



Design Principles of Infectious Diseases Containment Facilities

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Bio-Containment Facilities





Bio-Containment Facilities

Facilities

**Human or Animal Pathogens or
Infectious Agents are grown
for Research or Development
Purposes**



Infectious Agent Biosafety Levels

Biosafety Level 1 - Basic

Biosafety Level 2 - Basic

Biosafety Level 3 - Containment

**Biosafety Level 4 - Maximum
Containment**



Risk Assessment

Probability

Severity

Magnitude

Human

Animal

Plant

Environment



Selection of Biosafety Levels

Prudently Select Levels

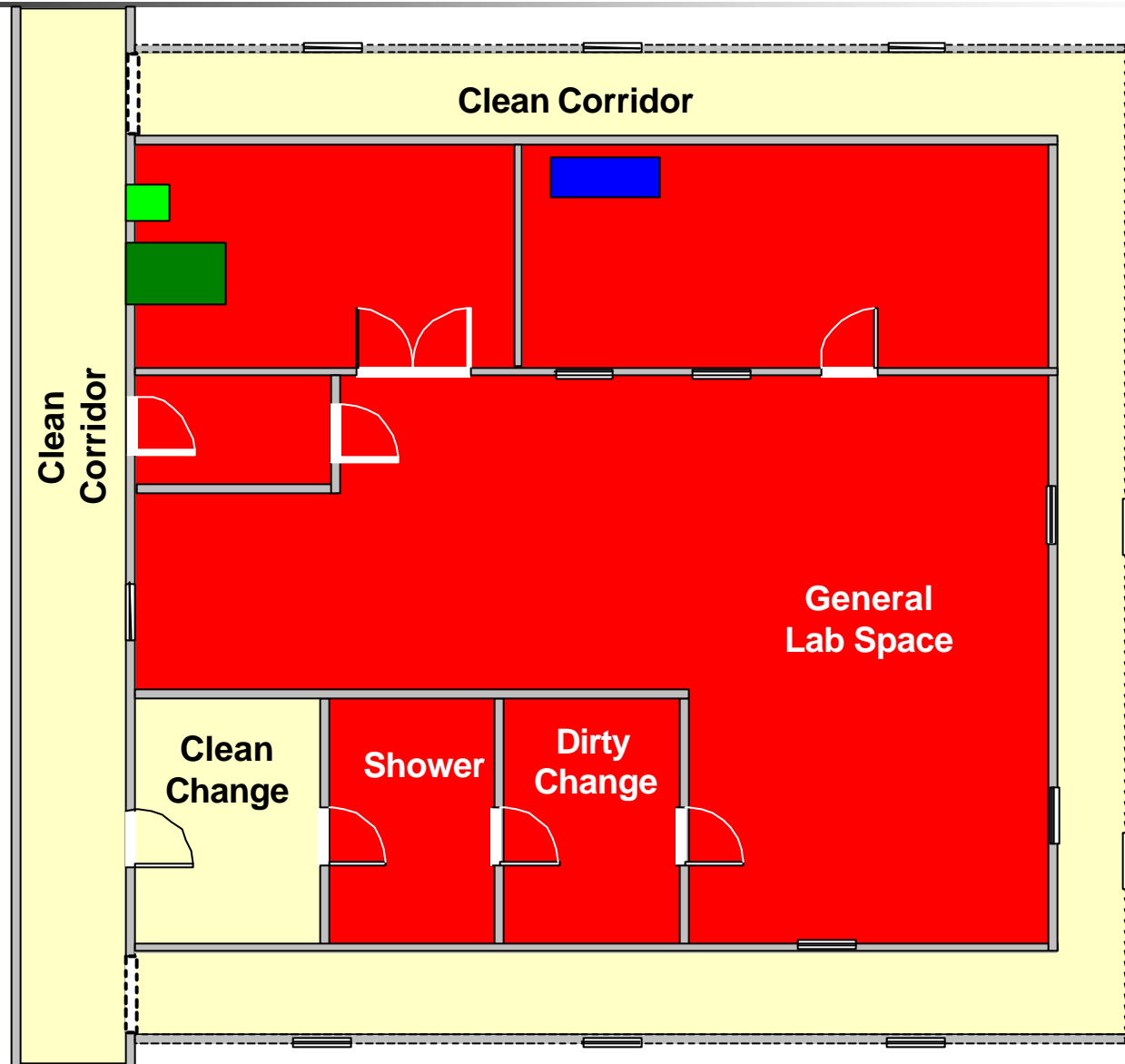
Inflexibility and Inadaptability

**Huge Cost Differentials Between
Levels**

Biosafety Level 2



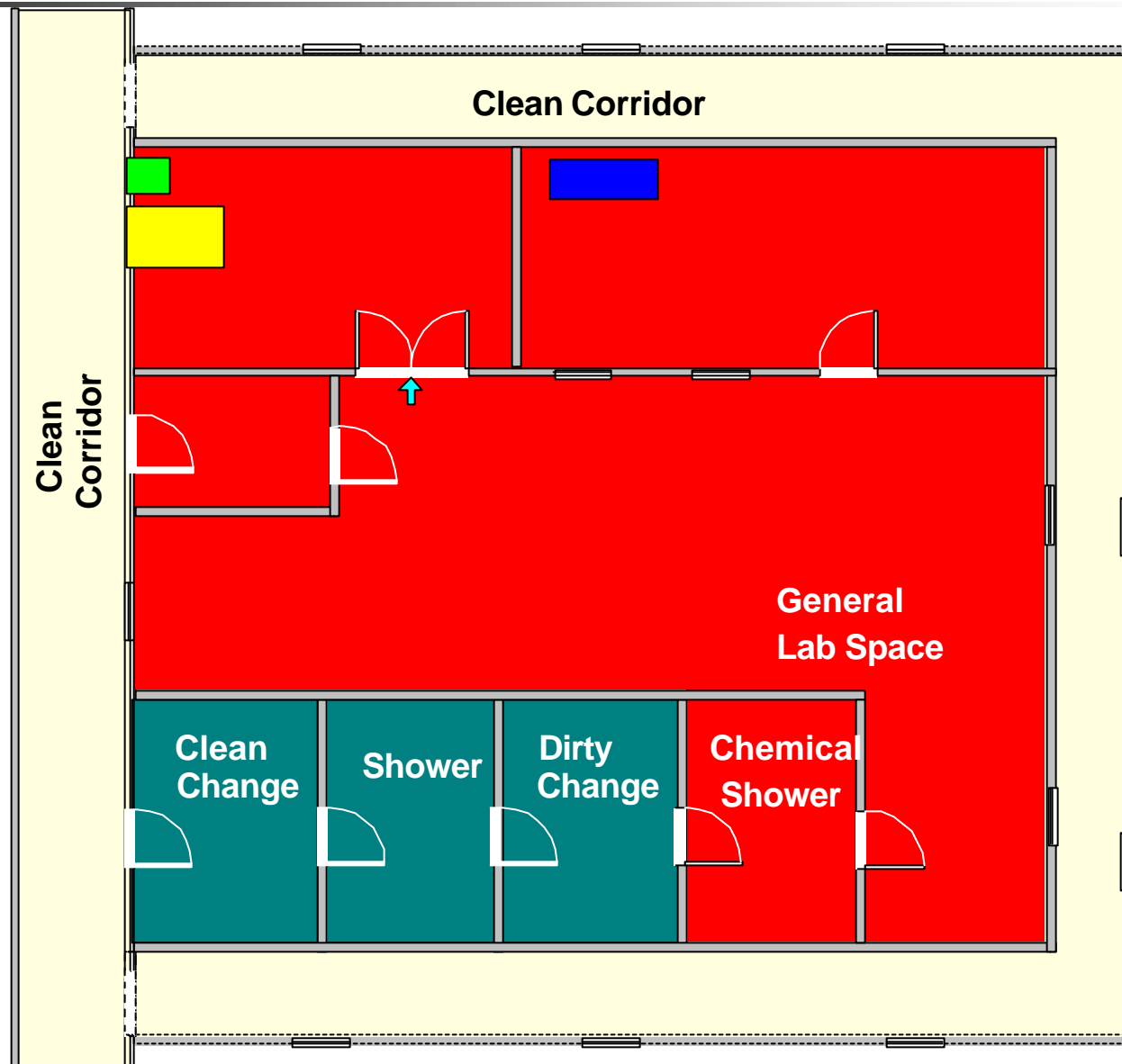
Biosafety Level 3



Biosafety Level 3



Biosafety Level 4



Biosafety Level 4



Biosafety Level 4





Objectives of Containment

**Minimize or Eliminate Potential
Hazardous Agents to:**

Laboratory Workers

Outside Environment

Community



Containment Barriers

Primary Barrier

Laboratory Equipment

Secondary Barrier

Engineering System Design

Tertiary Barrier

Building Envelope



Containment Barriers

Containment Facility

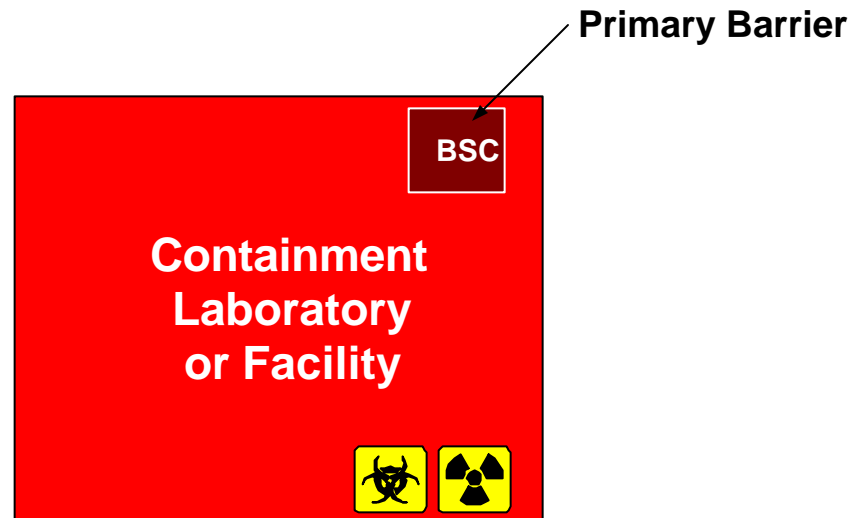


**Containment
Laboratory
or Facility**



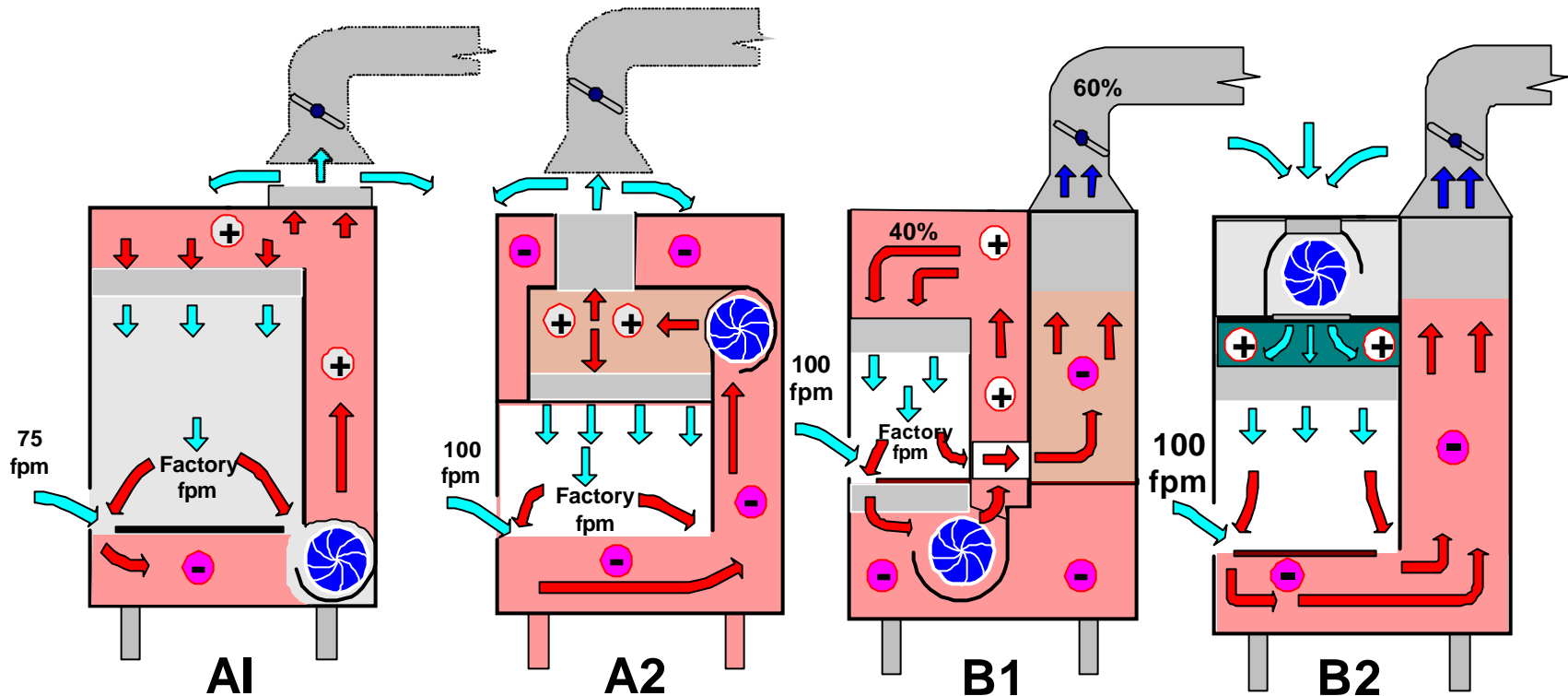
Containment Barriers

Primary Barrier



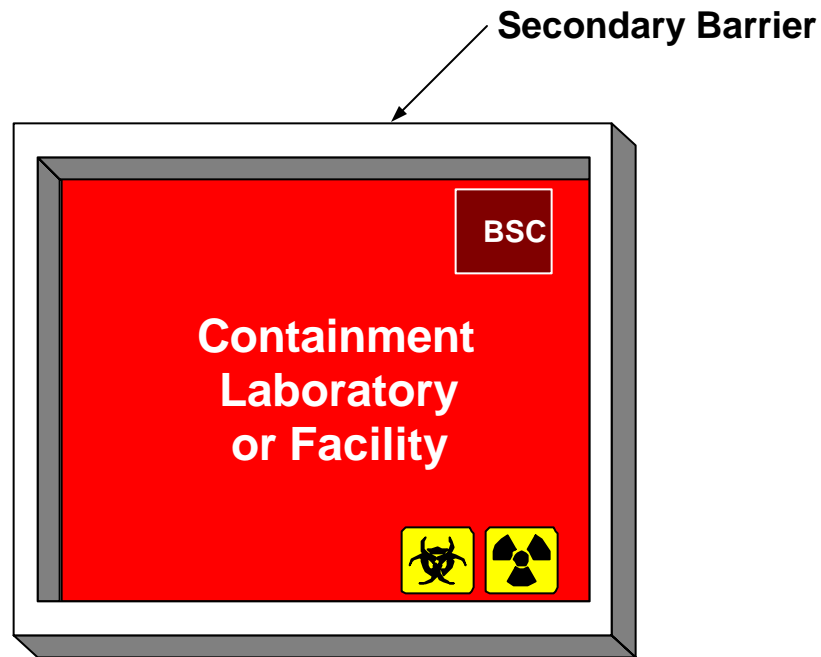
Containment Barriers

Primary Barrier – Biosafety Cabinets



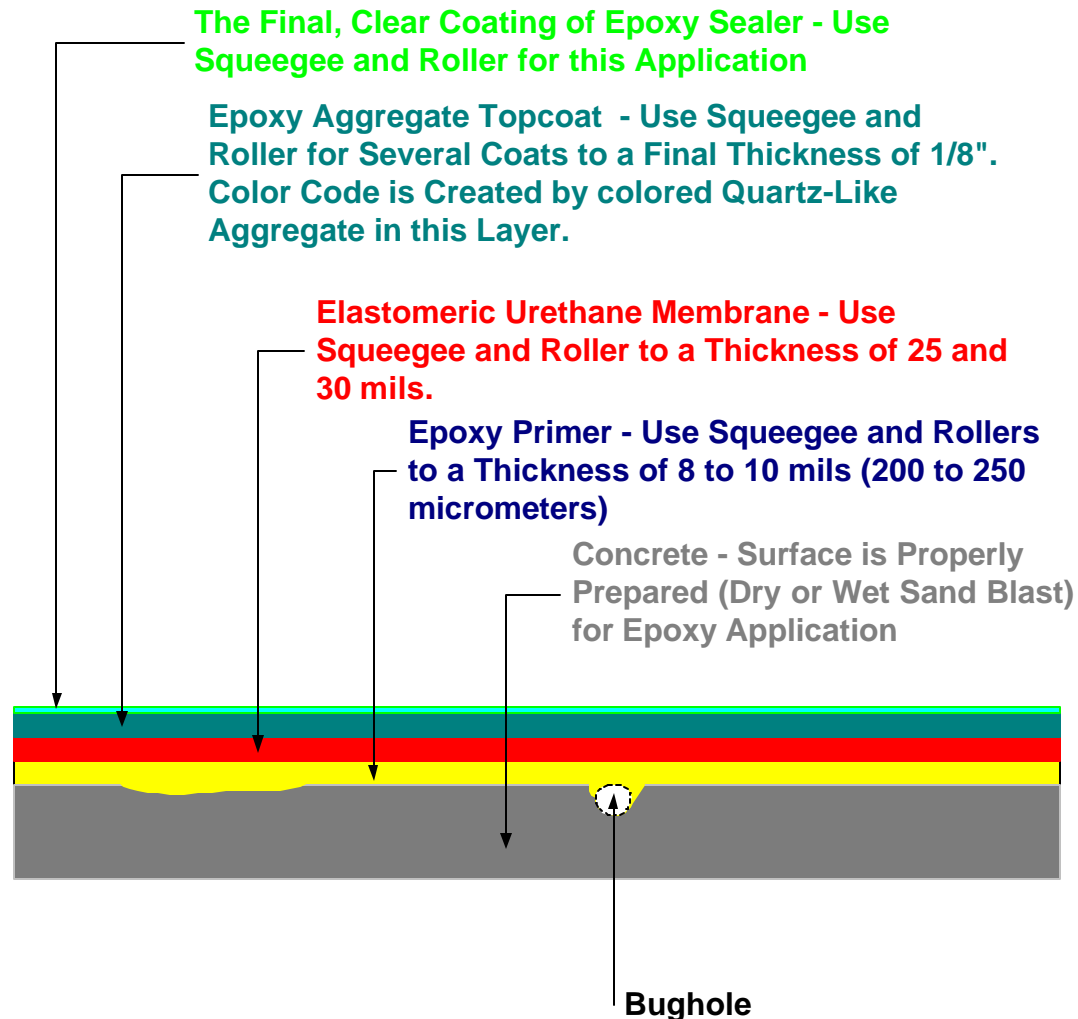
Containment Barriers

Secondary Barrier



Containment Barriers

Secondary Barrier – Concrete Surface Preparation



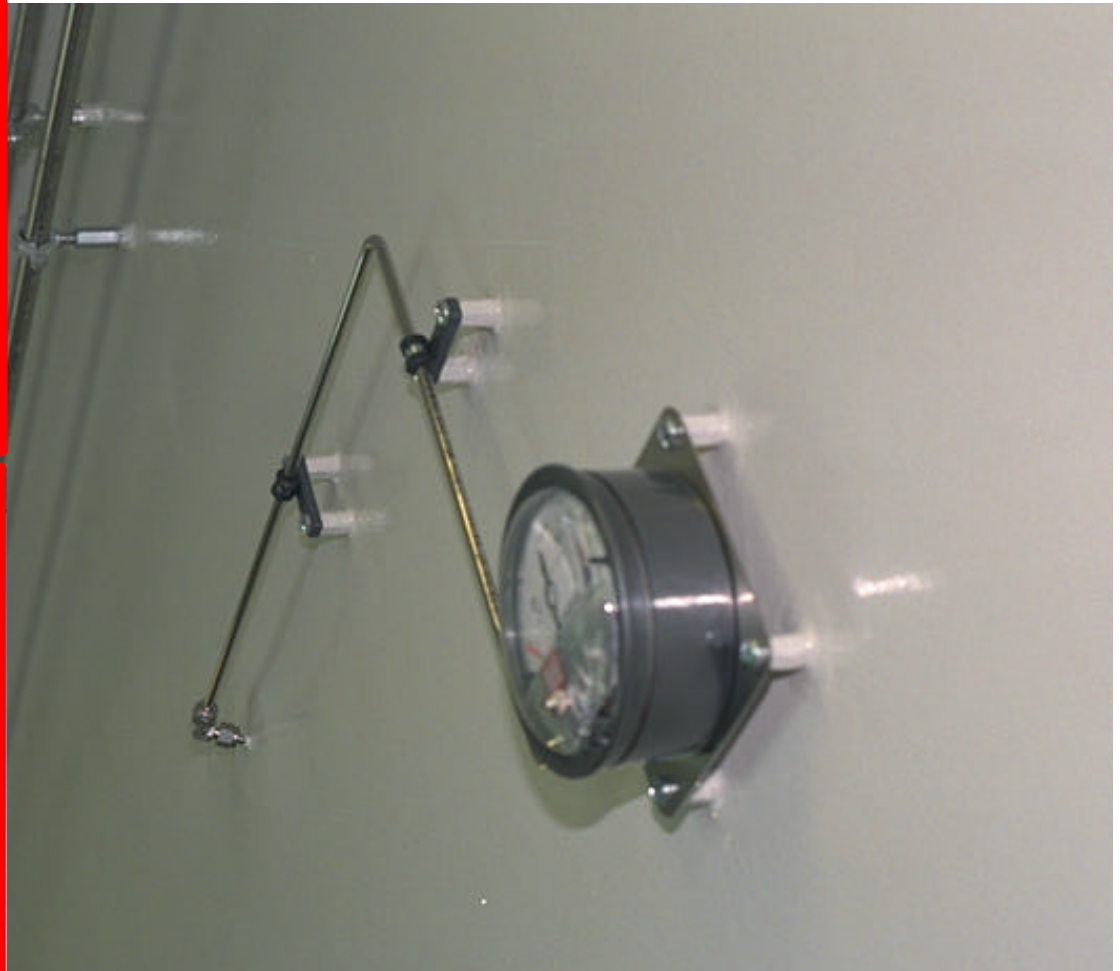
Containment Barriers

Secondary Barrier – Concrete Surface Preparation



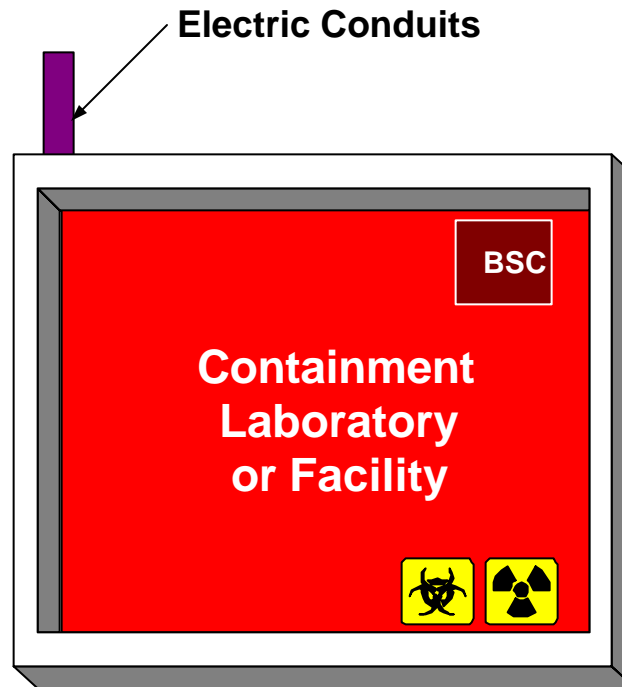
Containment Barriers

Secondary Barrier – Concrete Surface Preparation



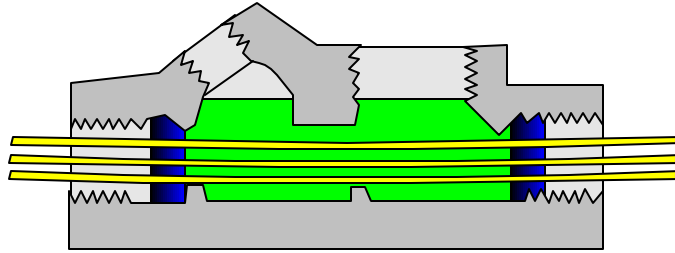
Containment Barriers

Conduits

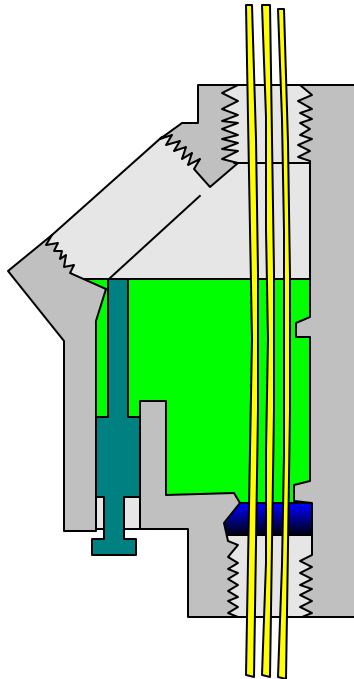


Containment Barriers

Conduits



Horizontal Conduit

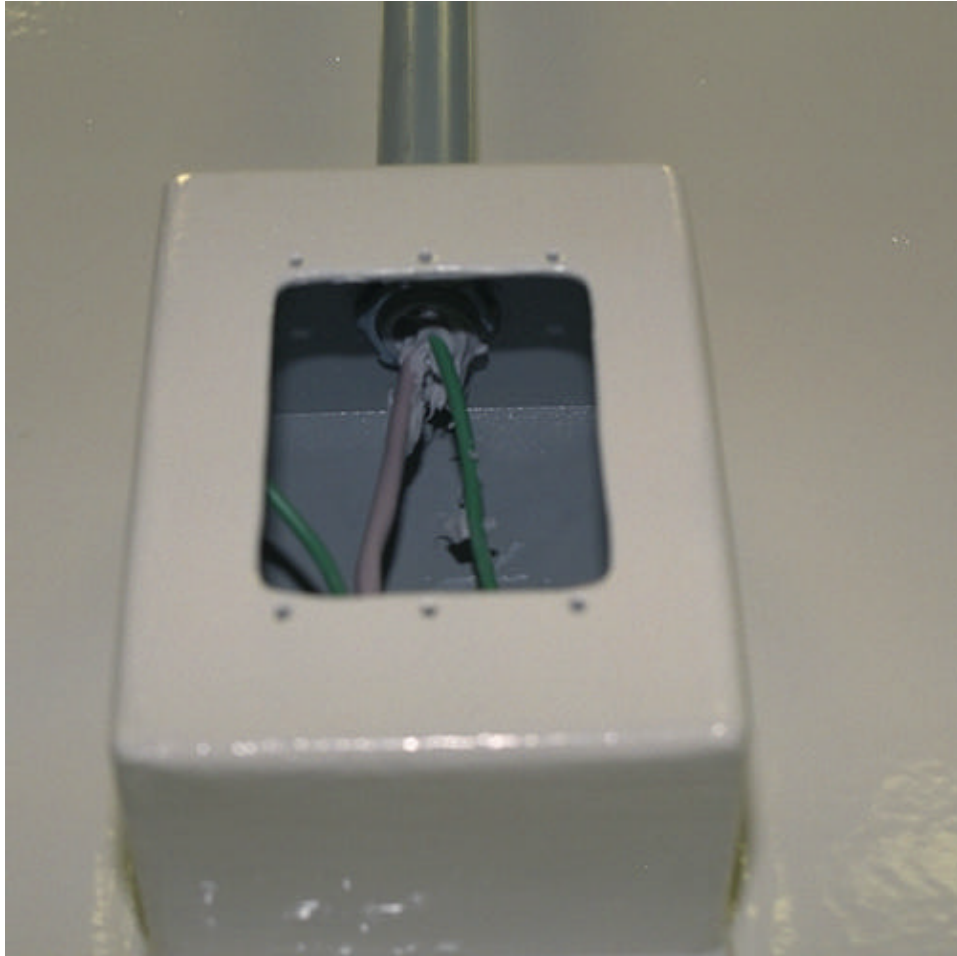


Vertical Conduit



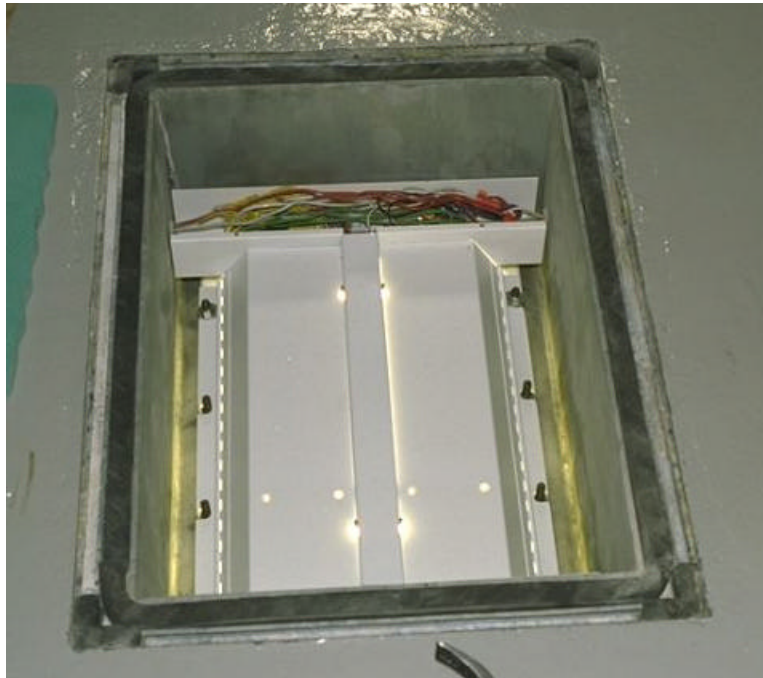
Containment Barriers

Conduits



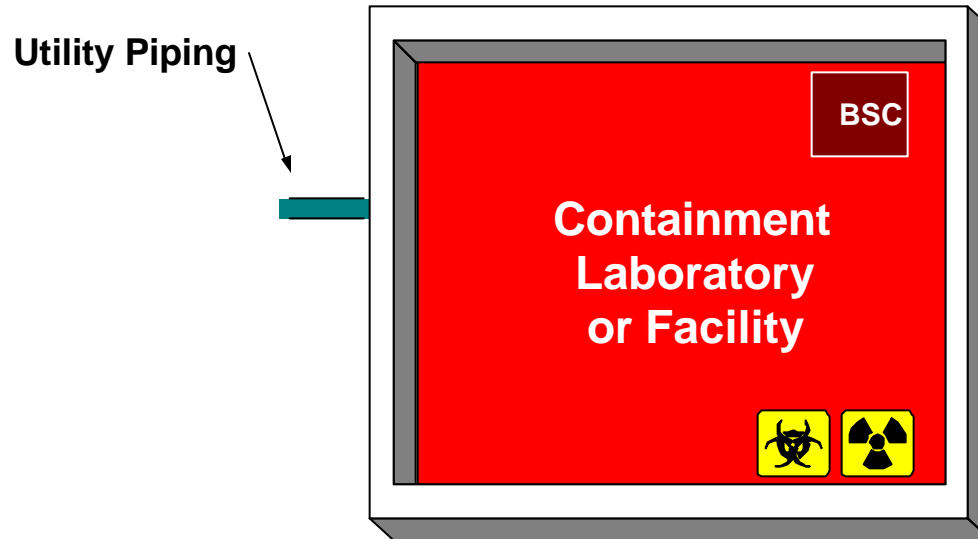
Containment Barriers

Lighting Fixture



Containment Barriers

Utility Piping



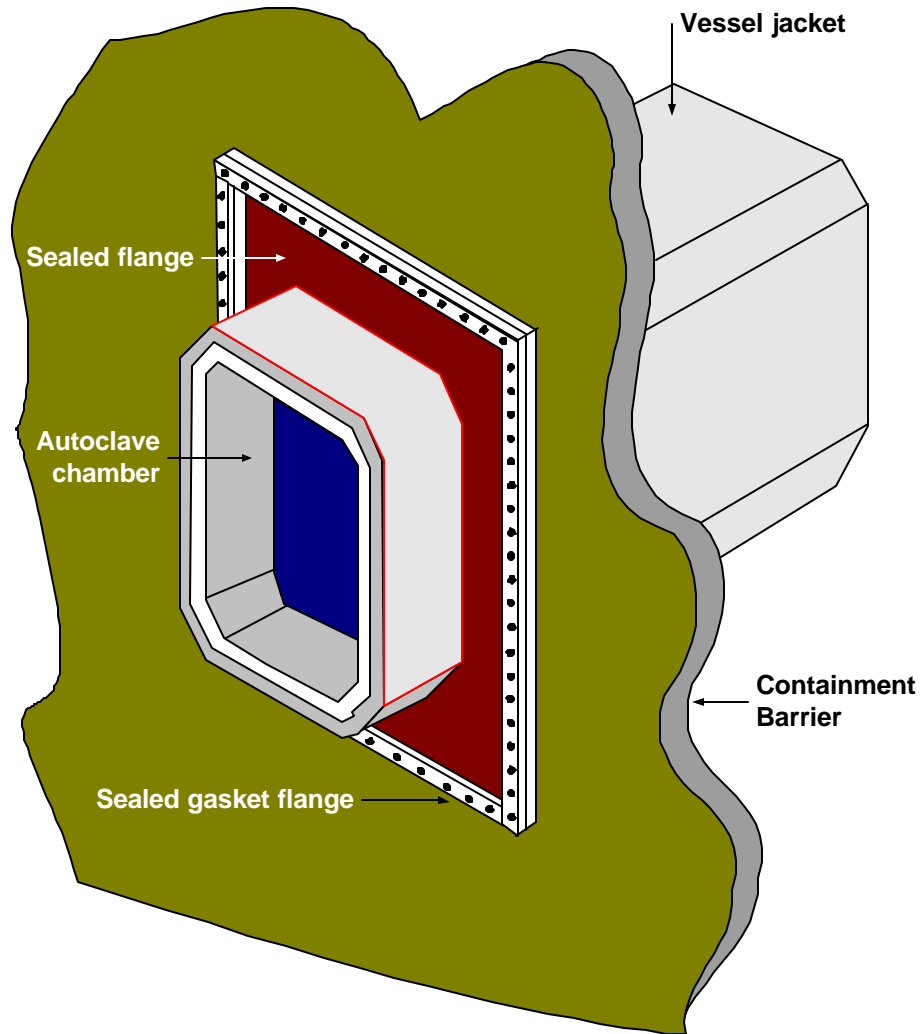


Containment Barriers

Utility Piping

Containment Barriers

Pass-through Equipment



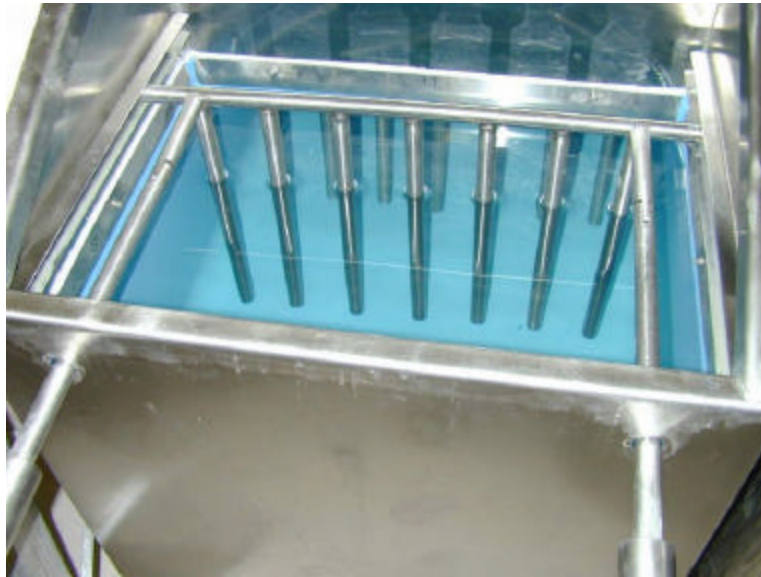
Containment Barriers

Pass-through Equipment



Containment Barriers

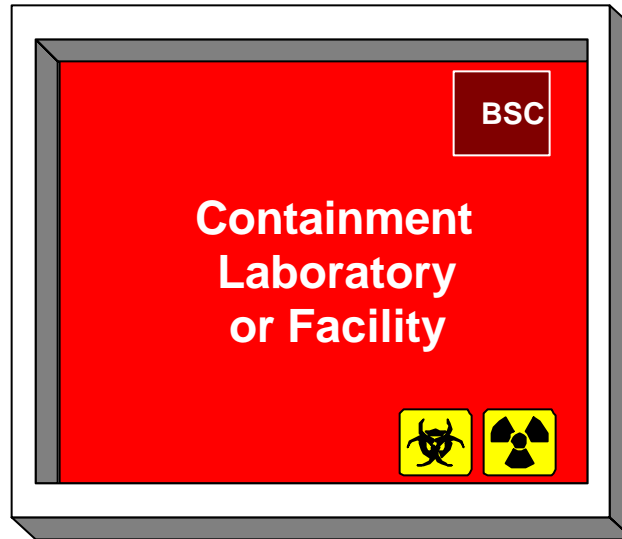
Pass-through Equipment





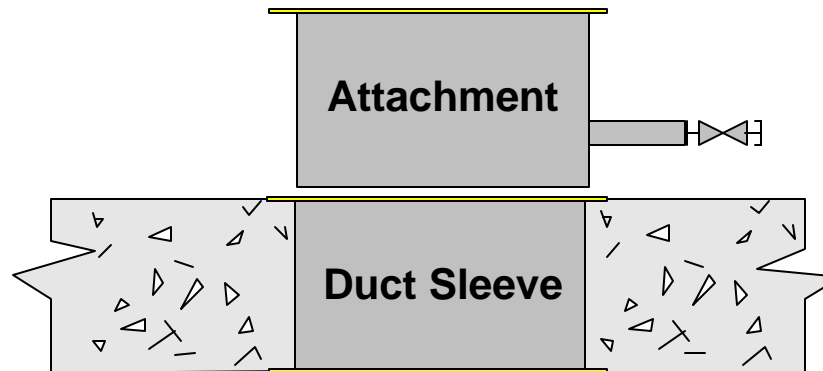
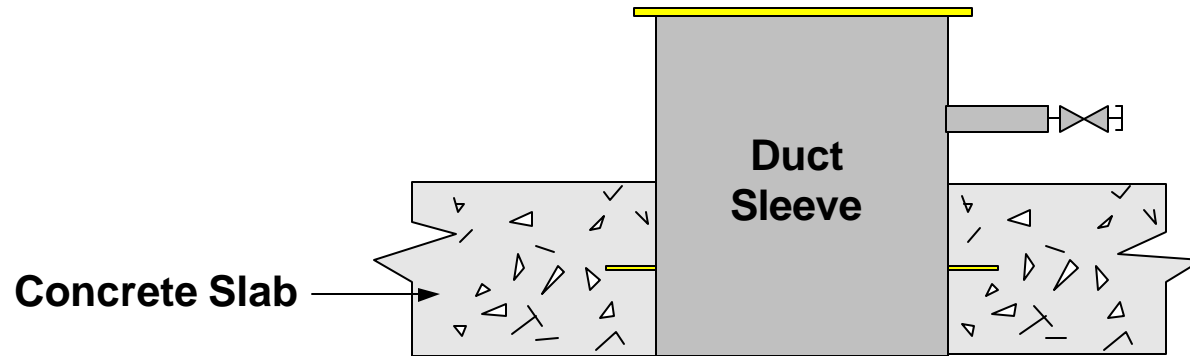
Containment Barriers

Air Ducts and Filters



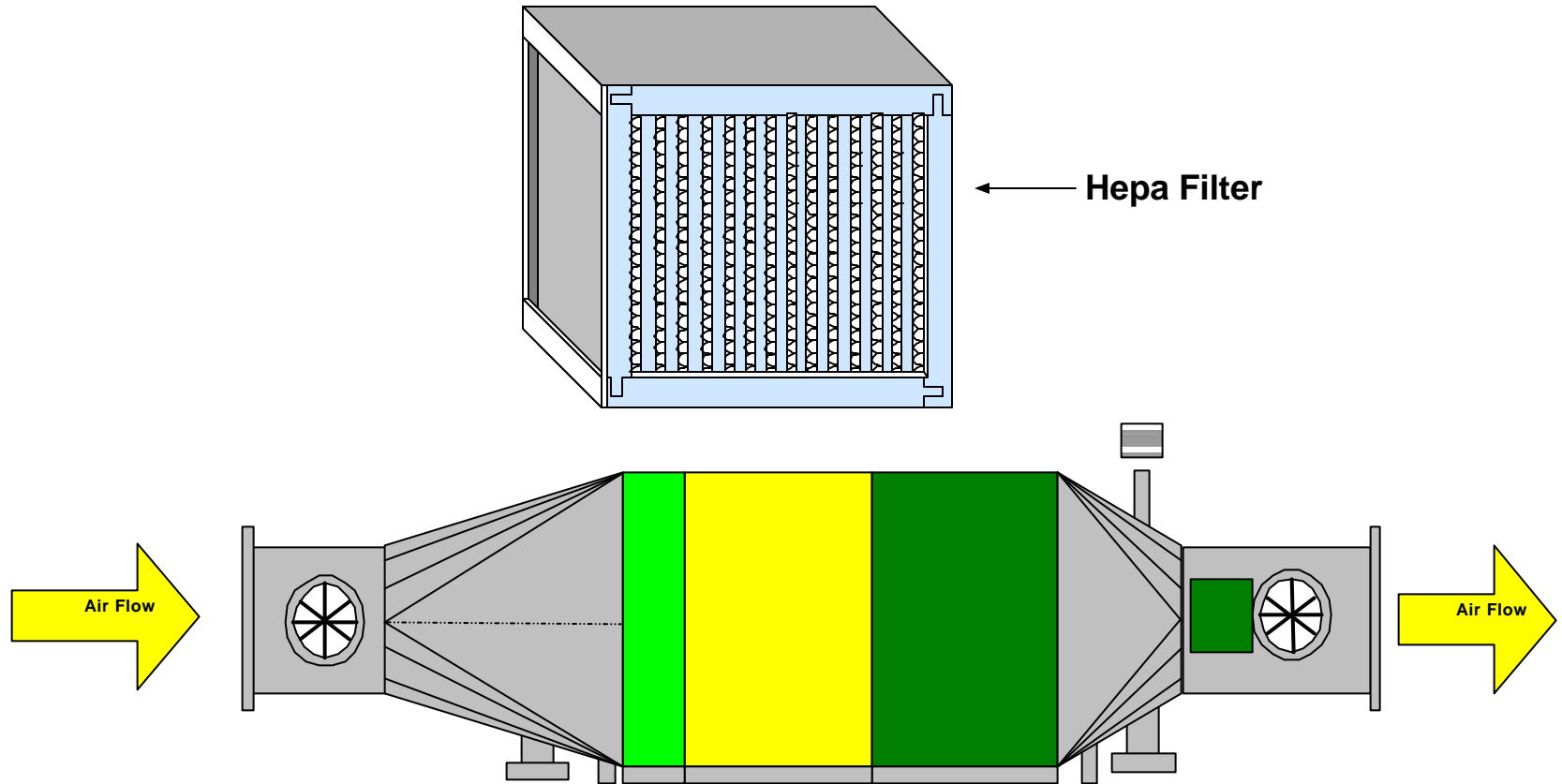
Containment Barriers

Air Ducts



Containment Barriers

Air Filters and Housing



Containment Barriers

Air Filters and Housing



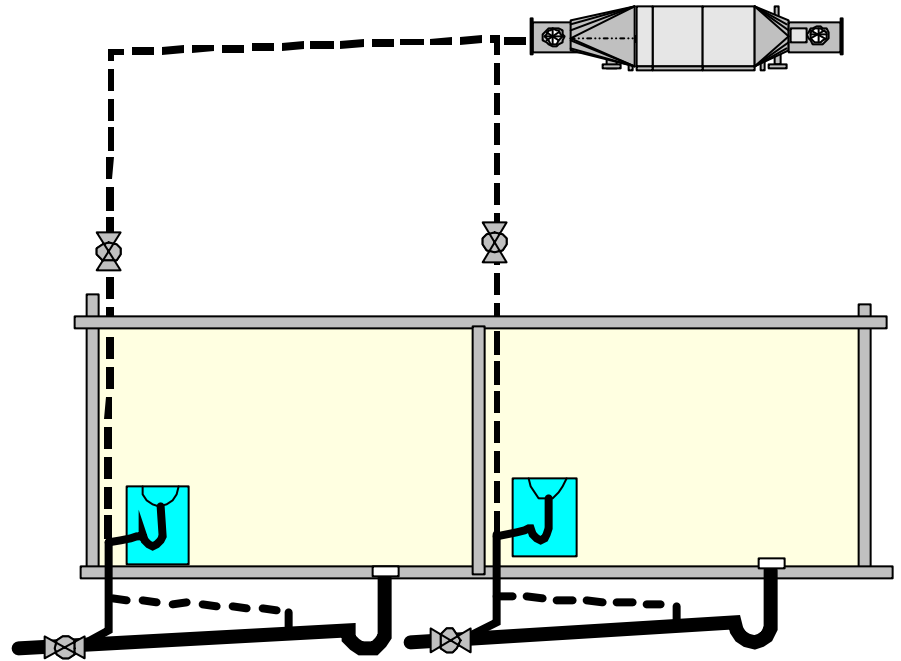
Containment Barriers

Air Filters and Housing



Containment Barriers

Air Filters and Housing



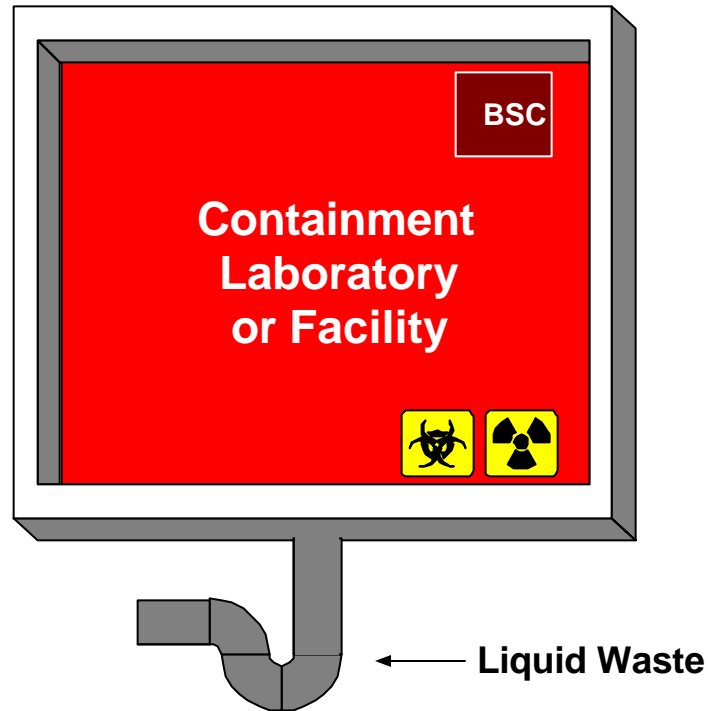
Containment Barriers

Air Filters and Housing



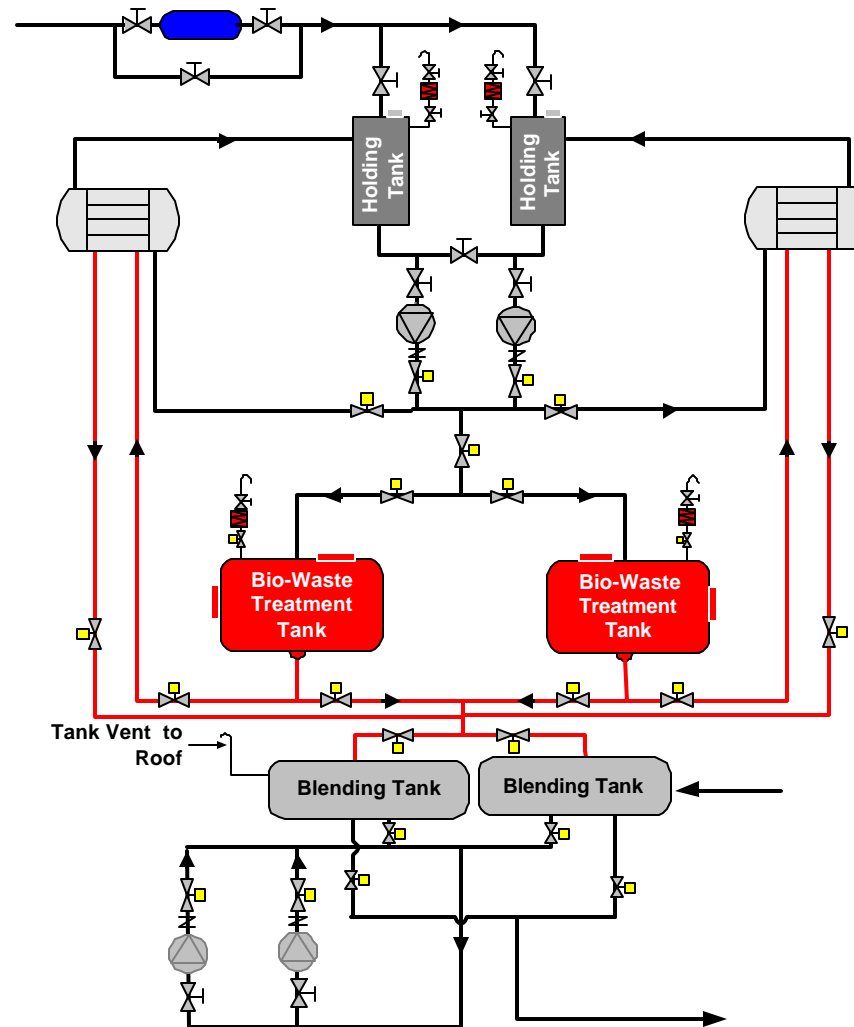
Containment Barriers

Liquid Waste



Containment Barriers

Liquid Waste Piping Schematic



Containment Barriers

Liquid Waste without Steam Agitation



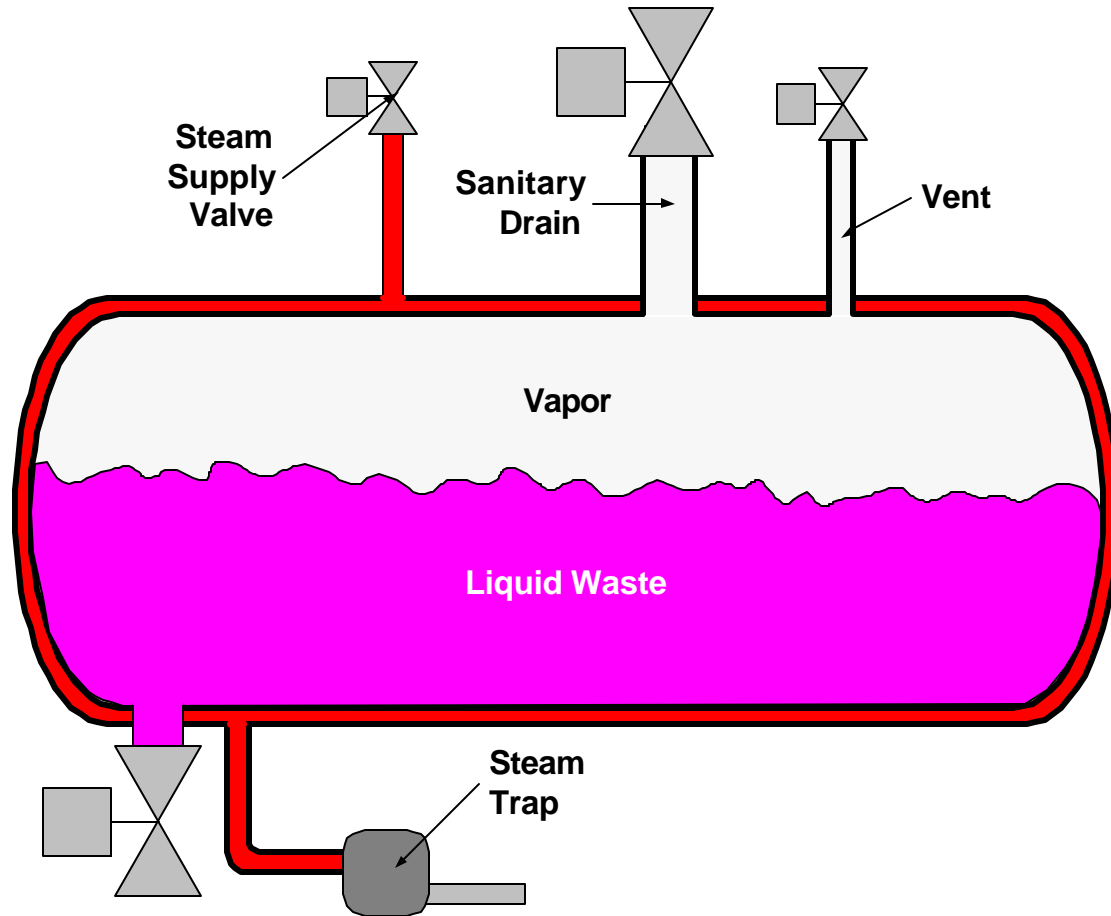
Containment Barriers

Liquid Waste without Steam Agitation



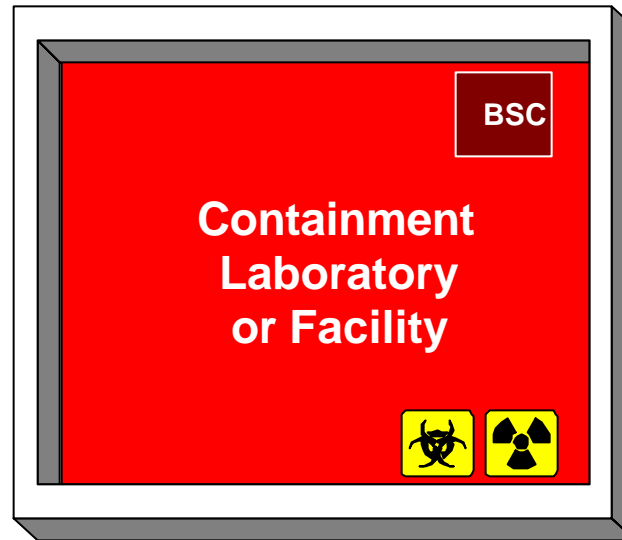
Containment Barriers

Liquid Waste without Agitation



Containment Barriers

Animal Carcass or Solid Wastes

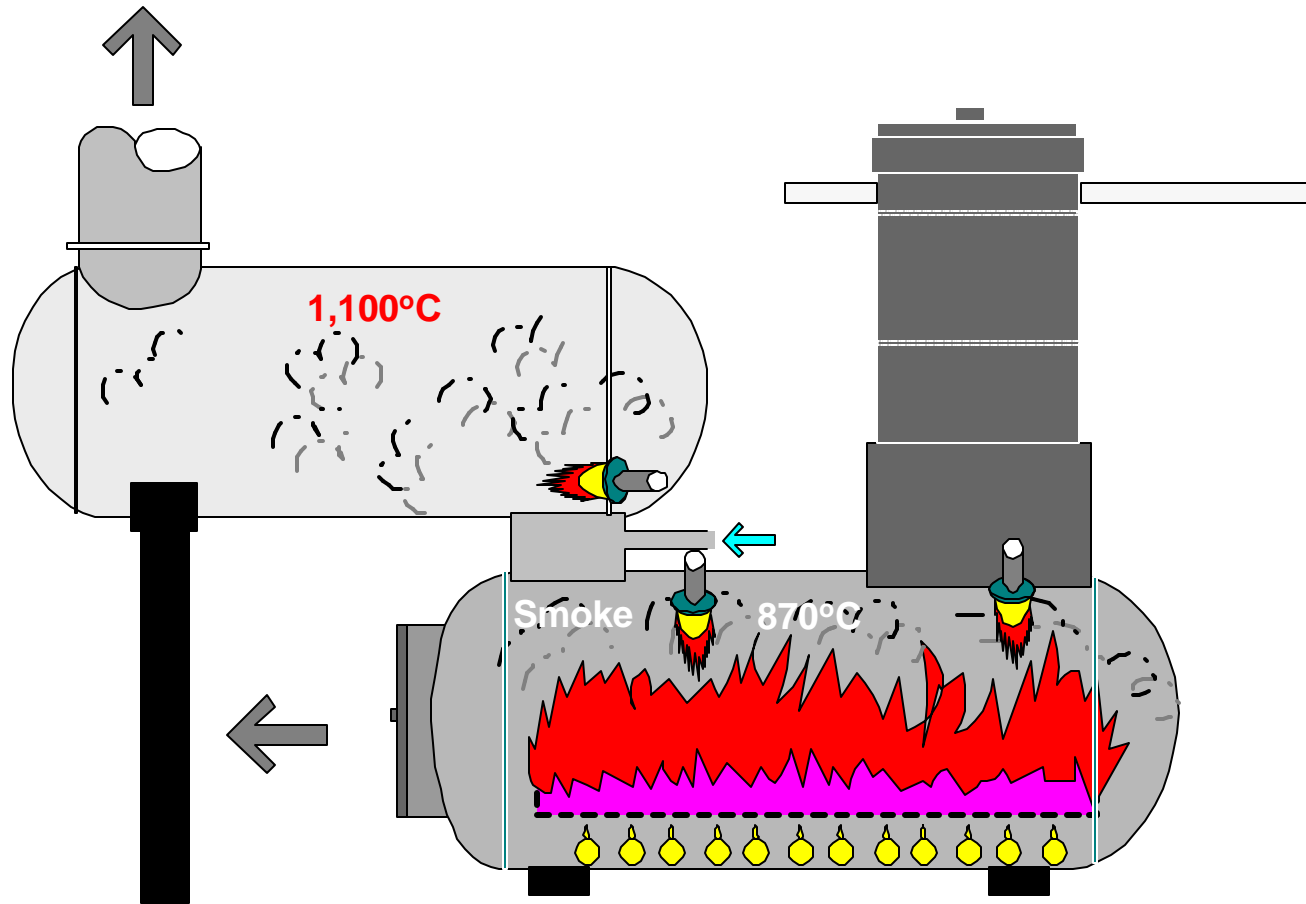


Animal Carcass →



Containment Barriers

Biowaste or Pathological Incinerator



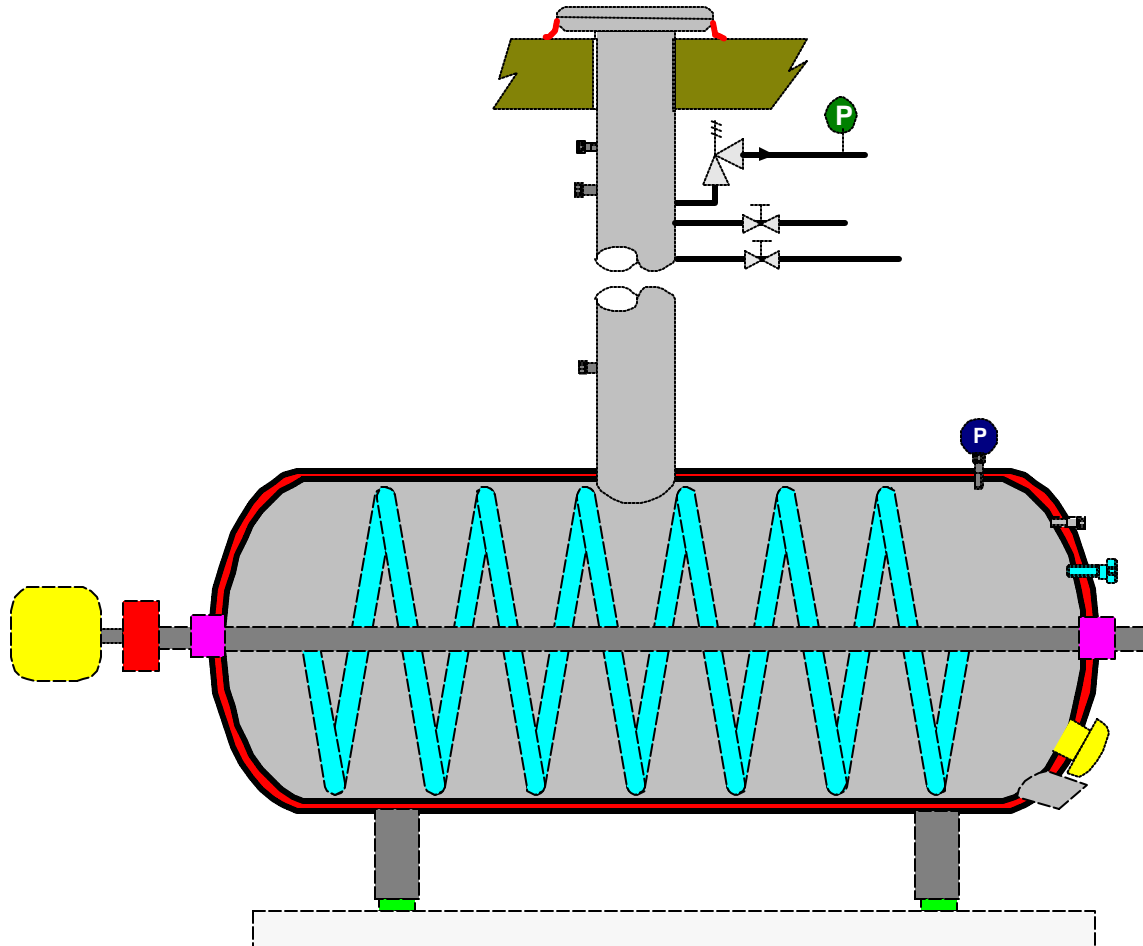
Containment Barriers

Biowaste or Pathological Incinerator



Containment Barriers

Solid Waste Rendering Tank



Containment Barriers

Solid Waste Rendering Tank – Alkaline Hydrolysis



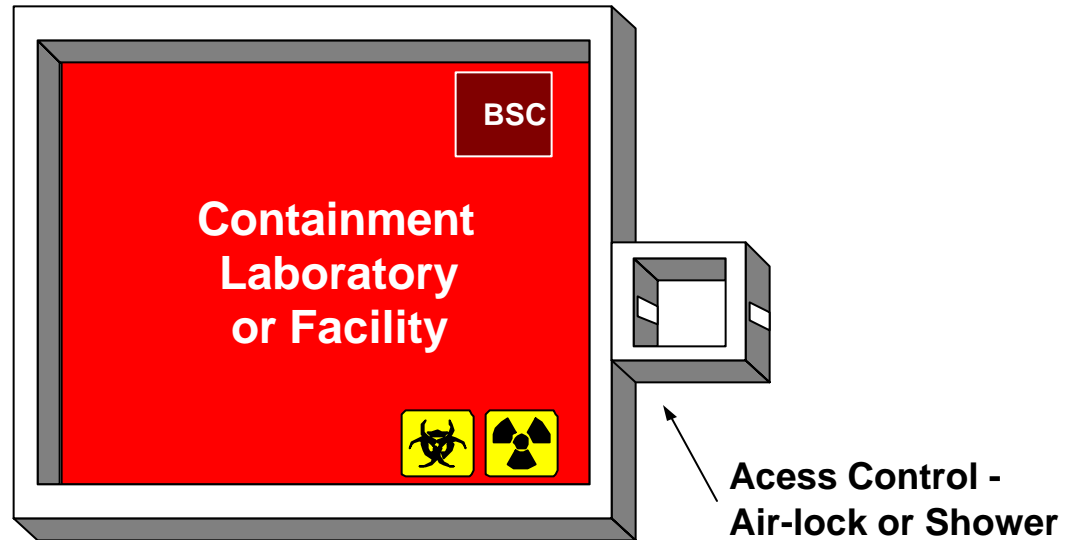
Containment Barriers

Solid Waste Rendering Tank – Alkaline Hydrolysis



Containment Barriers

Air Lock or Shower or Change Room



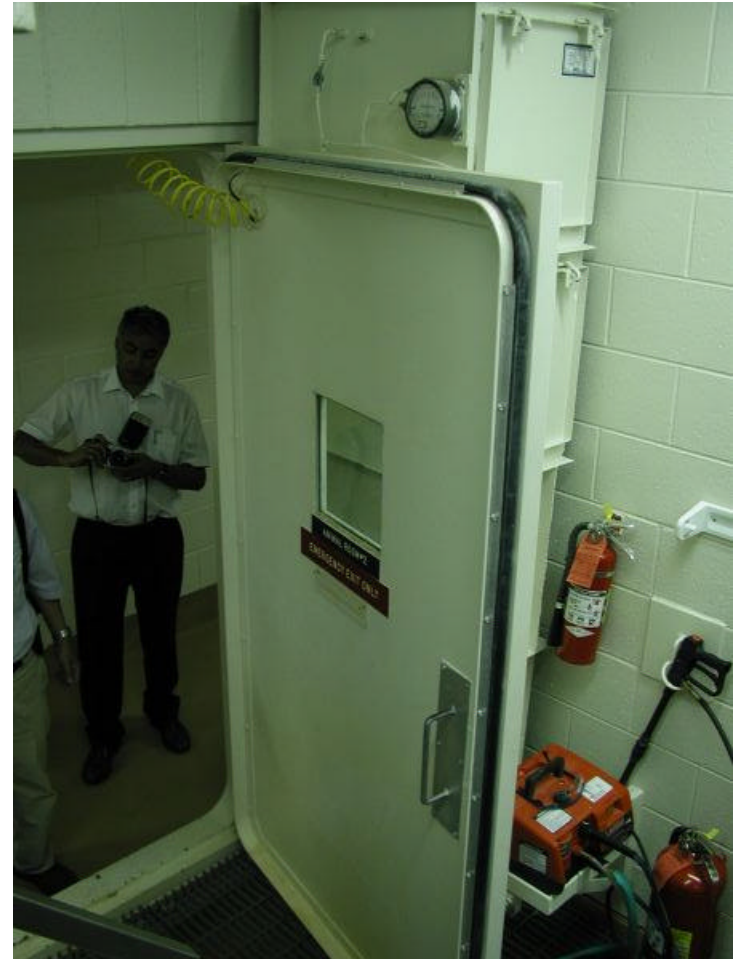
Containment Barriers

Air-tight Doors – Gasket Inflated and Mechanical



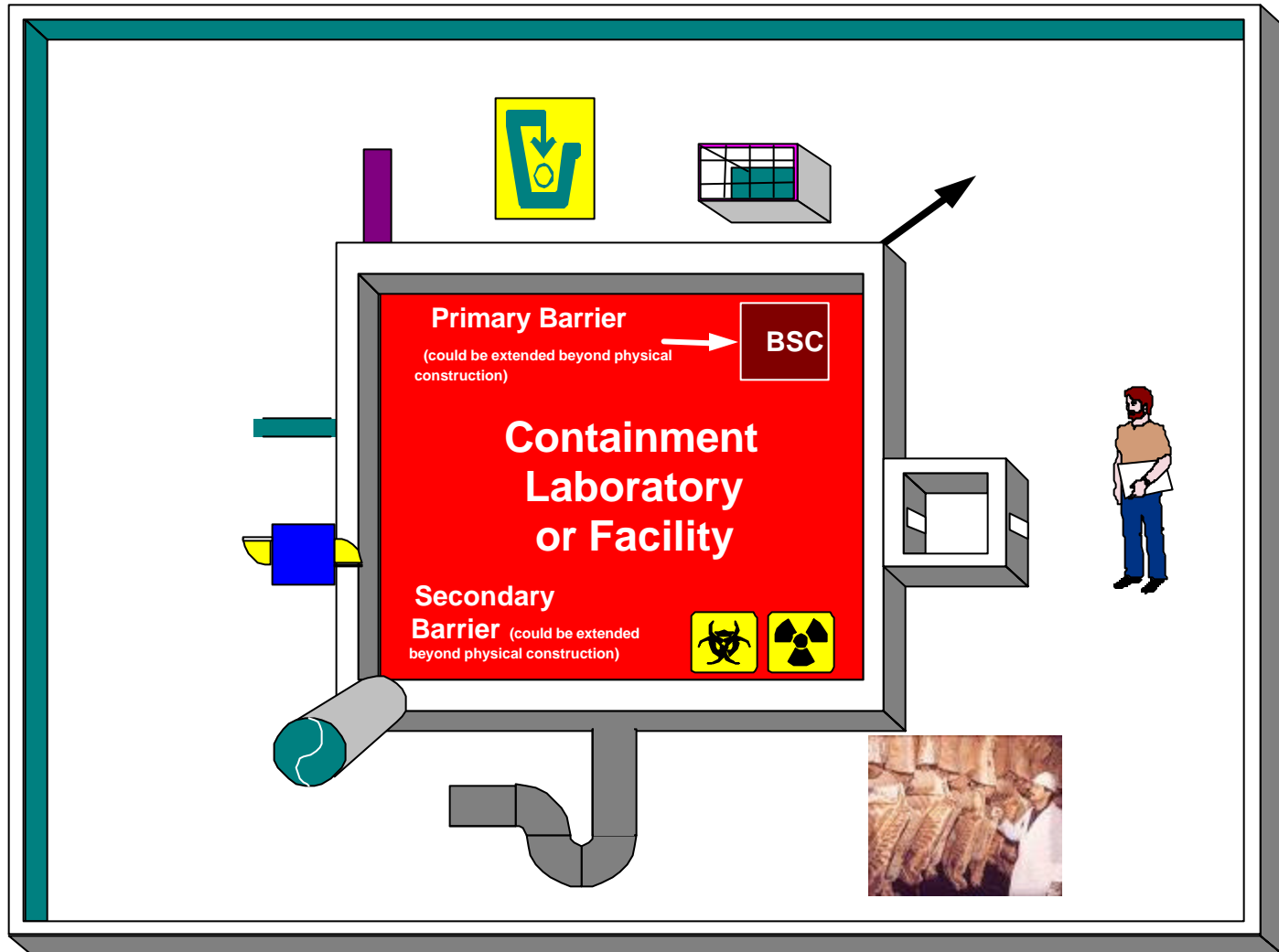
Containment Barriers

Air-tight Doors – Gasket Inflated and Mechanical

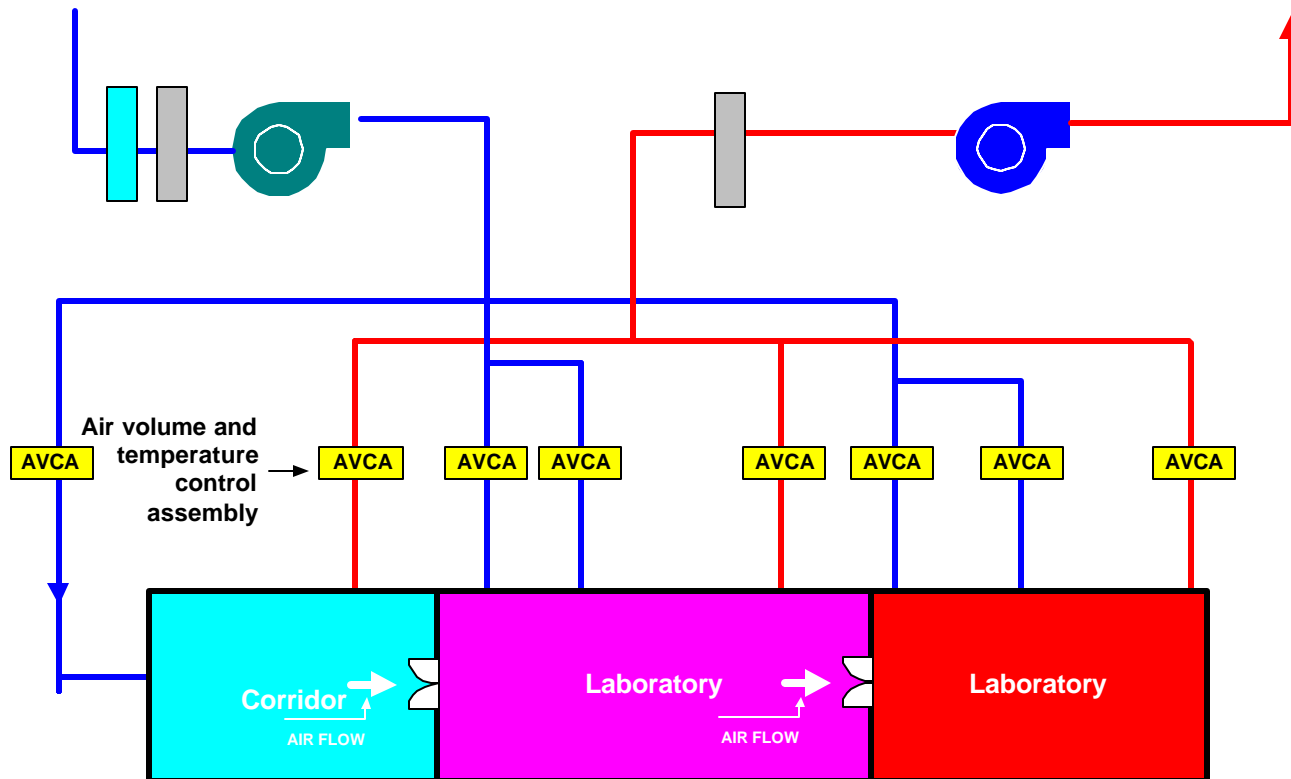


Containment Barriers

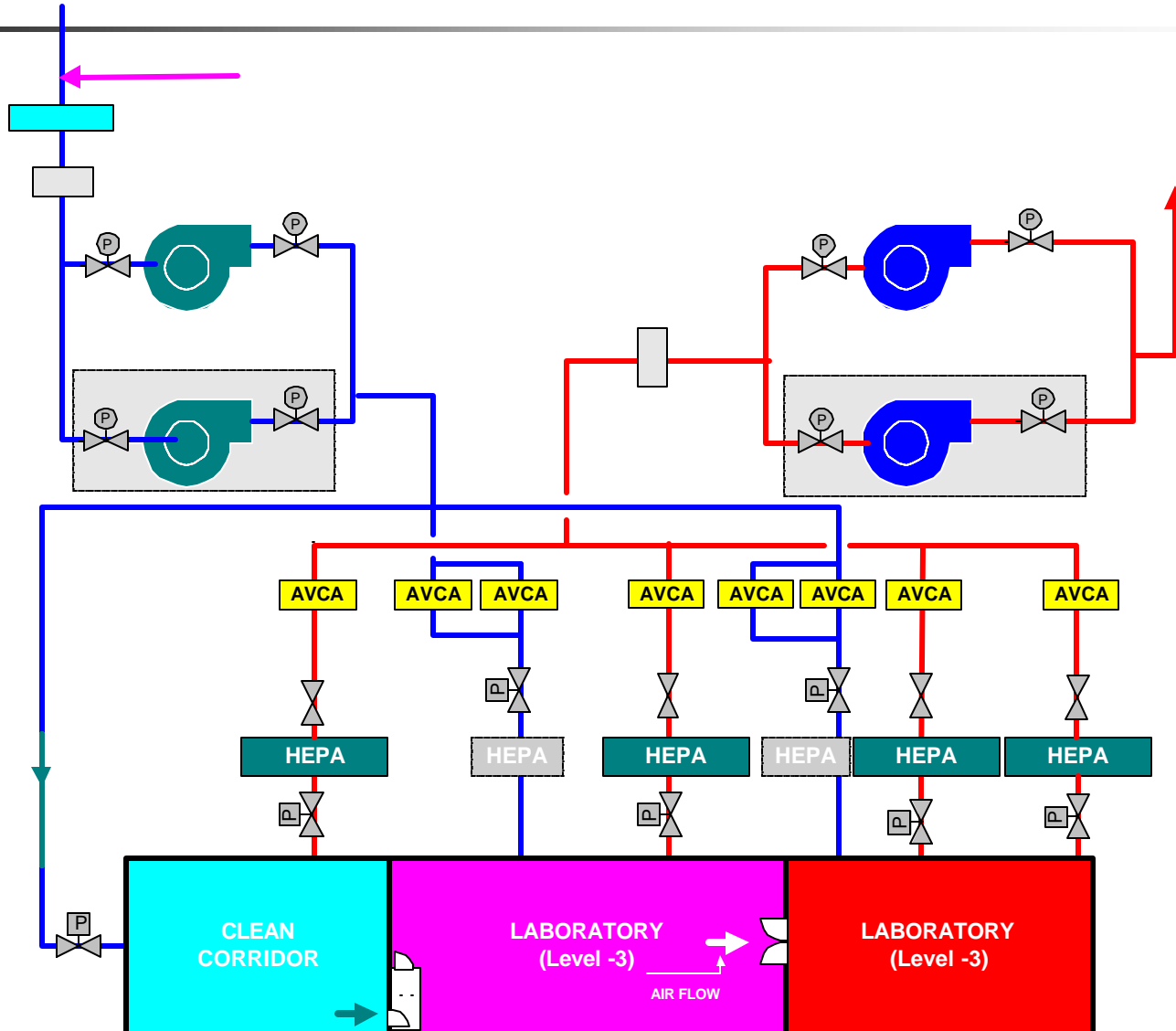
Tertiary Barrier



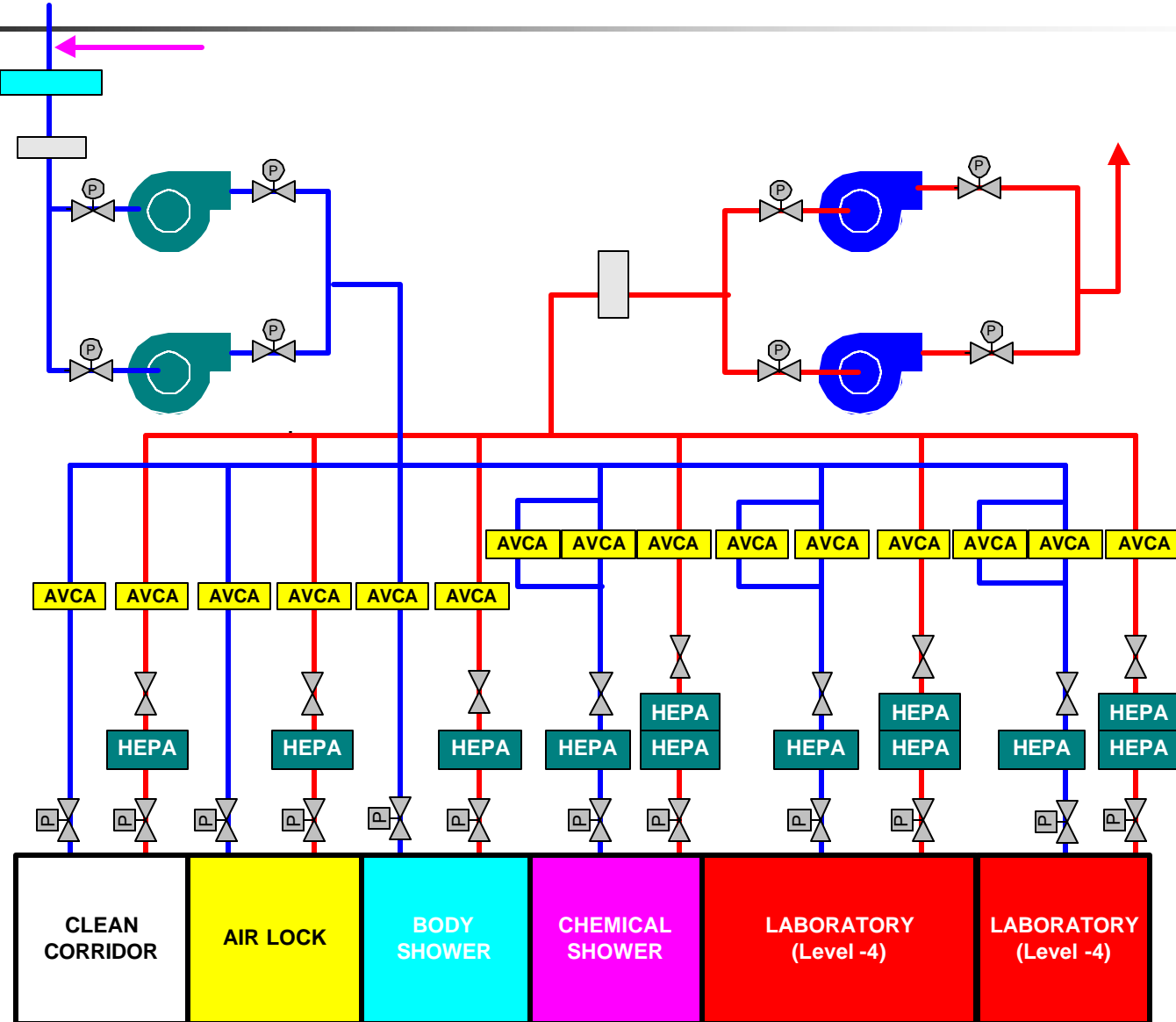
BL- 1/2 - Ventilation



BL- 3 - Ventilation



BL-4 - Ventilation





Design Considerations

Operation Protocols

Equipment Operation

Simplicity

Directional Air Flow

Pressure Differentials

**Constant Building Pressure
Reference**

**Number of Penetration through
Barrier**



Design Considerations

Redundancy

Monitoring

Decontamination

Liquid

Gases

Compatibility of Materials

**Sterilization of Liquid and Solid
Wastes**



Design Considerations

Indoor Environment

Equipment Performance

Emergency

**System Operation in Response to
Power Failure, Alarm,
Malfunction of Components
Pressure Decay**



Commissioning

Commissioning is a quality assurance process:

Provides a framework for a systematic, documented, collaborative, and a logical procedure in conducting inspection, testing, and verifying:

System components

Sub-system

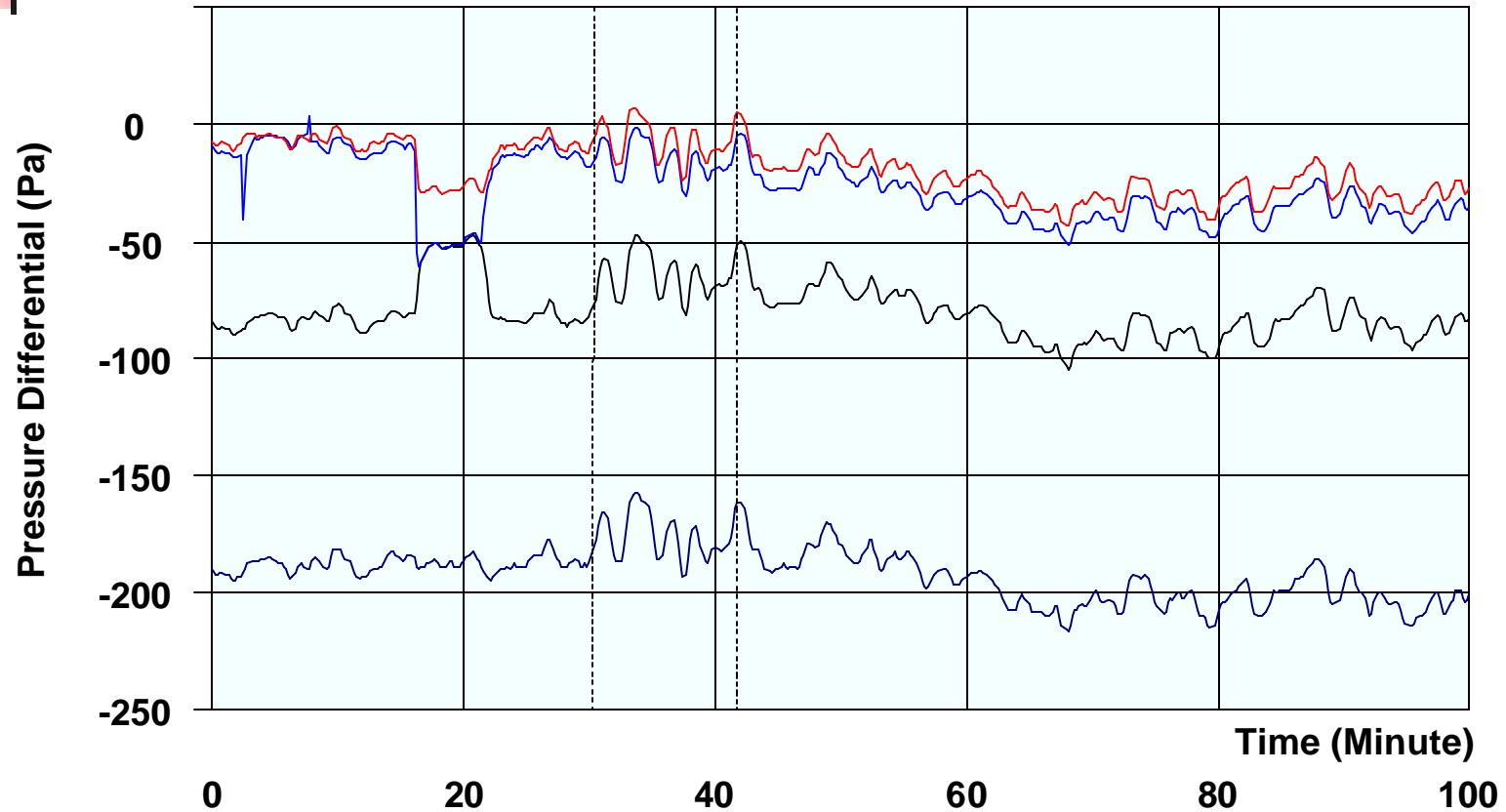
Integrated system performance



Commissioning

1.2.3. CEILINGS: Verify by visual inspection that the ceilings are constructed of reinforced steel frame and gypsum, filler primer and paint finish to prevent release of agent into any adjacent spaces.	Project Manager	YES/NO/NA
1.2.4. FLOORS: Verify by visual inspection that the floors are monolithic and slip-resistant and the continuity of seal is maintained between the floor and wall (a continuous cove floor finish up the wall is required).	Project Manager	YES/NO/NA
1.2.5. JOINTS AND SEAMS: Verify by visual inspection that joints and seams are permanently sealed to prevent passage of air and liquid and that all joints between fixed cabinetry and the floor or wall are smooth coved and sealed to ensure joints and seams can be easily and effectively cleaned.	Project Manager	YES/NO/NA
1.2.6. PENETRATIONS: Verify by visual inspection that all penetrations into the BSL3 are sealed with a smooth finish or non-shrinking sealant at the BSL3 Containment barrier (or capable of being sealed) to facilitate decontamination and cleaning and to assure isolation of the BSL3 Containment (e.g., light fixtures, fire sprinklers, electrical and telecommunication conduits, water and utility lines, HVAC ductwork, utility access panels, condensate return lines, air supply lines, etc.)	Project Manager	YES/NO/NA
1.2.7. INTERIOR SURFACES, COATINGS, AND FINISHES: Verify by visual inspection that the interior surfaces, coatings, and finishes are smooth, continuous, impermeable to liquids, detergents, disinfectants, and decontamination gases normally used in the laboratory.	Project Manager	YES/NO/NA

Commissioning





Operation and Maintenance

Distribution - Interstitial Space

**Decontamination and
Certification of Equipment**

**Accessibility of Ductwork and
Piping, Equipment**

Isolation of Piping and Ductwork

**Location of HVAC Equipment
Outside Lab Space**

Minimum Number for Floor Drain



Guidelines and References

**CDC-NIH – Microbiological and
Biomedical Laboratories**

**Health Canada – Laboratory
Biosafety Guidelines**

**CFIA – Containment Standards
for Veterinary Facilities**

**World Health Organization –
Laboratory Safety Manual**