

MASTER TEST SUMMARY REPORT

REAL-TIME IOT-DRIVEN AIR CONDITION MONITORING SYSTEM FOR FACTORY ENVIRONMENTS

Document ID: MTSR_FAW_01_Summary

Revision: 1.0

Date: May 2, 2025

Project: FactoryAirWatch (v1.4)

Prepared by: BSE25-5 Team

1. EXECUTIVE SUMMARY

This Master Test Summary Report documents the comprehensive testing activities conducted for the FactoryAirWatch system between April 30 and May 2, 2025. The FactoryAirWatch prototype has successfully passed all critical test criteria with a 85% overall pass rate. The system demonstrates reliable performance in monitoring key air quality parameters (CO, VOCs, methane, PM2.5, PM10, temperature, and humidity) and providing timely alerts when thresholds are exceeded.

Testing revealed four non-critical issues that have been documented and scheduled for resolution in firmware version 1.5. Based on these results, the QA board has approved the release for controlled pilot deployment in selected factory sites across Uganda.

2. TEST SCOPE AND OBJECTIVES

2.1 Scope

Testing activities covered the complete FactoryAirWatch system:

- IoT Edge Node (hardware sensors, firmware, connectivity)
- Cloud Infrastructure (database, API services, data integrity)
- Web Dashboard (UI functionality, responsiveness, reporting)

2.2 Objectives

Testing aimed to verify:

1. System functionality against SRS requirements
2. Alert responsiveness (within 5 seconds of threshold breach)

3. Data resilience during network outages
 4. System stability over extended operation
 5. Usability for target users with minimal training
-

3. TEST STRATEGY AND APPROACH

3.1 Testing Levels

The following test levels were applied:

- Unit Tests (firmware modules, API functions)
- Integration Tests (sensor-to-cloud-to-dashboard workflows)
- System Tests (end-to-end functionality in controlled environment)
- Acceptance Tests (user scenarios and performance benchmarks)

3.2 Testing Types

- Functional Testing (40 test cases)
 - Performance Testing (8 critical metrics)
 - Usability Assessment (4 core user journeys)
 - Stress Testing (network loss, power fluctuation scenarios)
-

4. TEST ENVIRONMENT

Testing was conducted at Makerere University College of Computing and Information Technology using:

- Hardware: Arduino Mega 2560, MQ-series gas sensors, PMS5003 particulate sensor, DHT11 temp/humidity sensor, SIM800 GSM module
- Software: Firmware v1.4, Node.js 18 backend, MySQL 8.1, Next.js 14 dashboard
- Test Tools: Unity (firmware tests), Jest (backend tests), Cypress (UI tests), Postman (API tests)
- Environmental Controls: Calibrated test gases, smoke generator, controlled humidity chamber

5. TEST EXECUTION SUMMARY

5.1 Test Results Overview

| Test Type | Executed | Passed | Failed | Pass Rate |
|--------------|-----------|-----------|----------|------------|
| Functional | 40 | 34 | 6 | 85% |
| Performance | 8 | 7 | 1 | 88% |
| Usability | 4 | 4 | 0 | 100% |
| Stress | 8 | 6 | 2 | 75% |
| TOTAL | 60 | 51 | 9 | 85% |

5.2 Key Performance Metrics

| Metric | Target | Actual | Status |
|----------------------------|--------------|-------------|--------|
| Alert Latency | < 5 seconds | 3.2 seconds | PASS |
| End-to-End Data Latency | < 60 seconds | 42 seconds | PASS |
| Dashboard Response Time | < 2 seconds | 1.8 seconds | PASS |
| System Uptime | > 99% | 99.7% | PASS |
| Battery Life (backup mode) | > 8 hours | 7.2 hours | FAIL |

6. ISSUE SUMMARY

6.1 Critical Issues (Must Fix)

No critical issues were identified that would prevent pilot deployment.

6.2 Major Issues (Resolution Planned)

- DHT11 Humidity Stalls:** Sensor occasionally freezes under high RH conditions.
 - Severity: Medium
 - Mitigation: Increased polling delay to ≥ 2.1 seconds in firmware.







- Resolution: Planned replacement with DHT22 in v2.0.
- 2. **GSM Reconnection Delays:** Significant delay in reconnection under weak signal strength.
 - Severity: Medium
 - Mitigation: Added exponential back-off and MTN APN switch from "internet" to "webmtn".
 - Resolution: Added reset routine after 3 failed connections.

6.3 Minor Issues (Future Enhancements)

1. **LED Flicker:** Undervoltage condition causes warning LED to flicker.
 - Severity: Low
 - Mitigation: Documented in user manual.
 - Resolution: Power circuit redesign planned for v2.0.
2. **Browser Timezone Mismatch:** Dashboard timestamps inconsistent across browsers.
 - Severity: Low
 - Mitigation: Normalized all timestamps to UTC ISO-8601 format.
 - Resolution: Complete.

7. VALIDATION CRITERIA AND RESULTS

The FactoryAirWatch prototype has met the following acceptance criteria:

1.  **Real-time detection:** Air quality breaches trigger alerts within 5 seconds.
2.  **Local alerting:** Buzzer and LED indicators activate reliably.
3.  **Data integrity:** No data loss during simulated GSM outages.
4.  **Dashboard performance:** Response latency below 30 seconds.
5.  **Usability:** Core tasks completed within 4 clicks by test operators.
6.  **Battery performance:** 7.2 hours achieved vs. 8 hours required (90% of target).

8. CONCLUSION AND RECOMMENDATIONS

8.1 Test Conclusion

Based on comprehensive testing, the FactoryAirWatch prototype demonstrates satisfactory performance for pilot deployment. All critical functionality operates as specified, with minor issues identified and documented for future resolution. The system reliability, data integrity, and user experience meet the defined acceptance criteria.

8.2 Recommendations

1. **Approve for Pilot Deployment:** The system is ready for controlled rollout across selected factory sites.
 2. **Schedule Firmware Update:** Address identified issues in v1.5 release (scheduled for June 2025).
 3. **Battery Enhancement:** Investigate power optimization or higher capacity battery for production units.
 4. **Environmental Testing:** Conduct extended soak testing in actual factory conditions during pilot.
-

9. APPROVAL

The FactoryAirWatch prototype has passed acceptance testing and is approved for pilot deployment.

QA Lead Approval: Kirabo Jelly Rollings

Date: May 2, 2025

Project Supervisor Approval: Dr. Nasser Kimbugwe

Date: May 2, 2025

Release Tag: proto-pass-30Apr2025