Cleanroom Design for Housing Isolators and Modular Cleanrooms

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Introduction to Cleanroom Design & Isolators

Cleanrooms must adhere to three principles simultaneously:

- They must be compliant
- They must be safe
- They must be financially viable

The new Annex 1 has this to say about isolators:

4.3 Restricted Access Barrier Systems (RABS) or isolators are beneficial in assuring required conditions and minimizing microbial contamination associated with direct human interventions in the critical zone. Their use should be considered in the CCS. Any alternative approaches to the use of RABS or isolators should be justified.

The compliance and safety benefits of RABS and Isolators are substantial.

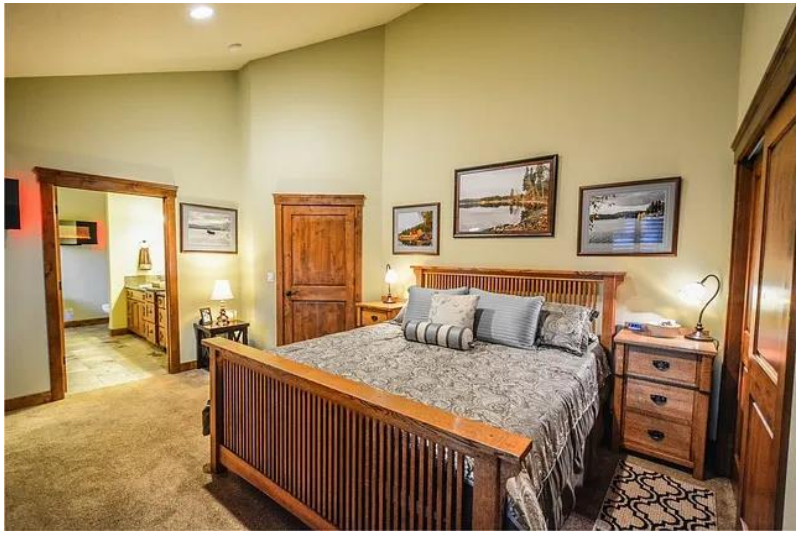
The financial implications are also substantial.

Terminology

This is a cleanroom

It is quantifiably assessed through the normative procedure in Annex A of AS ISO 14644-1 : 2017

This is a clean room



It is qualifiedly assessed by your mum

Layouts

General

- Layouts are primarily driven by how separate work centres of a facility must interact.
- Then it is a matter of mapping the flows of:
  - Personnel
  - Materials
  - Waste
- Decisions are driven by risks of:
  - Contamination & Cross Contamination
  - Mix-ups
  - Efficiency
  - Change

Materials and Personnel - Unidirectional or Bi-directional Flow?

- There are obvious benefits to unidirectional flow.
- Whether it is particularly necessary should depend on whether activity is ‘transactional’ or not. This means:
  - Work is done in ‘blocks’ of activity, or
  - There is a constant flows of personnel, materials and waste in and out
- If the facility is handling multiple products, this may also influence the decision.
- The level of containment of the process will also have an influence. Isolators will help this decision.

Classification

Fundamental Considerations

If operating a Grade A space, your background classification is **expected** to be:

- Grade B for:
  - Open cabinets
  - Open and closed RABS
  - Negative pressure isolators
  - Positive pressure isolators **without** validated decontamination step
- Grade C or D for:
  - Positive pressure isolators **with** validated decontamination step
  - Note bioburden difference between C & D

Classification Cascades

- New Annex 1 (PE009-17)
  - Personnel: "Airlocks of increasing cleanliness"… **"(e.g from the grade D area to the grade C area to the grade B area)".**

    For exit – no advice, but integrity of room you are leaving must be maintained.
  - Materials: focus on how materials are handled and protected on their way to grade A, particularly through grade B.

Your methods here should be a particular focus of your Contamination Control Strategy.

Sizing

Personnel & Material Airlocks

- Final stage entry PALs
  - One person at a time - ideally
  - Particularly for grade B
- Exit PALs
  - There is little guidance, but activities require much less structure
    - De-gowning releases huge amounts of particles
    - Ensure protection of the room you left
- MALs
  - Don't size on the largest item of equipment you will ever be likely to need
  - Look more at regular movements. Often a pass thru or two will do.

Production Rooms

- Map your process as it moves through the room
- Circulation space should be reasonable, but not generous
- Personnel movement should be planned and deliberate, not chaotic
- Stand alone cabinets and isolators should be able to be moved for cleaning

Storage and Service Space

- Storage space is always underestimated
- Service space is always:
  - Underestimated if designed by the client
  - Overestimated if designed by the engineer

Environmental Controls

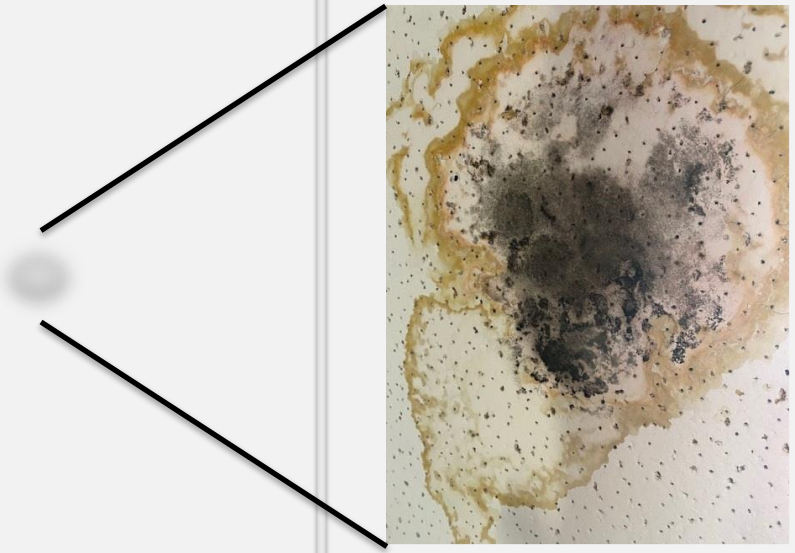
Room Pressure

- Room pressure is the number one problem I troubleshoot for new and existing facilities.
- Many contractors look at one point compliance, not long-term trend.
- “Leaky” (controlled) cleanrooms are more stable.
- Simple control (one element) or static HVAC systems are more reliable.
- VHP capable isolators require exhaust by-pass or thimble system during pressure testing.
- Use your full arsenal of cascade, bubble and sink airlocks to simplify pressure regimes.
- Bubble airlocks require special attention.

Temperature and Humidity

- Humidity is the number two problem I troubleshoot for new and existing facilities.
- For isolators, humidity inside is critical (sort of), outside not so much.
- Dehumidification:
  - Supply air pretreatment – common
  - Pre-cool / re-heat – sometimes
  - Desiccant wheel (etc) – specialist only
- Humidification:
  - Often installed, rarely used.
- Temperature:
  - Rarely a problem in rooms.
  - Sometimes a problem in isolators.

Details



Critical Services Management

Good Practices

- An independent EMS, that
  - Doesn't monitor everything
  - Gives operators the basics:
    - Proceed with confidence
    - Proceed with caution
    - Retreat!
- An independent BMS, that
  - Provides comprehensive information
  - Is well understood, and
  - Is secure

  Gives engineers the necessary information to solve problems

- All services should be able to be concealed within the wall – Builder Competency Test!
- Access panels, if absolutely necessary, should only be in less critical areas
- Low level returns. Everywhere, if possible
- Beware of spaces that are "airtight"
  - Airtight cleanrooms are difficult to control, pressure-wise
  - Spaces above cleanrooms should never be able to build up pressure

Modular & Portable Cleanrooms

Advantages

- Your cleanroom becomes an asset, like your autoclave or your isolator
- Ability to grow and relocate
- A standard template to expand the installation
- Can be used for a range of applications, not just cleanrooms
- Well suited to:
  - Start-up companies, clinical trials
  - Compounding industry, specialist hospital operations
  - Open access facilities, property groups, collaborative spaces

Words of Caution

- Meeting the building code
  - Must Australian Standards
  - If bringing in from overseas, work with a building certifier before placing an order
  - Meeting mechanical, hydraulic and electrical trade codes can be a problem
- Cost premium – 10 to >100%
- Space allocation
  - Sometimes difficult to work complex manufacturing to a grid
  - Circulation space can be a challenge
  - Unidirectional flow more challenging
- Access to the site (and out of the site)

Final Comments

Opportunities

- Comprehensive adoption of isolators is a positive step forward in patient safety
- Modular and portable cleanrooms provide a range of opportunities, particularly for start ups
- There are a range of suppliers across the world, that includes Australia

Challenges

- Are we sufficiently incentivised to move to isolators?
- Do we need to be importing cleanrooms?
- Are we getting better at building them here?
- Where are the gaps? How can we do better?

Thank You!

CBE Pure Solutions Modular designed Cleanrooms & Isolators

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