Balancing the Demands of Facility Cost, Redundancy, and Energy Efficiency- When Designing and Constructing a Medical Device Cleanroom Facility

Presented by:

Paul Lukitsch CEM
Energy Manager & Regional Facilities Manager

EMD Millipore Corporation

Danvers, MA. USA

Paul.lukitsch@emdmillipore.com

Our challenge is addressing sustainability across this "disposable" value chain

EMD Millipore Key Product Areas

- Bioscience systems, kits and reagents
- Analytical Reagents
- Process monitoring tools
- Advanced lab water systems & consumables
- Disposable manufacturing & filtration solutions
- Chromatography media
- Pharma raw materials

Life Science leader in creating value responsibly

	Products	Operations	People
Strategic Goals	**Increase Product Sustainability**	**Minimize Impacts**	**Mobilize Employees**
			
2015 Targets	10% Sustainable Product Families	10% Resource Reduction (GHGs, Water, Waste)	3 New Awareness Programs
	Re.Think	Re.Focus	Re.Commit

Project Case Study - Millipore Mobius II

Project Overview

- 10,000 sft Cleanroom X 2
- ISO Class 7
- Validated Facility
- Expansion of Existing Product Line within Existing Building

Project Requirements

- 24 hr. Operation
- Redundant Systems
- Hard Budget - $250.00/sft of clean space ($2.5 million)
- Fast Track
- LEED Gold

Design Features

- Redundant MAU System
- Redundant Chillers
- Redundant Recirculation AHU's
- Variable Airflow
- All Air Handlers on Emergency Generator

Challenge to operate cleanrooms efficiently

- Cleanrooms are typically “Set it and Forget it”

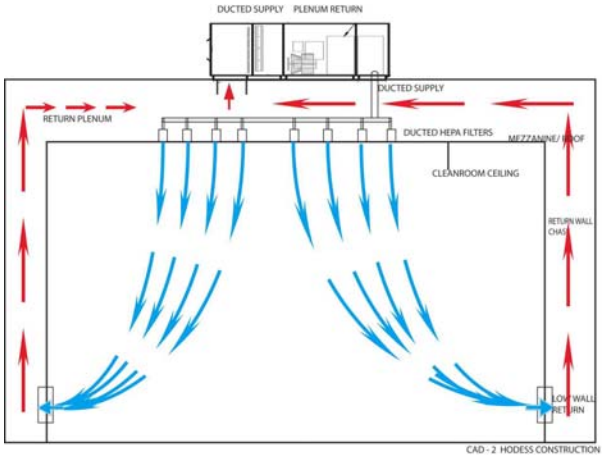
▪ This is a waste of energy
……if the filtration and air flow systems are designed correctly they often are cleaner than required.

Ducted Supply Plenum Return Advantage

▪Reduce Ductwork 50% from Ducted Supply Ducted Return

▪Eliminate Duct Insulation on Supply and Return in Plenum

▪Reduce Return Pressure Drop from Ducted Return



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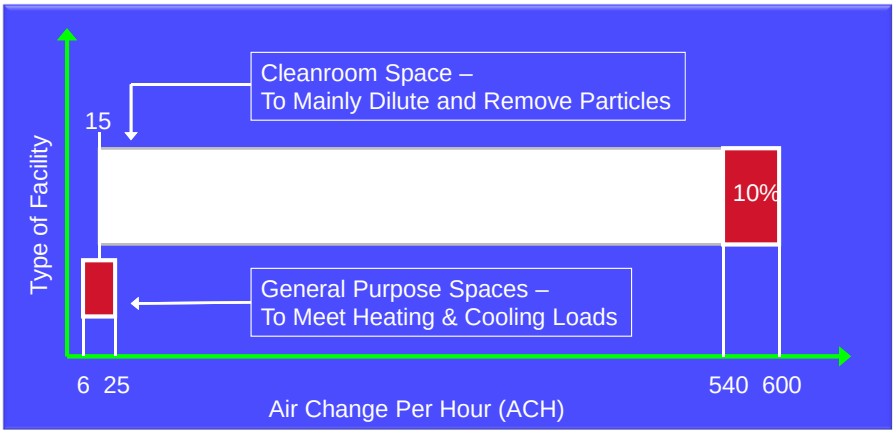
Air Change Rate
Cleanroom vs. General-Purpose Room



Cleanrooms utilize much higher airflow rate than for general purpose building, energy saving potential from airflow rate reduction is significant.

High volume airflows have been utilized to meet FS-209, IEST (RP), & ISO 14644-2 for decades

Classification		Air Change Per Hour Range
ISO Class	FS-209 Class	
8	100,000	5 – 48
7	10,000	60 – 90
6	1,000	150 – 240
5	100	240 – 480
4	10	300 – 540
3	1	360 – 540
2		360 – 600
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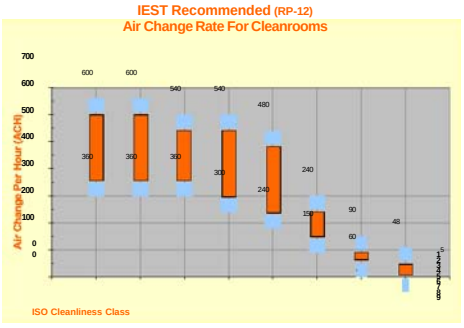

IEST Recommended Practices RP-12

This practice was based on old experience, in which air change rates were arbitrarily selected **solely** based on room cleanliness classes, leaving little or no room for analysis of the actual contamination generating practices.

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Cleanroom Air Change Rate (ACR)

Existing Practices and Problems

- Intuitively, ACR should be based on the required cleanliness class **and** the activities being performed in the space.
- Activities that generate high level of dust will need higher AC/H than those that generate at a lower level
- Most design/operating engineers choose to obey the existing guideline to avoid being challenged.
- However, to have a scientific justification to save fan energy, airflow modeling/simulation, to have a **quantitative** tool
- Cleanroom airflow rate should be provided **as needed** instead of **picking an arbitrary rate from the table.**
- Utilizing active particle monitoring can vary airflow by demand utilizing less airflow in times when particle generation is at a minimum due to inactive periods or enhance practices.

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What did we consider to make it work with our budget?

Reduce the required CFM for cleanliness

- Elected to reduce airflow to the lower end of the design parameters from data generated by airflow modeling to simulate normal contamination load requirements. We selected 30 AC/HR. This reduced energy consumption by an average of 50%.

- Direct drive fans with 20,000 hr. bearings to reduce maintenance requirements and shutdowns.

- Utilized (2) air handlers at 50% capacity each and tied the supply ducting distribution together to provide 50% redundancy

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Demand Flow Control to Maintain Room Cleanliness

For Recirculation/AHU Unit

- Single fan with two-speed or three-speed drives.
- Single fan with Variable Frequency Drive for volume control

For Fan-Wall Unit

- Turning off a number of fans.
- Variable Frequency Drive for volume control of multiple fans at the same place.

For FFU Units

- Turning off a number of FFU's selectively to lower AHR, and maintain airflow as uniformly as possible
- VFD of volume control for multiple fans at the same place

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Building Envelope Project – To Achieve LEED GOLD

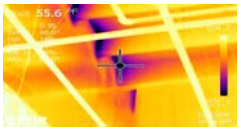
Scope

- As a result of a LEED ® Gold Project-Enhanced Commissioning Process detected a building envelope problem above our newly constructed Cleanroom.
- Infrared Scanning technology demonstrated lack of insulation R=1.
- Project was developed to upgrade the Building envelope to R=22

Benefits

- Natural gas savings. Reduce emissions.
- Eliminated a condensation issues above our Cleanroom.

Projected Results



This Image shows the conductive heat loss of the concrete roof T's on the interior side of the roof overhang. Planned future renovations of the exterior façade will eliminate a potential dew point concern on very cold winter days

Actual Results

854,235 KWh/yr Savings = $45,792 /yrs. Savings

Cost $ 243,833 Utility Incentive= $10,000

Simple Payback of 5.1 yrs.

Before R=1

After R=22

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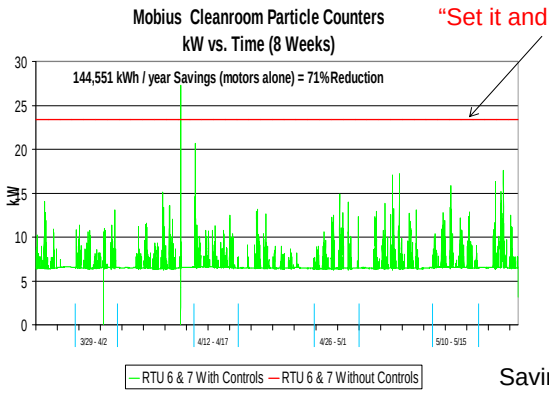
Mobius Project – Demand Control Ventilation

- Particle Counters- Controls Air Handling system to save Energy

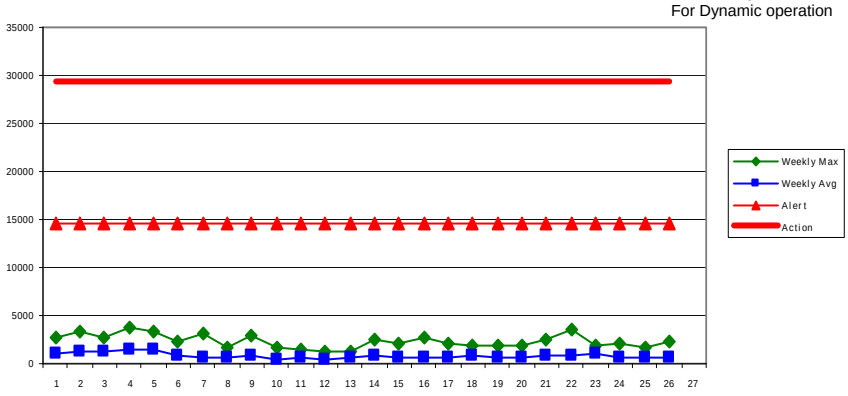


"Set it and forget it"

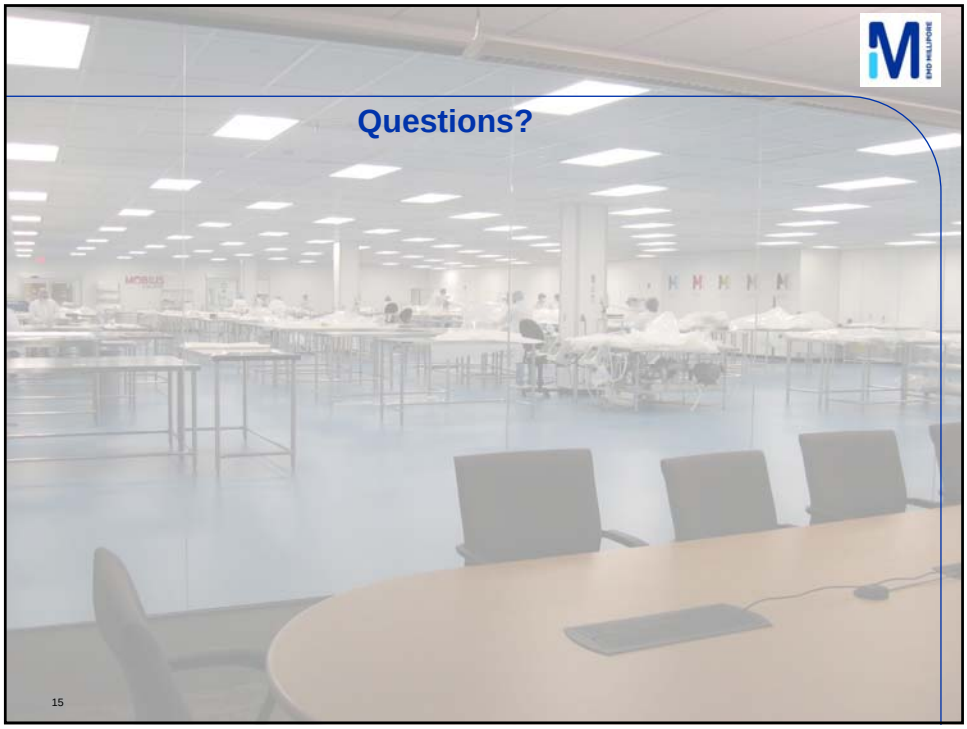
Savings for 2 cleanrooms $ 51,652/yr

Results - Particle Counts

Note: Alert & Action Limits are set upon European Commissioning Standard- grade "C" For Dynamic operation



Conclusion: The Mobius 2 clean room consistently operates below 5000.


Questions?
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