Session 002-006 — Training, Operation, and Maintenance

Instructor: Luis Linares
Course: High Containment Laboratory Design

Purpose of the document:

This lecture map is designed to help participants navigate the content of Session 002-006, identifying not only the topics covered, but the logic that connects them. The session does not introduce isolated elements, but develops a continuous chain: from operation as the critical point of containment, through system interpretation under real conditions, to decision-making, governance, and the sustained performance of the system over time. This document serves as a study and orientation tool and does not replace the lecture.

SECTION 1 — Containment is defined in operation

Primary focus:
Establish that containment is not lost in the absence of systems, but during operation under real conditions, where system behavior determines performance.

Key points:
- The laboratory does not fail when it is off.
- Containment is sustained under real operating conditions.
- Variability and human intervention are constant.
- The system degrades over time if not actively controlled.
- Operation determines whether containment exists in practice.

Rhetorical questions / Attention signals:
● When is containment actually lost?
● Can a technically correct system fail in operation?

Orientation signal:
Introduces operation as the critical point where containment is confirmed or lost.

SECTION 2 — The laboratory as an integrated system

Primary focus:
Reframe the laboratory as a system composed of people, rules, decisions, and maintenance, where infrastructure is only one component.

Key points:
● The laboratory is not the building.
● It is a system of interdependent elements.
● People, procedures, decisions, and maintenance interact continuously.
● Infrastructure does not guarantee behavior.
● Containment depends on system coherence.

Rhetorical questions / Attention signals:
● Where does the laboratory actually exist: in the building or in the system?
● What happens if one element is not aligned?

Orientation signal:
Defines the shift from component thinking to system thinking.

SECTION 3 — Operation and maintenance as system control

Primary focus:
Establish that operation and maintenance do not maintain equipment, but maintain containment conditions.

Key points:
● The objective is not that equipment functions.
● The objective is that the system maintains containment conditions.
● System behavior is the critical variable.
● Operation requires continuous control.
● Maintenance modifies system behavior.

Rhetorical questions / Attention signals:
● What is actually being maintained?
● What happens if equipment works but containment is lost?

Orientation signal:
Reframes the purpose of operation and maintenance.

SECTION 4 — Interpreting the system vs measured values

Primary focus:
Differentiate between indicators (such as pressure) and actual system behavior.

Key points:
● Pressure is an indirect indicator.
● Containment depends on airflow direction.
● A system can meet setpoints and still fail.
● The BMS represents the system but does not guarantee behavior.
● Verification requires real-world observation.

Rhetorical questions / Attention signals:
● What does a “correct” value actually mean?
● Can a system appear stable and still not contain?

Orientation signal:
Introduces interpretation as a requirement beyond measurement.

SECTION 5 — Transients and dynamic conditions

Primary focus:
Explain that most failures occur under dynamic conditions, not steady state.

Key points:
● The system does not operate under constant ideal conditions.
● Doors, loads, and usage create disturbances.
● Transients affect airflow direction.
● The system must recover quickly.
● Containment is compromised during these intervals.

Rhetorical questions / Attention signals:
● Where do failures actually occur?
● What happens during a disturbance?

Orientation signal:
Introduces real system dynamics.

SECTION 6 — System verification after intervention

Primary focus:
Establish that no intervention is complete until the full system behavior is verified.

Key points:
● A component may function correctly.
● The system may not have recovered equilibrium.
● Verification must be functional, not only technical.
● Flow, pressure, and direction must be validated.
● Lack of verification creates silent degradation.

Rhetorical questions / Attention signals:
● When is an intervention truly complete?
● What happens if the full system is not verified?

Orientation signal:
Introduces verification as an operational requirement.

SECTION 7 — Training as a condition of containment

Primary focus:
Define training as a structural component of the system, not a secondary activity.

Key points:
- Training is not optional or complementary.
- It is part of the containment system.
- Poor training equals operational failure.
- Knowledge must align with the real system.
- Training defines operational capability.

Rhetorical questions / Attention signals:
- Can containment exist without proper training?
- What happens when personnel do not understand the system?

Orientation signal:
Positions training as a critical system element.

SECTION 8 — Decision-making under real conditions

Primary focus:
Explain that procedures cannot cover all conditions and that operation requires decision-making.

Key points:
- Not all situations are defined by procedures.
- The system operates under uncertainty.
- Operators must interpret conditions.
- Behavior must be adapted.
- Decisions sustain containment.

Rhetorical questions / Attention signals:
- What happens when procedures do not apply?
- How are decisions made under uncertainty?

Orientation signal:
Introduces decision-making as a core capability.

SECTION 9 — Human factors as a system variable

Primary focus:
Analyze human behavior as an integral part of the containment system.

Key points:
- Behavior is not external to the system.
- Inexperience, complacency, and overconfidence create risk.
- Deviations become normalized.
- The system can degrade without being noticed.
- Containment depends on behavior.

Rhetorical questions / Attention signals:
- How does risk change with experience?
- Which type of operator represents the highest risk?

Orientation signal:
Integrates human factors into the technical system.

SECTION 10 — Governance and decision authority

Primary focus:
Define containment as the result of structured organizational decisions.

Key points:
- Containment is not purely technical.
- It depends on who decides.
- Roles must be clearly defined.
- Stopping criteria must exist.
- Ambiguity weakens the system.

Rhetorical questions / Attention signals:
- Who decides under critical conditions?
- What happens if authority is unclear?

Orientation signal:
Introduces governance as a control structure.

SECTION 11 — Continuous training as a system

Primary focus:
Establish that training must evolve with the system and not remain a one-time event.

Key points:
- The system changes continuously.
- Training must adapt to those changes.
- Real events must be integrated into training.
- Competence must be periodically validated.
- Operational coherence depends on it.

Rhetorical questions / Attention signals:
- What happens if the system changes but training does not?
- Is operational capability sustained over time?

Orientation signal:
Extends training across the operational lifecycle.

SECTION 12 — Operation within a broader system

Primary focus:
Introduce the laboratory as part of a network where local decisions affect global risk.

Key points:
● The laboratory is not an isolated unit.
● It is part of an institutional network.
● Local decisions impact the broader system.
● Interdependence exists between nodes.
● Capability depends on coordination.

Rhetorical questions / Attention signals:
● What happens when one laboratory fails within a network?
● How is risk distributed across nodes?

Orientation signal:
Closes the session by expanding the system to institutional scale.

How to use this lecture map

When reviewing the session:
● Identify how containment is sustained in operation.
● Recognize the laboratory as an integrated system.
● Understand the difference between measurement and interpretation.
● Evaluate the role of training and decision-making.
● Analyze governance as a control structure.