# Standard Operating Procedure: Thermal Infrared (TIR) Radiometer

## Field Servicing, Blackbody Calibration, and Crop Water Stress Index (CWSI) Mapping

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| **Document Title:** | Thermal IR Radiometer Calibration SOP | **Doc ID / Ref:** | SOP-TIR-002 |
| **Lead Specialist / Author:** | Kadeem Manning | **Effective Date:** | September 2026 |
| **Status / Revision:** | Approved - Rev 1.0 | **Target Review:** | Annual Field Audit |

## 1. Purpose & Technical Scope

Thermal Infrared (TIR) radiometers measure longwave infrared radiation (8.0 µm to 14.0 µm atmosphere window) to construct surface skin temperature maps ($T_s$). Skin temperature variations are directly linked to crop transpiration, evapotranspiration rates, and topsoil moisture deficits. This SOP defines blackbody reference calibration, emissivity correction ($\epsilon_s = 0.98$), body temperature drift compensation, and Crop Water Stress Index (CWSI) evaluation [1].

## 2. Required Calibration Standards & Equipment

• **Precision Field Blackbody Calibrator:** NIST-traceable variable temperature cavity blackbody ($0.05^\circ\text{C}$ stability).
• **TIR Radiometer / Pyrometer:** Apogee / Everest 8–14 µm thermopile radiometer.
• **Contact Reference Thermometer:** Certified Pt100 RTD immersion probe.
• **Target Mount:** Adjustable mast mount with bubble level and solar radiation shield.

## 3. Step-by-Step Calibration & Operating Procedure

1. **Housing & Shield Audit:** Verify the radiometer is mounted inside a white anodized solar radiation shield. Check that the germanium window is clean and free of condensation.
2. **Internal Thermistor Check:** Monitor internal sensor body temperature ($T_{body}$). Ensure internal sensor body temperature corrections are applied to eliminate thermal gradient errors between thermopile junctions.
3. **Two-Point Blackbody Verification:** Set the reference blackbody cavity sequentially to $15.0^\circ\text{C}$ and $45.0^\circ\text{C}$. Aim the radiometer directly into the cavity ($99.9\%$ emissivity). Verify radiometer readings match blackbody targets within $\pm 0.2^\circ\text{C}$.
4. **Emissivity ($\epsilon_s$) Setting:** Set target emissivity to $\epsilon_s = 0.98$ for dense vegetation/soil. Convert measured brightness temperature ($T_b$) to true surface temperature ($T_s$) via Stefan-Boltzmann compensation:
   **$T_s = \left[ \frac{T_b^4 - (1 - \epsilon_s) T_{sky}^4}{\epsilon_s} \right]^{0.25}$**
5. **Crop Water Stress Index (CWSI) Inversion:** Calculate CWSI = $( (T_c - T_a) - (T_c - T_a)_{lower} ) / ( (T_c - T_a)_{upper} - (T_c - T_a)_{lower} )$, where $T_c$ is canopy temperature and $T_a$ is air temperature. Verify CWSI scales between 0.0 (fully transpiring) and 1.0 (severe moisture stress).

| FIELD VERIFICATION & APPROVAL SIGN-OFF | |
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| **Prepared & Approved By:** | **Kadeem Manning** (Lead Field Specialist) |
| **Technician Signature:** | *Kadeem Manning* |
| **Verification Date:** | September 16, 2026 |

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| **Calibration Status:** | **[ X ] PASSED & VERIFIED** [ ] REJECTED |