CAN THIS LABORATORY CONTINUE OPERATING DURING A POWER FAILURE?

Diagnostic Guide
GD-009

A technical diagnostic guide to emergency power, exhaust continuity, controls, alarms, and recovery in high-containment laboratories

A practical guide to determining what must remain available, what can shut down safely, and whether the facility can preserve containment during loss of normal power and transfer to backup systems.

DIAGNOSTIC GUIDE

HOW TO USE THIS GUIDE

A POWER FAILURE IS NOT A SINGLE EVENT. IT IS A SEQUENCE OF SYSTEM STATES.

This guide was created for laboratories that have a generator, UPS, or emergency electrical panel but have never fully established whether the containment system remains controlled throughout the electrical transition.

Why we developed it

High-containment facilities depend on electrical power for exhaust, supply, pressure monitoring, controls, alarms, access systems, decontamination equipment, and other functions. The presence of emergency power does not by itself demonstrate containment continuity.

The critical questions arise during the transition: what stops immediately, what remains on UPS, what restarts automatically, how long transfer takes, whether pressure relationships are preserved, which alarms remain visible, and whether the facility recovers in the correct sequence.

The purpose of this guide is to help institutions distinguish electrical backup capacity from demonstrated containment continuity.

Who can use it

The guide is intended for facility managers, electrical and mechanical engineers, biosafety personnel, commissioning teams, maintenance personnel, operators, and institutional authorities responsible for high-containment operations.

It may be used during design review, commissioning, periodic verification, generator testing, planned outages, or after an actual electrical event.

HOW TO USE IT IN PRACTICE

Map the containment functions that depend on power, identify their electrical source and transfer behavior, define which functions must persist and which must fail safely, and then review the sequence from loss of normal power through emergency transfer and degraded operation to restoration.

The objective is not to keep every piece of equipment operating. It is to preserve the functions necessary to avoid an uncontrolled containment state and recover safely.

01 MAP

02 TRANSFER

03 MAINTAIN

04 RECOVER

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 an electrical study, emergency-power design, failure-response procedure, acceptance criterion, certification, compliance determination, authorization to operate, or site-specific recommendation.

Technical and operational decisions

No decision regarding continuation of work, load transfer, UPS or generator configuration, modification of sequences, evacuation, shutdown, or return to service should be based solely on this guide.

Applicable technical basis

The content should be interpreted together with the risk assessment, Basis of Design, electrical studies and diagrams, emergency-power strategy, commissioning criteria, institutional emergency procedures, regulatory requirements, manufacturer instructions, and other site-specific documentation.

Competent personnel

Transfer testing, failure simulations, and modifications to power systems, controls, or containment-critical sequences should be planned, performed, or reviewed by appropriately qualified personnel under controlled conditions.

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 what must remain available

Emergency-power design should follow the containment function, not simply the importance of the equipment.

The first question is not “what is connected to the generator?” It is “what functions are necessary to prevent loss of containment or support a safe shutdown?”

Airborne containment

- exhaust fans;
- critical supply functions;
- pressure control;
- essential dampers;
- controls required to preserve directional airflow.

Monitoring and alarms

- pressure monitors;
- BMS/PLC controls;
- local alarms;
- remote notification;
- generator/ATS status.

Access and egress

- door interlocks;
- access control;
- emergency release;
- egress lighting;
- communications.

Process-dependent loads

- BSCs where continuity is required;
- freezers/incubators;
- autoclaves/EDS;
- critical analyzers;
- UPS-backed computers/controls.

Functional map: classify each load as uninterrupted, emergency-backed, safe to stop, delayed restart, or nonessential.

02 Distinguish UPS continuity from generator continuity

These systems cover different parts of the failure sequence.

Power source	What it may provide
Normal utility power	Primary operating condition for the laboratory and supporting systems.
UPS	Immediate continuity for controls, sensors, communications, computers, or other selected critical loads during the transfer gap or for the available autonomy period.
Emergency generator	Longer-duration supply after startup and transfer, subject to generator capacity and the connected emergency loads.
Stored energy or local backup	Specific continuity for devices such as controllers, actuators, or local instruments where provided.

Ask about the gap

If generator transfer takes several seconds, what happens during those seconds to controls, pressure monitoring, exhaust, and alarm visibility?

The UPS does not solve every load

Large motors, such as exhaust fans, are often not backed by UPS. The strategy may instead depend on safe transient behavior, rapid transfer to the generator, and an appropriate system sequence.

THE CRITICAL CONDITION MAY EXIST BETWEEN LOSS OF NORMAL POWER AND ESTABLISHMENT OF EMERGENCY POWER.

03 Review the actual transfer sequence

Generator startup is only one step in the transition.

The complete sequence from loss of utility supply to stabilization on emergency power should be understood.

01

Normal power is lost.
Which loads drop immediately? Which remain on UPS or stored-energy backup?

02

Automatic transfer logic begins.
Does the ATS correctly detect the loss? Are intentional delays present?

03

The generator starts and reaches acceptable voltage/frequency.
How long does this take under realistic conditions?

04

Emergency loads are transferred.
Which loads reconnect first? Are motors sequenced to avoid overload?

05

Containment systems restart or stabilize.
Do exhaust, supply, and controls recover in the correct order?

06

Operators receive clear indication of the degraded state.
Can they tell that the laboratory is on emergency power and whether any redundancy has been lost?

> Successful generator startup does not demonstrate that the containment system survived the transition in the intended state.

04 Preserve exhaust priority where the strategy requires it

Supply and exhaust should not recover in an order that creates an unintended positive condition.

For negative-pressure containment, failure and restart logic should reflect the required directional-airflow strategy.

Review

- which fan stops first when power is lost;
- whether supply and exhaust fail simultaneously;
- restart sequence;
- fail-safe damper positions;
- pressure response during the gap;
- alarm generation;
- recovery time.

Potential failure mode

If supply restarts before exhaust or remains energized while exhaust is unavailable, room pressure may move in the wrong direction.

The control sequence should prevent or limit that condition where negative containment is required.

FAILURE LOGIC SHOULD PRESERVE THE CONTAINMENT HIERARCHY — NOT SIMPLY RESTORE EQUIPMENT AS QUICKLY AS POSSIBLE.

05 Review generator capacity under the actual emergency load

Nameplate capacity alone does not demonstrate functional reserve.

Connected emergency load

Confirm all loads actually connected to the emergency system, including later additions.

Motor starting

Large fan and pump motors may impose a transient starting demand above the running load, depending on the motor and starting method.

Load sequencing

Staggered restart may be required to avoid generator overload or voltage/frequency instability.

Future modifications

New equipment may have been added to emergency panels without reevaluating total capacity or sequence.

Fuel autonomy

Consider expected outage duration, refueling strategy, and site access during emergencies.

Environmental conditions

Altitude, temperature, and equipment condition may affect available generator output and starting performance.

Diagnostic question: can the generator support the required containment loads under the actual startup and operating sequence, with adequate margin?

06 Review controls, sensors, and alarms during the outage

A system may remain physically stable while operators lose visibility of its condition.

Continuity questions

- Does the PLC remain energized?
- Do pressure monitors remain energized?
- Does the BMS retain communication?
- Do alarm annunciators remain active?
- Are event records retained?
- Do network switches or gateways remain available?

Loss of visibility is significant in itself

If the laboratory loses power to monitoring and alarm systems during the same interval in which pressure control is disturbed, operators may have no direct indication of what the containment system is doing.

UPS backup for controls and monitoring may therefore be important even when large mechanical loads are generator-backed rather than uninterrupted.

CONTAINMENT CONTINUITY INCLUDES VISIBILITY OF SYSTEM STATUS, NOT ONLY MECHANICAL OPERATION.

OPERATIONAL DECISION

CAN WORK CONTINUE WHILE THE FACILITY OPERATES ON EMERGENCY POWER?

A laboratory that remains technically contained on generator power is not automatically in its normal operating condition.

Redundancy may be reduced

A standby fan, redundant control component, or secondary service may not be available.

Nonessential systems may be disconnected

Some process equipment, comfort loads, or supporting systems may be intentionally disconnected.

Fuel autonomy is finite

The facility may be stable now but unable to sustain the same condition during a prolonged outage.

Utility restoration may create another transition

Return to normal power may create a second disturbance that must be managed.

Response capability may be reduced

Maintenance or emergency support may be limited during a site-wide electrical event.

Institutional criteria should govern

Define in advance whether work continues, is reduced, paused, or stopped during operation on emergency power.

> The safe question is not simply “is the generator running?” It is “what operating state has the laboratory entered, and what activities are authorized in that state?”

COMMON EMERGENCY-POWER FAILURES

WHAT OFTEN GOES WRONG

“The generator passed its monthly test.”

A no-load or lightly loaded test does not demonstrate transfer of the actual containment loads.

“The fan is on emergency power.”

The controls, damper, sensor, starter, or communication path may not be backed by the same source.

“Everything restarts automatically.”

Automatic restart may create an incorrect sequence or overload the generator if it is not coordinated.

“The UPS will cover the gap.”

Only loads actually connected to the UPS receive uninterrupted backup, and battery autonomy should be verified.

“We only need to test the generator.”

The containment question includes ATS behavior, controls, alarms, fan sequencing, pressure response, and recovery.

“When utility power returns, the event is over.”

Retransfer to normal power may introduce another transient and should form part of the tested sequence.

BACKUP POWER IS A SYSTEM FUNCTION, NOT A GENERATOR COMPONENT.

07 Functionally test the transition

Emergency-power continuity should be demonstrated under controlled and representative conditions.

A useful test observes both electrical transfer and containment behavior.

Before the test

- define scope;
- identify risks;
- establish abort criteria;
- confirm competent personnel;
- notify operators;
- prepare independent instruments.

During the loss

- record transfer time;
- observe pressure;
- record fan status;
- confirm UPS continuity;
- capture alarms;
- observe door/access behavior.

On emergency power

- confirm stable containment condition;
- verify emergency loads;
- review generator load;
- identify lost redundancy;
- confirm operator visibility.

During restoration

- observe retransfer;
- confirm correct restart sequence;
- verify alarms clear appropriately;
- confirm stable normal condition;
- review event record.

> The test should demonstrate the behavior of the integrated facility, not merely produce a successful generator-start record.

08 Define acceptable degraded states

Containment systems do not always move directly from “normal” to “failed.”

An electrical event may leave the facility contained but with reduced resilience, monitoring, or process capability.

Possible state	Institutional question
Normal containment, full redundancy	Normal operation may continue under ordinary criteria.
Contained, redundancy unavailable	Can work continue, or should new high-risk activities stop until redundancy is restored?
Contained, some support loads unavailable	Which procedures can continue safely and which should be suspended?
Monitoring partially unavailable	Is independent/local monitoring sufficient for temporary operation?
Pressure control unstable but recoverable	Does the condition require immediate suspension, safe shutdown, or evacuation?
Containment cannot be demonstrated	Apply the emergency response and operational restrictions defined by the institution.

DEGRADED OPERATION SHOULD BE A DEFINED STATE WITH KNOWN LIMITS — NOT AN IMPROVISED DECISION DURING THE OUTAGE.

DIAGNOSTIC SEQUENCE

CAN THIS LABORATORY PRESERVE CONTAINMENT DURING A POWER FAILURE?

01

Have all power-dependent containment functions been identified?

No → map loads by containment function and required continuity class.
Yes → continue.

02

Is the transfer gap understood?

No → determine UPS coverage, generator startup time, and actual behavior during power loss.
Yes → continue.

03

Does the restart sequence preserve the intended containment hierarchy?

No → review controls, sequencing, or load priority.
Yes → continue.

04

Can the generator support the actual emergency load and motor-starting sequence?

No → correct capacity, sequencing, or emergency-load assignment.
Yes → continue.

05

Do monitoring and alarms remain available during the event?

No → operators may lose visibility of containment status; correct the continuity strategy.
Yes → continue.

06

Has the complete loss-transfer-emergency-retransfer behavior been functionally tested?

No → continuity remains partly assumed.
Yes → document the demonstrated state and operating restrictions.

WHAT SHOULD BE AVAILABLE?

Electrical

- single-line diagram;
- emergency panels;
- ATS data;
- generator capacity;
- UPS loads;
- load study;
- fuel strategy.

Mechanical / controls

- fan sequence;
- fail-safe damper positions;
- pressure strategy;
- PLC logic;
- alarm logic;
- restart sequence.

Testing

- generator load tests;
- ATS tests;
- functional power-loss tests;
- pressure trends;
- alarm records;
- retransfer results.

Operations

- outage SOP;
- degraded-state criteria;
- work restrictions;
- emergency contacts;
- fuel/refueling plan;
- return-to-service authority.

Review objective: demonstrate a traceable chain from the required containment function to the electrical source, transition behavior, tested performance, and operational response.

AFTER AN ACTUAL OUTAGE

DO NOT ASSUME RESTORATION BECAUSE NORMAL POWER HAS RETURNED

An actual electrical event may reveal failures, create control resets, or leave systems in a configuration different from the pre-event condition.

Review the event

- duration of utility loss;
- generator startup and transfer time;
- loads that did not restart;
- alarms generated;
- pressure excursions;
- operator actions;
- fuel and generator condition;
- retransfer behavior.

Before full return to service

Confirm, as applicable:

- normal pressure cascade;
- fan and redundancy status;
- controls and alarm function;
- equipment recovery;
- absence of unresolved failures;
- documentation of deviations and corrective actions.

> **RESTORATION OF POWER IS AN ELECTRICAL EVENT. RETURN TO SERVICE IS A CONTAINMENT DECISION.**

09 Classify electrical dependencies by the interruption they can tolerate

Placing a load on “emergency power” does not define what happens during the seconds before that source becomes available.

Continuity need	Diagnostic question
Uninterrupted / near-continuous	Which controls, monitoring, communications, alarms, or process functions cannot tolerate the generator transfer interval and therefore require UPS or equivalent continuity?
Brief interruption acceptable	Which loads may stop briefly but must restart automatically in a defined sequence without unsafe manual intervention?
Sustained generator-backed operation	Which mechanical/process loads must remain available throughout the outage once emergency generation is established?
Fail-safe shutdown	Which equipment should stop, isolate, or move to a defined safe position rather than restart automatically?
Nonessential / shedable	Which loads may be intentionally removed to preserve generator capacity for critical containment functions?

Map the complete dependency, not only the motor feeder. A generator-backed exhaust fan may still be unavailable if its starter, VFD, damper actuator, PLC I/O, control transformer, network path, or permissive signal is supplied from a different source.

Verification objective: demonstrate the actual end-to-end function during loss, transfer, emergency operation, and retransfer.

CAN THE FACILITY REACH AND MAINTAIN AN ACCEPTABLE CONTAINMENT STATE DURING A POWER LOSS?

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

□ Define the acceptable containment state during power loss: continued operation, controlled degraded operation, or safe shutdown.

□ Classify critical loads by continuity need: uninterrupted / UPS, tolerant of brief interruption, generator-backed, fail-safe, or nonessential.

□ Trace the complete dependency chain for exhaust and critical controls, including VFDs, actuators, control power, PLC / I/O, networks, and permissive signals.

□ Confirm automatic transfer logic, generator-start sequence, and expected transfer duration.

□ Verify what happens to supply, exhaust, pressure relationships, alarms, access systems, and critical process equipment during the transfer gap.

□ Confirm that alarms and operator visibility remain available when normal power is lost.

□ Test or otherwise verify the restart sequence so that restoration of power does not create an unsafe transient or uncontrolled simultaneous restart.

□ Evaluate the system during operation on emergency power, not only at the moment of transfer.

□ Verify retransfer to normal power and recovery of the accepted containment condition.

□ Document deficiencies, temporary operating restrictions, unresolved dependencies, and authority to continue operation.

> **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 FAILURE STATES, REDUNDANCY, CONTROLS, AND RESTORATION 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-032–033
Commissioning and functional testing

NT-035
Documentation as a containment control

NT-036
Operation as a continuous containment activity

NT-037
Maintenance as a containment-risk domain

NT-039
Lifecycle drift in containment systems

BIOLAB DIAGNOSTIC GUIDES

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

Series concept: symptom → system → evidence → restoration.

CLOSING DIAGNOSTIC PRINCIPLE

EMERGENCY POWER IS USEFUL ONLY IF THE CONTAINMENT FUNCTION SURVIVES THE TRANSITION.

Electrical continuity in a high-containment laboratory is not defined by the presence of a generator.

It is defined by what happens to exhaust, pressure control, monitoring, alarms, access systems, and critical processes when normal power disappears, during the transfer gap, while emergency power sustains the facility, and again when normal power returns.

A robust strategy identifies which functions must be uninterrupted, which can tolerate a controlled interruption, what degraded operating state is acceptable, and what evidence demonstrates that the complete transition behaves as intended.

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.

POWER LOSS → TRANSITION → CONTAINMENT STATE → RECOVERY