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Split Cleanroom Concept for Integration and Test of Satellites

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Agenda

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- Introduction
  - Description of the Facility
  - Purpose of using Split Concept
  - Description of the Concept
- Studies Performed
  - Particle Count Surveys
  - Airflow Check
- Performance Data
- Challenges
- Conclusion

Introduction

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- Facility Description
  - Large Highbay Facility designed/certified to ISO 14644-1 Class 8 (100K)
  - 76’ x 170’ x 30’, with approximately 15 air changes/hour
  - Previously used for high volume manufacturing of satellites
- Multiple concurrent programs coming online
  - Two contamination sensitive programs needed an integration area, current program was winding down
  - No good area to put all of the required EGSE/I&T Workstations
- Facility Split Concept
  - 100K side to be physically separated by a wall to allow the other program to finish its work
  - The other side would be converted to an ISO Class 7 (10K) cleanroom
    - Separate integration area protocols:
      - Full garments for work around the Spacecraft and Observatory.
      - Frocks for I&T Console Workstations.
      - Maintain our normal ISO 7 type protocols throughout
  - Managing garmenting protocol, clean hardware access, and head count is mandatory

Implementation of the Split Concept

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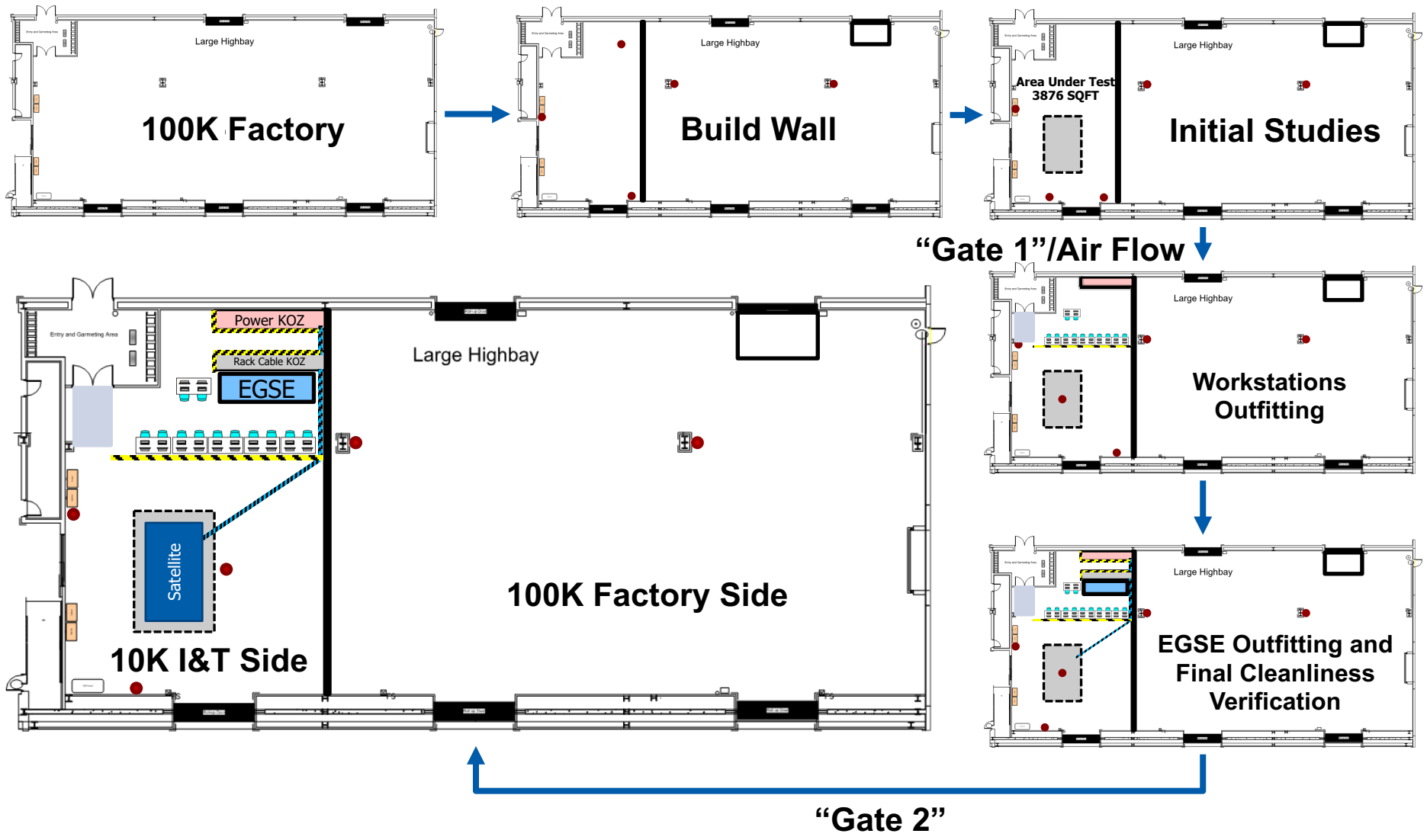
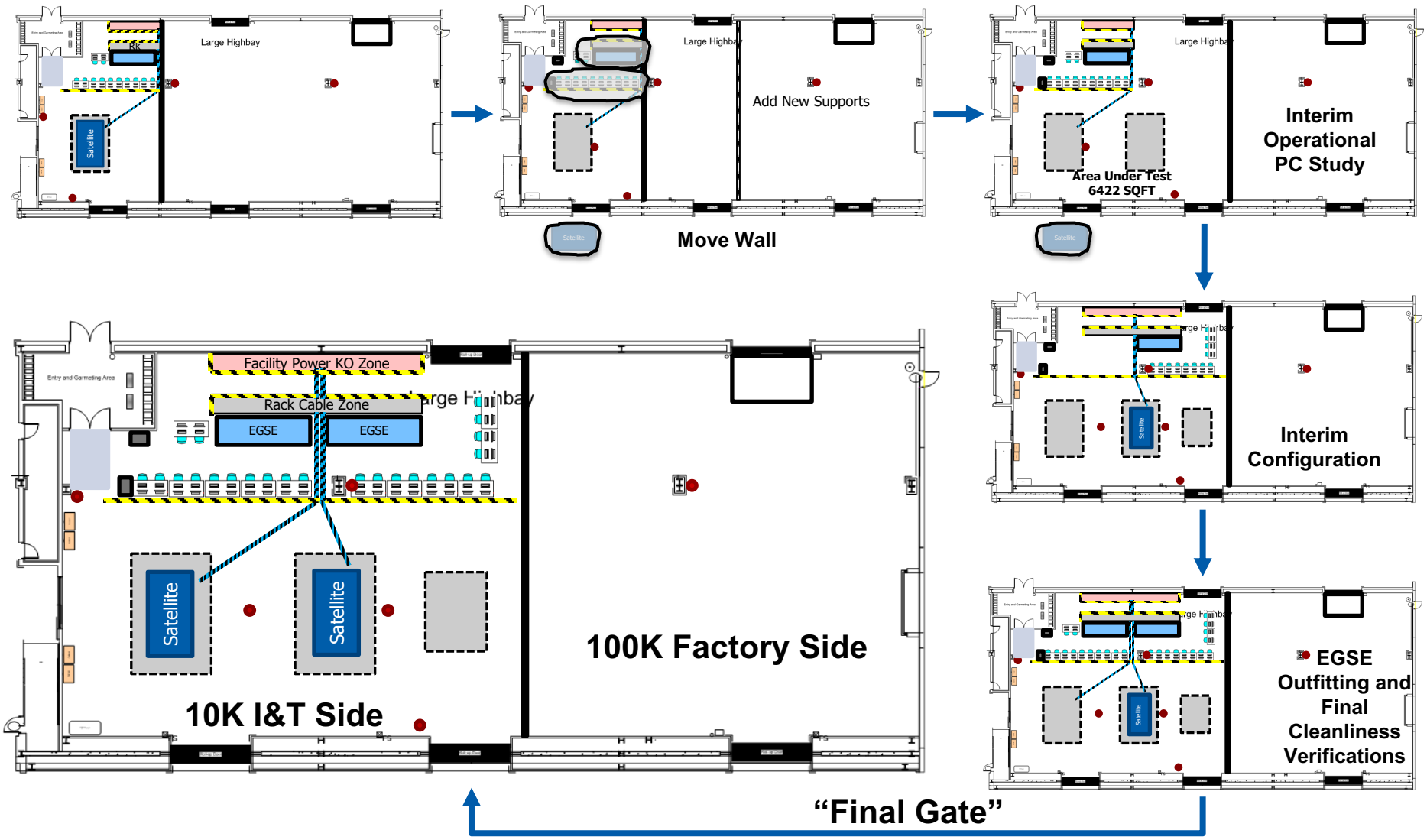
The implementation plan was split into two phases

- Only one of the contamination sensitive programs was ready to begin I&T
- The high volume factory program needed a transition period to wind completely down
- Phase I
  - Compress the factory footprint
  - Build the physical barrier
  - Clean the facility
  - Perform the concept cleanliness verifications
  - Outfit the room
  - Final cleanliness verification
  - Start the work
- Phase II
  - Compress the factory footprint further
  - Move the physical barrier
  - Clean the facility
  - Perform cleanliness verifications
  - Outfit the room
  - Final cleanliness verification
  - Start the work

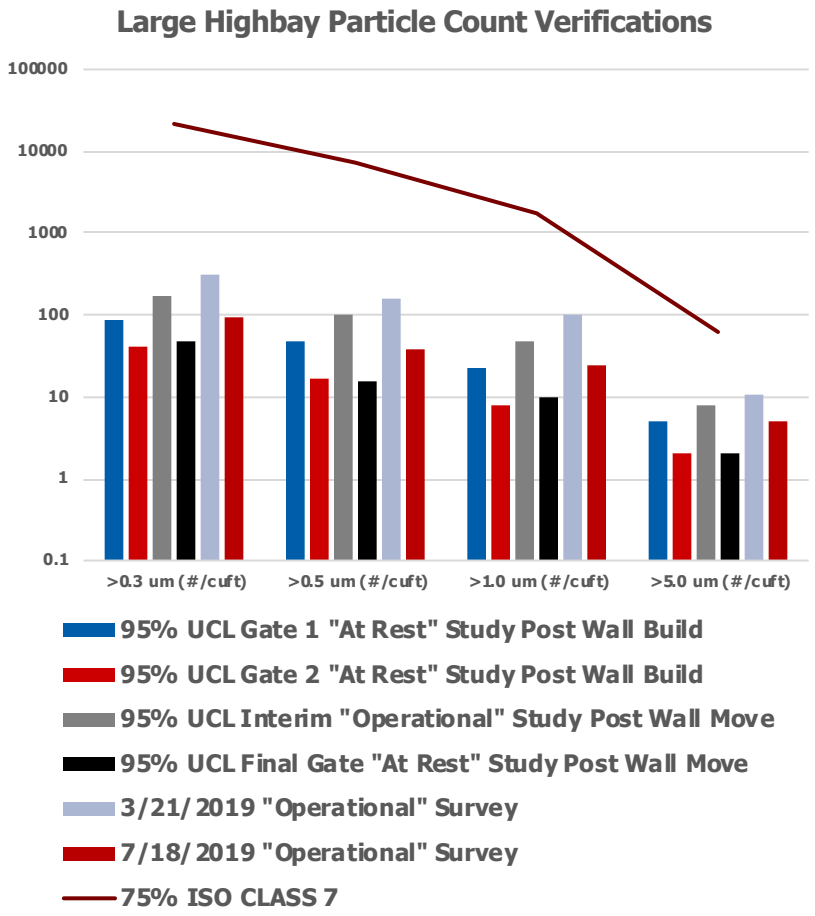
Phase I

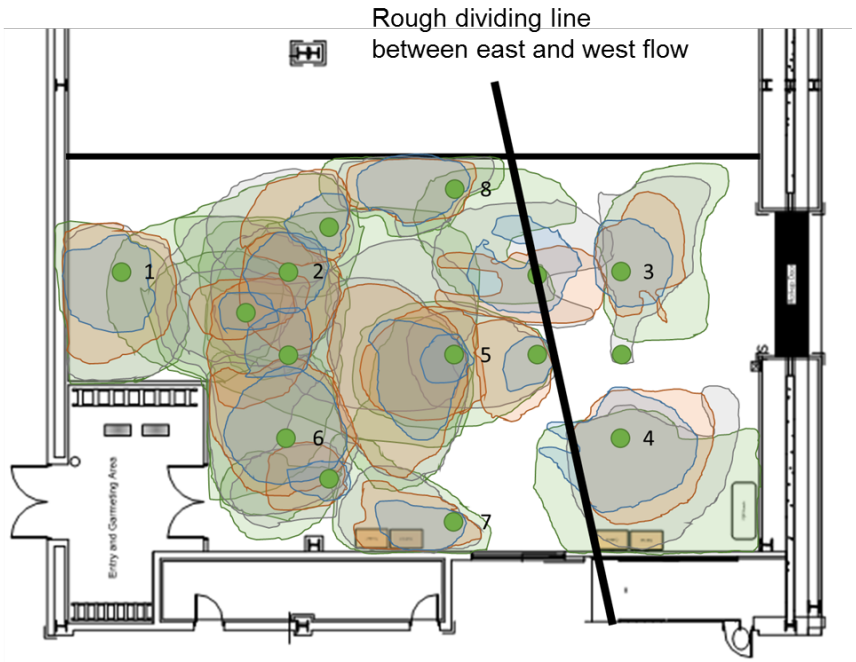


Phase II



Concept Verification Studies

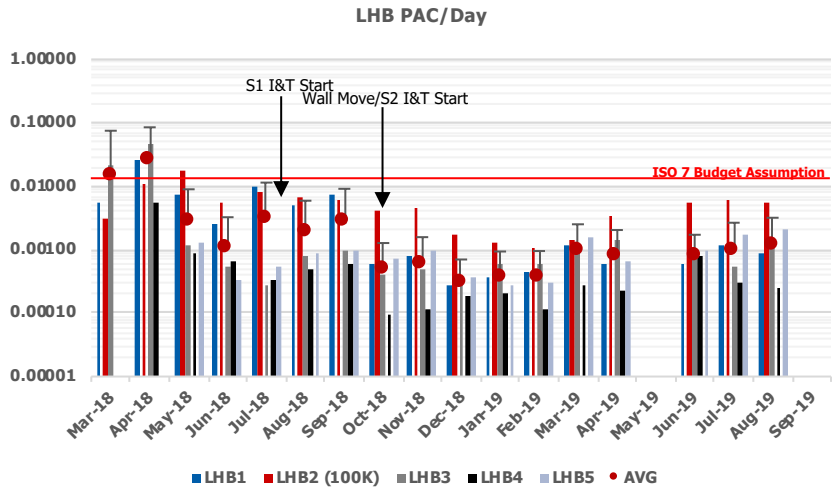


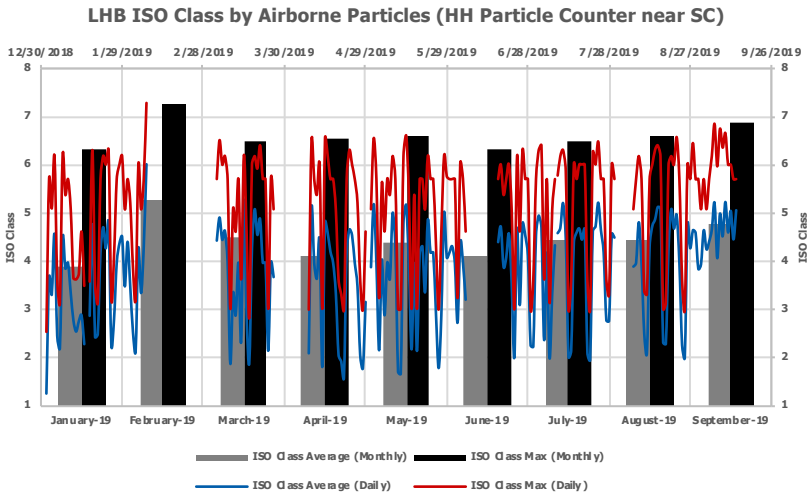


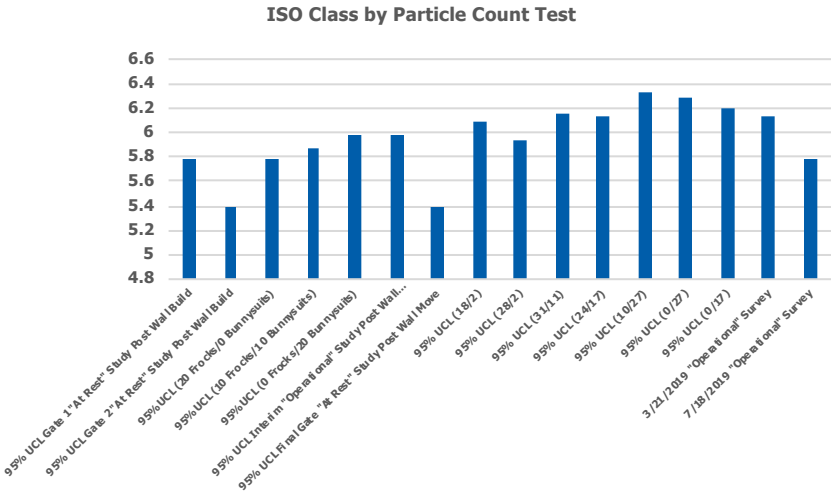
Air Flow Visualization

Operational Performance Data

- Burden studies were performed with up to 40 people in various garmenting states showing the ability to maintain ISO 7 conditions in the satellite integration area.
- The fallout and airborne particle count trends support compliance with ISO 7 in an area with a split protocol concept







Challenges

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- Training to the new protocols is a huge factor in the implementation of this concept.
  - Personnel must follow strict garmenting protocols to keep the areas segregated
  - Tool/Equipment usage must be strictly controlled
    - Add monitors in the satellite I&T area so that the personnel in the I&T area can see the screens of the personnel in the EGSE area
  - Personnel who use the cleanroom on a regular basis must monitor those who come into the cleanroom for the one-off testing to ensure proper protocols are observed
- Does not provide mitigation of outgassing/molecular contamination
  - Personnel must still follow the material restrictions for the higher class cleanroom, even in the EGSE area
- Programs must both be on board with the requirements and the most strict requirement for cleanliness must be followed by both
- Space can become even tighter, and with multiple programs can increase the number of personnel and level of required coordination

Conclusion

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- We have demonstrated the capability to maintain a clean working environment with a virtual barrier through careful planning and configuration with a non-typical cleanroom set-up
  - EGSE and Computer workstations typically are physically separated from the cleaner environment
  - Mixed garmenting is typically not used on a day-to-day basis for operations without a physical barrier to separate the areas
- Our data has shown that we can do both of those things and still meet our cleanliness requirements on two separate satellite programs
  - ISO 14644 allows for the designation of a cleaner “zone” within a cleanroom, so long as that cleanliness zone meets the letter and intent of the standard.

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