IS OUR BMS TELLING US ENOUGH ABOUT CONTAINMENT?

Diagnostic Guide
GD-016

A technical diagnostic guide to monitoring, trends, alarms, sensor quality, and the limits of building management system data

A practical guide to determining what containment-relevant information the BMS should provide, how that information should be interpreted, and what still requires direct verification.

DIAGNOSTIC GUIDE

HOW TO USE THIS GUIDE

THE BMS CAN SHOW THE REPORTED STATE OF THE SYSTEM. IT CANNOT DEMONSTRATE EVERY CONTAINMENT FUNCTION.

This guide was created for facilities that depend heavily on BMS screens, trends, and alarms but have not clearly defined which containment decisions can be supported by those data.

Why we developed it

Building management systems are essential operational tools in modern containment laboratories. They can display room pressures, fan status, filter differential pressure, damper positions, temperatures, alarms, and system transitions over time.

However, the BMS only reports information generated by its sensors, control logic, and communication architecture. A normal display does not independently demonstrate sensor calibration, HEPA integrity, envelope continuity, actual airflow, or every failure mode relevant to containment.

The purpose of this guide is to help institutions use BMS data as strong operational evidence without allowing monitoring to substitute for verification.

Who can use it

The guide is intended for facility managers, controls engineers, biosafety personnel, maintenance and commissioning teams, and institutional authorities responsible for containment monitoring and technical decision-making.

It may be used during BMS design, commissioning, periodic verification, alarm review, failure investigation, controls upgrades, or retrospective assessment of an operating facility.

HOW TO USE IT IN PRACTICE

Begin by defining which containment functions require continuous visibility. Then identify the variables the BMS actually measures, review sensor quality and trend configuration, evaluate the usefulness of alarms, and determine which decisions still require independent measurement or functional testing.

The objective is not to collect more data. It is to collect the data that help operators understand containment status, detect drift, and know when direct technical verification is required.

01 DEFINE

02 MONITOR

03 INTERPRET

04 VERIFY

HOW THIS GUIDE MAY BE USED — AND WHAT IT DOES NOT AUTHORIZE

This guide is a general diagnostic-orientation tool. It is designed to help structure technical questions, organize evidence, and define what requires more specific evaluation.

Acceptable use

It may be used to:

- structure preliminary technical investigations;
- prepare internal reviews and multidisciplinary discussions;
- identify missing information, measurements, and documentation;
- support definition of the scope of a subsequent evaluation;
- serve as educational and internal technical reference material.

It does not constitute

This guide does not constitute a BMS specification, complete alarm strategy, commissioning or verification protocol, certification, compliance determination, authorization to operate, or site-specific recommendation.

Technical and operational decisions

No decision regarding containment performance, alarm modification, sensor replacement, control-logic adjustment, continued operation, or return to service should be based solely on BMS data or this guide.

Applicable technical basis

The content should be interpreted together with the risk assessment, controls specifications, alarm philosophy, sensor and calibration criteria, commissioning and verification plans, cybersecurity requirements, regulatory requirements, and other site-specific documentation.

Competent personnel

Configuration, modification, and interpretation of containment-critical variables, sensors, alarms, and trends should be performed or reviewed by appropriately qualified personnel, supplementing BMS data with independent measurement or testing where appropriate.

Responsibility

BioLab Solutions assumes no responsibility for decisions, modifications, interventions, or actions carried out outside a site-specific evaluation and without review by competent personnel.

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01 Define which containment functions require continuous visibility

Monitor the system state operators need to understand, not simply every point available from the controls contractor.

Pressure hierarchy

Room differential pressures, reference spaces, and critical cascade relationships.

Air-system status

Supply and exhaust fan status, VFD command, airflow where measured, and critical damper positions.

Filter condition

Filter differential pressure and alarms indicating abnormal resistance where instrumentation is provided.

Doors / interlocks

Door status, simultaneous-opening conditions, and interlock failures where relevant.

Power / redundancy

Normal/emergency power status, duty/standby condition, and loss of redundancy.

Critical services / barriers

Selected status of autoclave, EDS, decontamination, or transfer systems where these functions are operationally significant.

> **Monitoring question:** what information must an operator see to know whether the laboratory is in a normal, degraded, or failed containment state?

02 Understand what a BMS value actually represents

Every displayed number is the final result of a measurement chain.

01

Physical condition.
Room pressure, airflow, temperature, filter resistance, or equipment status exists in the real facility.

02

Sensor / device.
The condition is converted into an electrical or digital signal.

03

Reference / tubing / wiring.
Pressure references, impulse lines, signal wiring, and local installation affect the reading.

04

Controller / scaling.
The signal is interpreted, scaled, converted, and used in control logic.

05

Network / BMS display.
The value is transmitted, trended, alarmed, and presented to the operator.

A BMS VALUE IS ONLY AS RELIABLE AS THE MEASUREMENT CHAIN THAT PRODUCES IT.

03 Review sensor quality before trusting the trend

Long-term data are valuable only if the underlying measurement remains reliable.

Review

- sensor range and resolution;
- calibration interval;
- zero drift;
- pressure-tubing condition;
- reference-port location;
- environmental sensitivity;
- signal scaling;
- replacement history.

Trend drift versus sensor drift

A gradual change in displayed pressure may reflect the facility, the sensor, or both.

Periodic independent comparison helps distinguish lifecycle system drift from instrumentation drift.

> A perfectly stable trend from an uncalibrated sensor or poor reference can create false confidence.

04 Correlate variables in trends rather than reviewing them in isolation

Containment behavior emerges from relationships between variables.

Trend combination	What it may reveal
Pressure + fan speed	Whether increasing mechanical effort is required to maintain the same differential.
Pressure + door status	Magnitude and recovery from routine door-opening disturbances.
Fan speed + filter DP	Whether increasing resistance is consuming exhaust authority.
Pressure + damper position	Whether control devices are approaching their modulation limits.
Pressures across multiple rooms	Whether an event in a shared system is propagating through the cascade.
Power status + fan status + pressure	Containment behavior during electrical transfer or power loss.
Alarm + process/equipment status	Whether recurring alarms coincide with a repeatable operating event.

> **THE VALUE OF BMS DATA OFTEN LIES IN THE RELATIONSHIP BETWEEN TRENDS, NOT IN THE ISOLATED NUMBER.**

05 Configure trends to preserve useful technical evidence

Data resolution and retention determine what can later be reconstructed.

Sampling interval

A trend that is too slow may miss brief pressure excursions, transfers, or control oscillations.

Change-of-value logging

Useful for discrete states, but may require careful configuration for dynamic analog variables.

Data retention

Retain enough history to identify gradual change, recurring alarms, and maintenance-related drift.

Time synchronization

Controllers, BMS, generators, and other systems should use aligned timestamps when events will be reconstructed together.

Context labels

Clear point names, units, and room/system references reduce misinterpretation during later review.

Exportability

Trend data should be retrievable in a format useful for engineering, commissioning, and investigation.

> If the BMS retains only a few days of low-resolution trend data, many event and lifecycle investigations become reconstruction exercises rather than evidence-based reviews.

06 Use alarms to identify meaningful deviations

Alarm design should help operators distinguish normal variation from loss of control.

Review

- alarm threshold;
- delay;
- priority;
- local annunciation;
- remote notification;
- acknowledgment;
- reset logic;
- event retention.

Alarm context matters

A pressure alarm may be expected during a brief door-opening event but significant if it persists. A fan alarm may represent loss of redundancy even while pressure remains normal.

The alarm strategy should distinguish those conditions rather than reduce them to a single generic “failure.”

THE BMS SHOULD MAKE DEGRADATION VISIBLE BEFORE OPERATORS HAVE TO DISCOVER IT THROUGH A CONTAINMENT FAILURE.

WHAT THE BMS CANNOT DEMONSTRATE BY ITSELF

MONITORING IS NOT THE SAME AS VERIFICATION

Sensor accuracy

The BMS displays the sensor output; it does not independently demonstrate that the sensor is calibrated.

Actual airflow

Pressure and fan-speed trends do not replace direct airflow measurement where airflow must be verified.

HEPA integrity

Filter differential pressure does not demonstrate installed HEPA integrity or the absence of bypass.

Envelope continuity

A normal pressure differential can coexist with greater leakage if the exhaust system compensates for it.

Failure response

Programmed logic and status points do not by themselves demonstrate that the system will behave correctly during a transition or failure condition; that response should be verified through functional testing or other appropriate technical evidence.

Operator response

An alarm appearing on screen does not demonstrate that personnel receive, understand, and respond to it appropriately.

> **THE BMS IS STRONG EVIDENCE OF WHAT THE MONITORED SYSTEM REPORTED. IT IS NOT INDEPENDENT EVIDENCE OF EVERYTHING THE SYSTEM ACTUALLY DID.**

07 Use BMS trends to detect lifecycle drift

One of the strongest uses of continuous monitoring is comparison over time.

A laboratory can remain within alarm limits while becoming progressively more difficult to control.

Fan-speed drift

Increasing speed at the same room pressure may indicate greater resistance or leakage.

Recovery drift

Slower recovery after door opening may indicate reduced control authority.

Alarm-frequency drift

Increasing nuisance or pressure alarms may indicate deterioration in margin.

Damper-position drift

Devices approaching fully open/closed positions may indicate loss of modulation range.

Filter-DP drift

Expected loading can be correlated with fan and pressure response.

Inter-room drift

Changes in adjacent zones may reveal shared-system or envelope effects.

> Trend review is most useful when compared with commissioning or another accepted baseline rather than interpreted only against alarm thresholds.

USE TREND DATA BEFORE AND AFTER INTERVENTIONS

Maintenance creates an opportunity to determine whether the system returned to the same condition or simply restarted.

Before maintenance

- record room pressure;
- fan speed;
- damper position;
- filter DP;
- alarm status;
- relevant equipment status.

After maintenance

- compare the same variables;
- look for changes in operating points;
- confirm alarms were restored;
- verify overrides were removed;
- review recovery and stability;
- retain the event as part of the technical history.

BMS DATA CAN SHOW WHETHER THE SYSTEM RETURNED IN A DIFFERENT CONDITION EVEN WHEN THE COMPONENT APPEARS TO WORK.

COMMON MISUSES OF THE BMS

WHAT SHOULD NOT BE ASSUMED

“The BMS says -30 Pa.”

Confirm the sensor condition and reference before treating the display as independent evidence.

“There are no alarms.”

Thresholds may be too broad, disabled, overridden, or simply not configured for the relevant failure.

“The trend is flat, so the room is stable.”

Sampling interval or data smoothing may be hiding brief disturbances.

“Filter DP is normal, so the HEPA is fine.”

Resistance and integrity are different properties.

“The standby status is green.”

Status does not demonstrate that the standby path can support the required load during a real failure.

“Periodic verification can be done with the BMS.”

BMS evidence is useful, but direct measurements and functional testing may still be required.

A GOOD BMS REDUCES UNCERTAINTY. IT DOES NOT ELIMINATE THE NEED FOR ENGINEERING JUDGMENT OR DIRECT VERIFICATION.

08 Protect BMS configuration as technical infrastructure

Setpoints, alarms, and control logic form part of the containment configuration.

Access control

Define who can modify setpoints, alarm thresholds, delays, schedules, and control sequences.

Change records

Retain what changed, why, who authorized it, and what verification was performed afterward.

Backups

Maintain recoverable controller programs, graphics, alarm configuration, and point databases.

Version control

Know which logic and graphics are current after controls upgrades or contractor interventions.

Cyber / network dependency

Loss of network or server availability should not create an unrecognized loss of containment control.

Commissioning baseline

Retain accepted setpoints, sequences, and alarm behavior as part of the facility's technical memory.

> A small undocumented BMS change can alter containment behavior as much as a physical HVAC modification.

A TREND IS ONLY AS USEFUL AS ITS TIME BASE, SOURCE, AND MEASUREMENT QUALITY

BMS data become diagnostic evidence only when the facility can reconstruct what the value represented, when it was recorded, and whether the underlying measurement was reliable.

Review the evidence chain

- sensor identification and location;
- reference point for differential measurements;
- calibration status;
- engineering units and scaling;
- sampling and trend interval;
- alarm delay or averaging;
- controller and BMS time synchronization;
- current configuration revision.

Sequence-of-events analysis

When several alarms or system changes occur at the same time, unsynchronized clocks or overly coarse trend intervals can obscure which event occurred first.

For critical containment events, retain sufficient temporal resolution to distinguish initiating conditions from consequential alarms where the installed system permits.

> A BMS display may be technically correct and still constitute insufficient evidence if the measurement chain, timing, or configuration cannot be reconstructed.

DIAGNOSTIC SEQUENCE

DOES OUR BMS TELL US ENOUGH?

01

Are the containment functions requiring continuous visibility clearly defined?

No → first define the operating states that must be visible.
Yes → continue.

02

Does the BMS monitor the variables needed to identify those states?

No → close critical monitoring gaps.
Yes → continue.

03

Are the sensors, references, and data chain reliable?

No → calibrate, repair, or independently verify before relying on the data.
Yes → continue.

04

Are trends and alarms configured to capture meaningful behavior?

No → improve sampling, retention, threshold, delay, or priority logic.
Yes → continue.

05

Is the BMS being used within its evidentiary limits?

No → add direct measurement or functional testing where required.
Yes → continue.

06

Are BMS changes controlled and retained as part of the containment baseline?

No → establish technical configuration control.
Yes → use the system as an active diagnostic tool throughout the lifecycle.

WHAT SHOULD BE AVAILABLE?

Point architecture

- point list;
- units/ranges;
- sensor locations;
- references;
- network architecture;
- critical dependencies.

Control configuration

- setpoints;
- sequences;
- PID logic;
- failure states;
- alarm thresholds;
- delays;
- priorities.

Evidence

- calibration records;
- trend exports;
- alarm history;
- functional tests;
- independent measurements;
- commissioning baseline.

Lifecycle control

- change records;
- software backups;
- version records;
- overrides;
- maintenance history;
- access permissions.

Review objective: establish that the BMS provides reliable and interpretable operational evidence without requiring it to demonstrate functions it cannot independently verify.

USE MONITORING TO IDENTIFY THE QUESTIONS THAT REQUIRE DIRECT TESTING

Escalate the investigation when trends show

- increasing fan speed with constant pressure;
- longer recovery after door events;
- frequent recurring alarms;
- damper saturation;
- instability between rooms;
- unexpected pressure drift after maintenance;
- repeated communication or sensor failures.

Then verify physically

Depending on the symptom, continue with independent pressure measurement, TAB, envelope inspection, filter testing, controls functional testing, or maintenance review.

The BMS provides its greatest value when it efficiently directs attention toward the system requiring investigation.

MONITOR CONTINUOUSLY. VERIFY DELIBERATELY.

BEFORE USING A TREND OR DISPLAY AS CONTAINMENT EVIDENCE, CONFIRM WHAT IT ACTUALLY REPRESENTS

Use this checklist as diagnostic support. A checked item does not constitute acceptance; each element must be interpreted against the risk basis, facility configuration, and applicable criteria.

□ Identify the sensor, point name, physical location, and reference condition behind each containment-relevant value.

□ Confirm calibration status, units, scaling, and any known offset or substitution affecting the displayed value.

□ Review sampling interval, trend interval, averaging / damping, and alarm delay before interpreting transient behavior.

□ Confirm time synchronization between controllers, BMS servers, and other event records used for sequence-of-events analysis.

□ Distinguish measured values from calculated, inferred, commanded, or status points.

□ Verify that the BMS displays the variables needed to understand system interaction, not only the final room-pressure result.

□ Review priority, persistence, suppression, override, and acknowledgment logic for containment-relevant alarms.

□ Compare BMS data with independent measurement when the decision requires verification rather than monitoring alone.

□ Confirm that configuration changes, point remapping, or controls revisions are traceable and reflected in current documentation.

□ Define which containment decisions may be supported by BMS evidence and which functions still require direct testing.

Technical-use note: This review checklist is a diagnostic-support tool. It does not establish site-specific acceptance criteria, replace risk assessment or professional judgment, constitute certification, or authorize operation or return to service.

If the review identifies a condition requiring site-specific evaluation, BioLab Solutions can support technical assessment, verification, and definition of the required evidence.

RELATED BIOLAB RESOURCES

EXPLORE CONTROLS, ALARMS, VERIFICATION, AND LIFECYCLE DRIFT IN GREATER DEPTH

NT-010–013
Directional airflow, pressure cascades, and pressure-control failure modes

NT-014–017
HVAC integration, exhaust authority, redundancy, and control hierarchy

NT-032–035
Commissioning, functional testing, authority, and documentation

NT-036
Operation as a continuous containment activity

NT-037
Maintenance as a containment-risk domain

NT-039
Lifecycle drift in containment systems

GD-005
Does our periodic verification really demonstrate containment?

GD-007
Why does this BSL-3 keep going into alarm?

BIOLAB DIAGNOSTIC GUIDES

Short technical resources organized around real containment problems rather than individual disciplines.

Series concept: symptom → system → evidence → restoration.

CLOSING DIAGNOSTIC PRINCIPLE

THE BMS SHOULD HELP US SEE CONTAINMENT, NOT SUBSTITUTE FOR DEMONSTRATING IT.

A well-designed BMS is one of the most useful lifecycle tools available to an operating high-containment laboratory.

It can make system status visible, capture events no technician witnessed, reveal gradual loss of margin, and connect maintenance, alarms, and pressure behavior across years of operation.

Its value is greatest when its limits are understood. Sensor data require calibration, trends require context, alarms require meaningful logic, and some containment functions still require direct measurement or functional testing. Used in this way, the BMS becomes part of the facility's technical memory rather than a screen that simply indicates everything is green.

BIOLAB SOLUTIONS

Independent technical support for planning, design, commissioning, assessment, and lifecycle management of high-containment laboratories.

For site-specific evaluation, BioLab Solutions can support technical review, verification, and definition of evidence requirements.

MONITORING → CONTEXT → EVIDENCE → DECISION