Measuring, Monitoring & Documentation Systems

The **Sensors Layer** defines all devices and documentation systems used by AOFS controllers to ensure **safe operation, authoritative control, and auditable farm management**.

All AOFS-compliant deployments **must implement the sensors and documentation systems specified here**.

1. Sensor Layer Scope & Authority

AOFS sensors are classified by **operational authority**, not by technology type.

Sensor inputs fall into four functional roles:

- **Safety enforcement** (prevent damage or loss)
- **Authoritative control inputs** (drive irrigation decisions)
- **Documentation & audit**
- **Optimization & research**

AOFS controllers **must never depend on remote systems** to interpret or validate sensor data.

2. Critical Safety & Protection Sensors

Purpose: Prevent equipment damage, flooding, dry-run pumps, and unsafe operating states.

Mandatory Measurements:

- Tank levels: LOW and FULL float switches
- Flow meters on main and zoned pipelines
- Pressure sensors on pumps and main distribution lines
- Rainfall measurement for irrigation lockout

Safety Requirements:

- These sensors **must directly enforce Field Controller fail-safes**
- Operation must be fully local and offline
- Loss or invalid data from these sensors must trigger safe shutdown or degraded mode

3. Primary Agronomic Control Sensors

Soil Monitoring Sensors

Purpose: Provide authoritative inputs for irrigation scheduling.

Required Measurements:

- Soil moisture (volumetric water content) per irrigation zone

Optional but Recommended:

- Soil temperature
- Electrical conductivity (salinity)

Placement Guidelines:

- At least one sensor per irrigation zone
- Additional sensors for heterogeneous fields
- Placement at crop-appropriate root depth

Weather Monitoring Sensors

Purpose: Modify irrigation behavior and enforce environmental lockouts.

Required Measurements:

- Rainfall
- Ambient temperature
- Relative humidity

Optional Measurements:

- Wind speed
- Solar radiation / light intensity

Integration with AOFS:

- Rainfall triggers irrigation suspension
- Weather data refines thresholds and scheduling

4. Power / Energy Monitoring

Purpose: Protect electrical systems and support energy-aware operation.

Required Measurements:

- Pump power consumption
- Valve power consumption

Optional Measurements:

- Battery voltage and current
- Solar panel output

Integration:

- Low-voltage or overload conditions must trigger fail-safe behavior
- Energy data may inform event prioritization and anomaly detection

5. Human Input / External Event Logging

Purpose: Capture critical farm activities not measurable by sensors.

AOFS treats human input as **first-class data**, equal to automated sensor measurements.

Examples of Loggable Events:

- Fertilizer application
- Manual irrigation or drainage
- Pest or disease treatment
- Planting, pruning, or harvest activities

Requirements:

- All events must be timestamped
- Events must be linked to a field or irrigation zone
- Operator identity must be recorded
- Full audit trail for edits or deletions is required

6. Optical / Camera Documentation Systems

Purpose: Provide visual documentation for review, auditing, and optional analysis.

AOFS Scope:

- Still images only
- No video streaming requirements

Use Cases:

- Crop development tracking
- Soil surface condition documentation
- Pest or disease observation

Requirements:

- Images must be timestamped
- Camera ID and zone reference required
- Images stored locally on the Field Controller
- Optional synchronization with Farm and HQ Controllers

AI-based image analysis is **explicitly optional** and must not interfere with core logging or manual review.

7. Data Logging & Synchronization Rules

- All sensor readings and human-input events **must be logged locally**
- Logs must include:
  - Timestamp
  - Source or sensor ID
  - Measured value or event data
  - Status or quality flags
- Synchronization follows AOFS federation rules
- Loss of connectivity must never result in data loss

8. Calibration & Maintenance

- All sensors must be calibrated according to manufacturer specifications
- AOFS deployments must log:
  - Calibration events
  - Maintenance actions
  - Sensor replacements
- Calibration and maintenance logs are auditable and synchronized

9. Compliance Requirements

Minimum mandatory implementation:

- Soil moisture sensors per irrigation zone
- Tank LOW and FULL level sensors
- Flow meters and pressure sensors on irrigation systems
- Power monitoring for pumps and valves
- Rainfall measurement for irrigation lockout

Optional sensors enhance optimization and research but **do not affect baseline compliance**.

10. References

- Field Controller Layer
- Farm Controller Layer (Local / Federated)
- Hydraulic & Water Systems
- Electrical & Control Interfaces

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