Design and Construction of Biocontainment Laboratories

Sustainability

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3 December 2009
No instant solution, cannot be copied project to project
Guiding principles developed to inform each project
Perspective

- EU Legislation
- Funding
- Economic Drivers
- Containment Requirements

‘Nearly’ Zero energy standards by 2018

Carbon Neutral Buildings
Design and Construction of Biocontainment Laboratories

Sustainability

Energy Use in kWh/m² Per Year

Medical / Bioscience (w/ Secure Facility): 245 kWh/m²
Medical / Bioscience (w/o Secure Facility): 139 kWh/m²
Chemical Science: 404 kWh/m²
Physical Engineering: 71 kWh/m²
Office: 15 kWh/m²

Note: Lab Energy Use Benchmarks provided by HEEPI; Office Benchmark from Energy Consumption Guide 19 (Both are based on Good Practice)
Carbon Neutral?

Paul Anastas and John Warner publish 12 Principles of Green Chemistry

1998

11 years

2009

ISTR Conference “Green but Safe”

Design Begins of First Zero Carbon Chemistry Lab

2015

3.5 years

2019

Zero Carbon Legislation Implemented
Currently Research funding allocated vs Research

Future ? Research funding allocated vs Efficient Research

• Efficient use of laboratory resources, energy efficiency

• Materials and equipment economies
Economic Drivers

No overlap of research

Integrated scientific community

Truly worldwide research strategies for novel paradigms

International communication and planning
Laboratory Functions

To protect occupier/environment and community from hazards

Provide appropriate research environment to produce valid and repeatable results

The principles remain the same only the technology and its application differs
Design and Construction of Biocontainment Laboratories

Sustainability

Topics
- Management
- Waste
- Energy
- Environment
- Materials
- Goals
Topics

Management

Design of facilities

- Long term view
- Challenge the ‘norm’
- Flexible space

If science becomes more technology driven and specialised will the need for flexibility decrease?
Operation of Building

- Maximise use
- Optimise space usage in containment
  - Right size equipment (MBSC’s, isolators etc)
- Challenge SOP ‘s and protocols to keep them updated
Operation of Systems

- Quality systems and controls
  - Night time setbacks
  - MBSC’s shut down over night
- Regular maintenance
- Develop condition monitoring strategies
- Simplicity vs Complexity

Fig 6: Condition monitoring strategy
Consumables

- Reusable vs Single use

Gowning, lab consumables, animal caging

<table>
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Decontamination

- **Autoclaves**
  - Use recirculatory systems (cooled with heat exchanger from building process cooling systems) for jacket cooling
  - No cooling to chamber waste discharged to effluent treatment plant (pipework material?)

- **Effluent Treatment plants**
  - Batch plants vs dedicated Continuous flow Technology
  - Optimise heat / sterilisation requirements (virus dependant vs one temperature kills all)
  - Energy recovery wherever possible (Air cooling possible on smaller units)

- **Water usage generally**
  - Use low flow systems wherever possible (design toilets out of containment wherever possible)
  - For dress in shower out facilities the concept and design may help reduce the number of showers required
### Energy

- **Air change rates**
  - Minimise air change rates where possible
  - Challenge to get rates down to say 6-8 changes per hour

- **Room conditions**
  - Look to use room cooling (fan coil units) rather than using air change rates to cool equipment rooms

- **Once through vs Recirculatory**
  - Look at options to use % of make up air from office areas as part of laboratory once through air system (less energy to heat air to laboratory)

- **Lighting**
  - **Day Lighting**
    - Best passive design
    - Light tubes
    - Light louver
  - **Low Energy**
    - Fluorescent
    - LED
    - Fiber optic solar
    - Task lighting
  - **Controllability**
    - No lights on during daytime
    - No light at night
  - **Light Tube**
Working Environment

- **Visibility**
  - Use vision panels for safety, amenity and bio security in all containment laboratories

- **Natural light**
  - Use external windows to create a good working environment wherever possible

- **Controllable systems**
  - Areas with good heating and air quality controls will provide a greater degree of user comfort
Balance of Contained vs. Non Contained

- **Working environment**
  - Can the work be undertaken in an isolator which provides the containment requirements and reduces energy usage for the surrounding areas

- **Working procedures**
  - Do as much work out of containment as possible. This may make more work but may also may provide overall savings in energy

- **Decontamination**
  - Limit decontamination by considering lab design, protocols, working practices and scientific procedures
  - Use the process as batch where possible (decontamination out of containment)
  - Use ‘right sized’ decontamination units (decon equipment in room may remove need for large decontamination unit/lobby)
  - Use ‘environmentally friendly’ criteria where possible
Embodied Energy

- Careful choice of materials (e.g., concrete vs. lightweight systems)
  - Consider whole life requirements of facility including re-use
- Materials
  Typical criteria
  - Recycled and recyclable
  - Local heavy materials
  - Low embodied energy
  - Re-purposed materials
  - Innovative material reuse

Additional containment criteria
- Able to withstand chemical decontamination
- Provides a suitable smooth finish to create a containment barrier with required air leakage rate criteria
- Easily cleanable
¶ Maximise use of daylight, lighting controls and efficiency

¶ Design to limit systems and their complexity

¶ Use energy efficient equipment and maximise controllability

¶ Use onsite renewable energy where possible

¶ Minimise use of energy for heating / cooling

¶ Define use of all materials for the building, systems and consumables against agreed site related sustainable criteria
There are many ‘myths and legends’ relating to containment design. Challenge the assumptions you may be given with, evidence, common sense and a good risk assessment.

During the life of a building almost everything will fail, think through how the facility will operate safely during times of failure.

Engineers and Architects like to reinvent the world and make things as complex as possible. Complexity is difficult to design, build and maintain. Work hard to keep your facility as simple as possible.