keysight / Keithley) can be sent to the manufacturer for re-calibration.

The manufacturers recommend that the meter get calibrated every year. Our field experience has shown that the meter can hold its calibration for over 2 years. The ohmmeter accuracy can be evaluated in the field by the resistance validation test, which uses accurate known resistors. A 3rd blackbody calibration validation as well as a resistance validation test is recommended in the field before and after the ohmmeter re-calibration.

## 4. Component Repairs and Replacement

When a major component of the AERI needs repair or replacement, appropriate testing should be performed before the instrument is returned to service, in order to confirm that the radiometric calibration is still valid, and that the instrument accuracy can be traced back to the original certification.

*4.1 He-Ne Laser Replacement*

The He-Ne metrology laser typical continuous operational lifetime is 2 years. The He-Ne laser can be user replaced in the field.

A 3rd blackbody calibration validation should be performed after a laser replacement. In addition, a spectral calibration test should be performed, and the files zfli.si1 & zfli.si2 updated with the new results. This involves collecting clear sky observations with the AERI with a concurrent launch of a radiosonde (a radiosonde in the general area is adequate). The spectral calibration update is particularly important when the AERI data are used for trace gas observations.

*4.2 Stirling Cooler Replacement*

The Stirling cooler typical continuous operational lifetime is 5 years. Replacing the cooler is an advanced procedure, best conducted by an experienced operator in a controlled environment.

A 3rd blackbody calibration validation should be performed after a cooler replacement.

*4.3 Dewar Repump*

The vacuum integrity of the detector dewar can degrade over time. The dewar can be sent to the vendor to be re-pumped and restore original performance. Dewar hold times typically exceed 10 years.

A field-of-view mapping and a 3rd blackbody calibration validation should be performed after a dewar repump. In addition, a spectral calibration test should be performed, and the files zfli.si1 & zfli.si2 updated with the new results. This involves collecting clear sky observations with the AERI with a concurrent launch of a radiosonde (a radiosonde in the general area is adequate). The spectral calibration update is particularly important when the AERI data are used for trace gas observations.

*4.4 Detector Replacement*

The need for detector replacement is rare, unless the dewar is damaged, or the detector type needs to be changed.

Because the detector properties affect all aspects of the AERI radiometric performance, a full re-certification is required, similar as for a new AERI instrument.

**ABB AERI Re-certification Table**

| | Maintenance Period (years) | | Required Calibration Tasks | | | | |
|---|---|---|---|---|---|---|---|
| | Manufacturer's Rec. | Field Experience | 3rd Blackbody | Resistance | Field-of-view | Spectral | Full Recertification |
| **Blackbody Thermistor Calibration** | 3 | 5 | X | | | | |
| **Resistance Meter Calibration** | 1 | 2 | X | X | | | |
| **Laser Replacement** | | 2 | X | | | X | |
| **Cooler Replacement** | | 5 | X | | | | |
| **Dewar Repump** | | 10 | X | | X | X | |
| **Detector Replacement** | | | X | | X | X | X |