

# Energy Benchmarking in Cleanroom Facilities



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# Who is Doing Benchmarking

- **Web search engines find > 50,000 hits**
  - **Airline Association for Benchmarking and Measurement**
  - **Activity Based Costing Benchmarking Association**
  - **Association for Benchmarking Health Care**
  - **Aerospace & Defense Benchmarking Council**
  - **Accounting and Finance Benchmarking Consortium**
  - **Automotive Suppliers Benchmarking Association**

# Benchmarking in Buildings

- **International Facilities Management Association**
- **Building Owners and Managers Association**
- **FM Datacom/Tradeline**
- **US Department of Energy**
- **US Environmental Protection Agency**



# Diverse Uses of Benchmarking Term

- **Business Use**

- ...Process analysis to identify and implement best practices

- **Operations Analysis**

- ...Collection and analysis of operations data

- ...Comparisons with standard and best practice

- **Baselining**

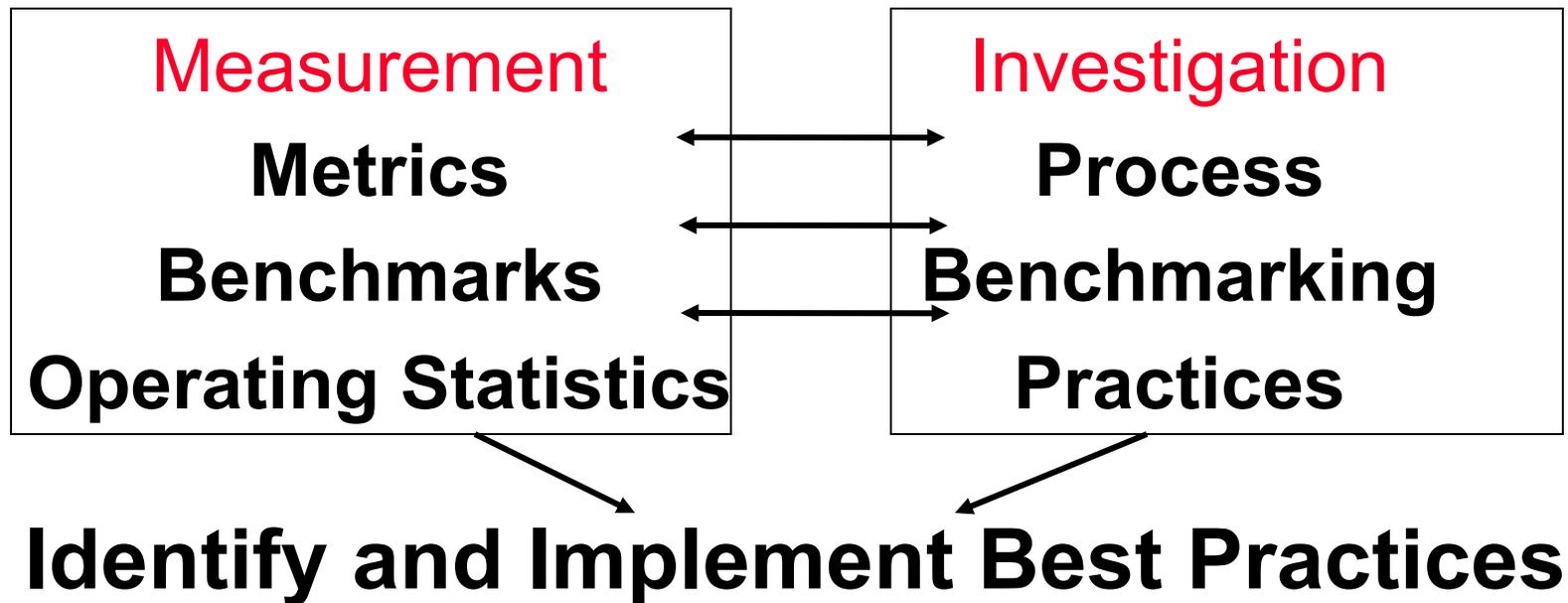
- ...Comparing a building's energy use to itself over time

- **Performance Standards**

- ...Compare a building to others

# Benchmarking for Best Practices

A business management activity that grew out of Total Quality Management



# Cleanroom Energy Benchmarking

## Goals of project:

- Obtain energy use breakdown for High-tech industries
- Define metrics of interest
- Establish and begin to populate database
- Provide measurement data and observations to participants



# Cleanroom Energy Benchmarking

## Additional goals:

- **Provide benchmark data to building owners/operators**
- **Identify best practices**



# Cleanroom Benchmarking Plan

- **Includes various cleanliness classes**
- **Large and small Utility customers included**
- **Focus on cleanroom environmental systems**
- **Data reported anonymously, but publicly**
- **Metrics defined**



# Typical Metrics

- **Annual Energy Cost per cleanroom square foot** **\$/sf**
- **Annual Fuel Use** **Mbtu/sf/yr**
- **Annual Electricity Use** **kWh/sf/yr**
- **Power intensity** **W/sf**
  - Process equipment
  - Lighting

# Important Cleanroom metrics

- **Air System efficiency** **cfm/kW**
  - **Make-up air**
  - **Recirculation air**
  - **Exhaust**
- **Chilled Water Plant efficiency** **kW/ton**
  - **Chiller Efficiency**
  - **Cooling Tower Efficiency**
  - **Chilled Water Pumps Efficiency**
- **Boiler Plant Systems** **kW/MBtu**

# Typical Chiller



# Other Cleanroom metrics

- **Process Utilities**

- **DI Plant**

**kW/gpm**

- **Nitrogen Plant**

**cfm/kW**

- **House Vacuum**

**cfm/kW**

- **Compressed air**

**BHP/100acfm**

- **Lighting**

**W/sf**

# Typical DI Plant



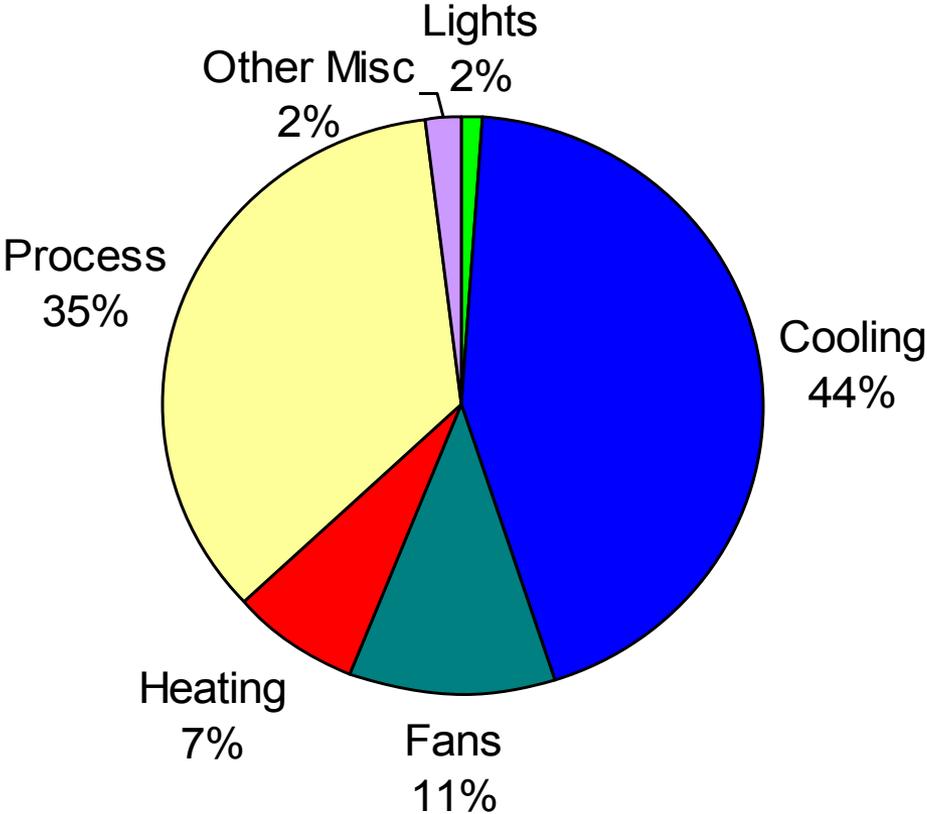
# Sample Benchmark Results

<b>Annual Energy Cost per Square Foot of Cleanroom</b>	<b>\$43.85</b>
<b>Chiller Efficiency</b>	<b>0.50 KW/ton</b>
<b>Central Plant Efficiency</b>	<b>0.69 kW/ton</b>
<b>Class 10 Recirculation Units efficiency</b>	<b>5460 CFM/kW</b>
<b>Class 100 Recirculation Units efficiency</b>	<b>7845 CFM/kW</b>

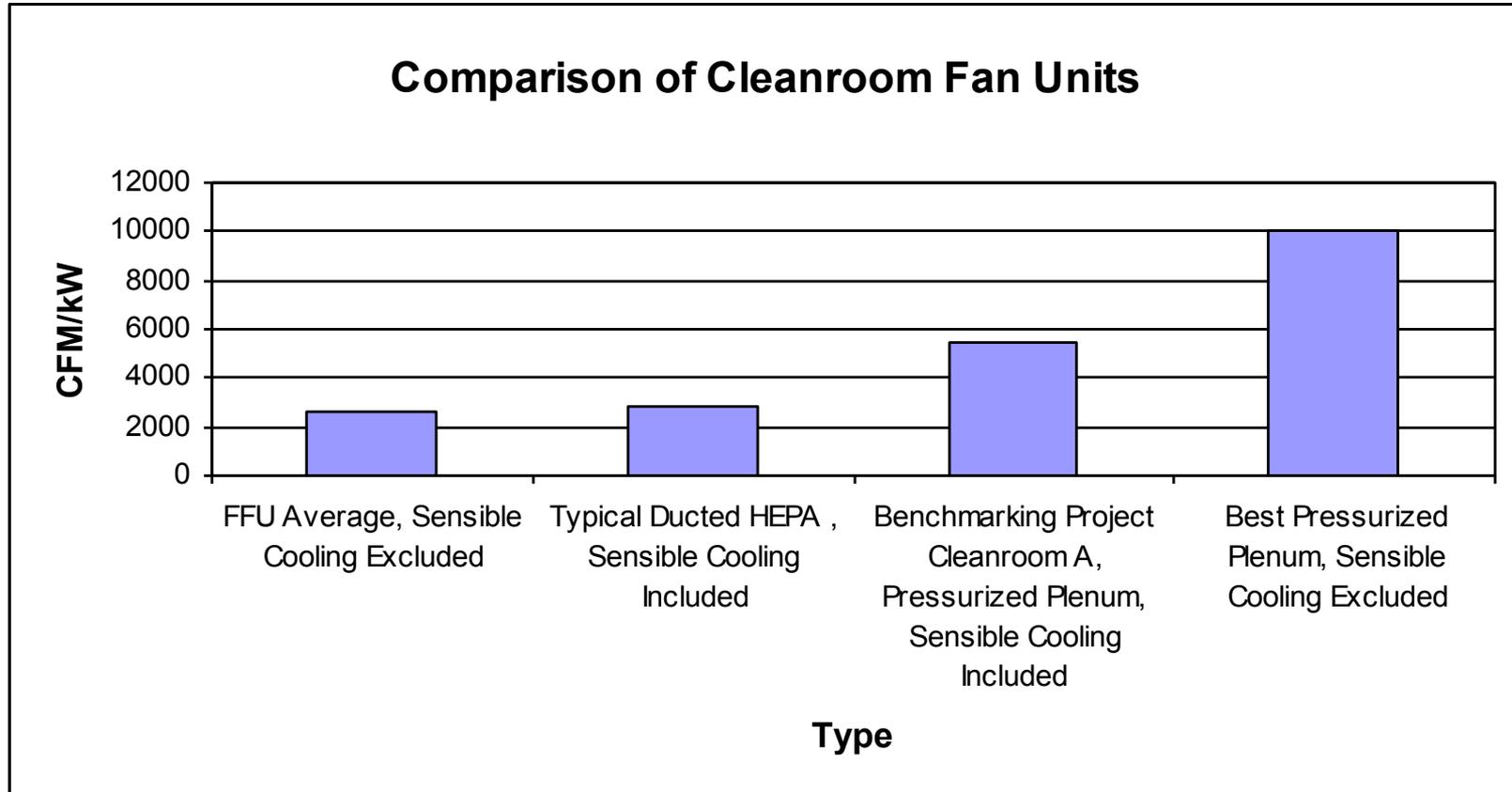
# Comparison of Class 10 and 100 in one facility

	Class 10	Class 100
Primary Cleanroom Area (sf)	25,600	10,430
Total MUAH Air Flow (cfm)	17,700	9,600
Total MUAH Power (KW)	15	6.4
MUAH CFM/kW	1180	1500
MUAH CFM/sf	0.69	0.89
Total RCU Air Flow (cfm)	1,900,000	227,500
Total RCU Power (kW)	348	29
RCU CFM/kW	5460	7845
RCU CFM/sf	74	21

# Representative Annual Energy Use (kWh/yr)

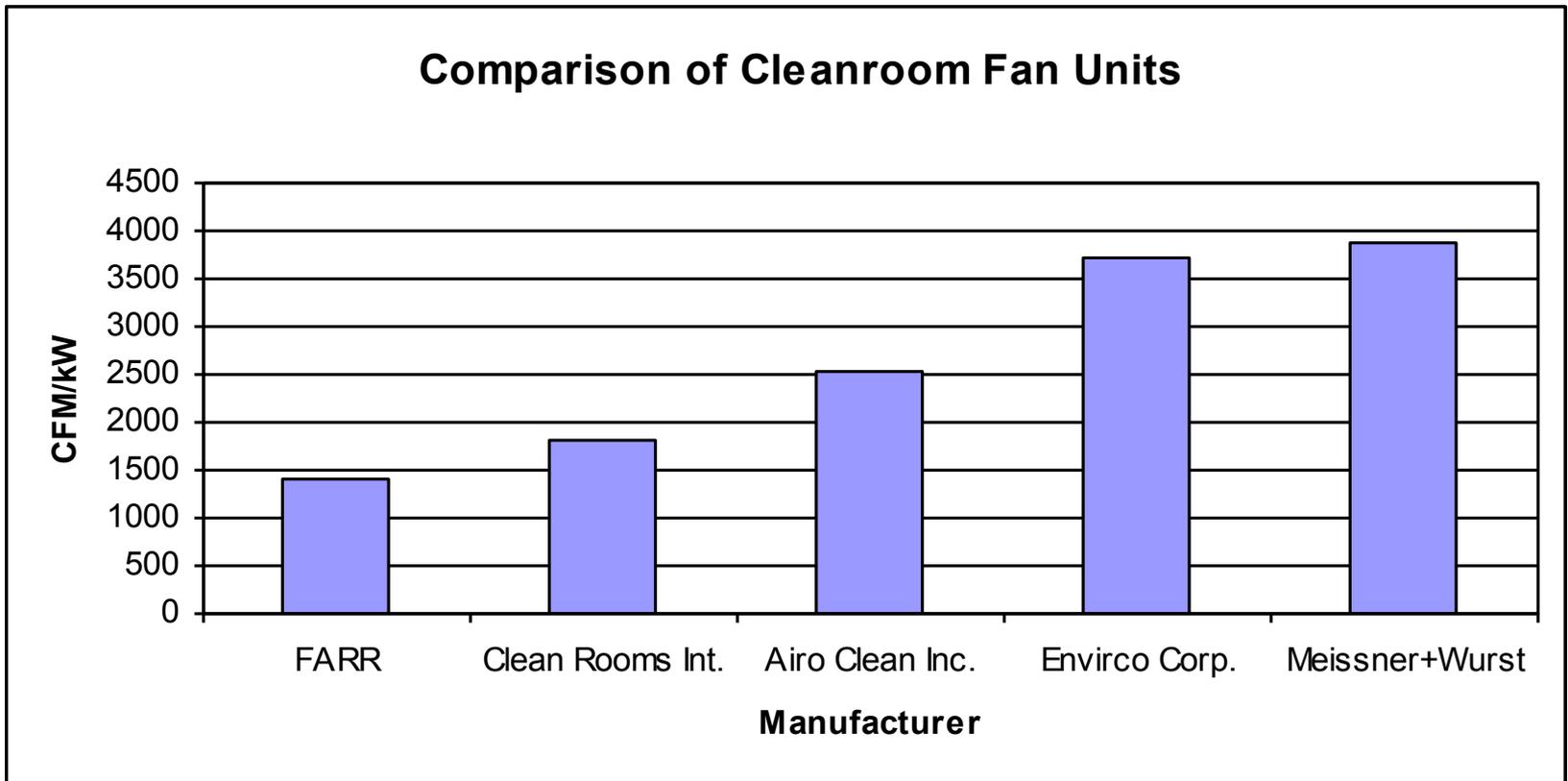


# Observations from Benchmarking



Source: Supersymmetry

# Fan Filter Units Energy Efficiency

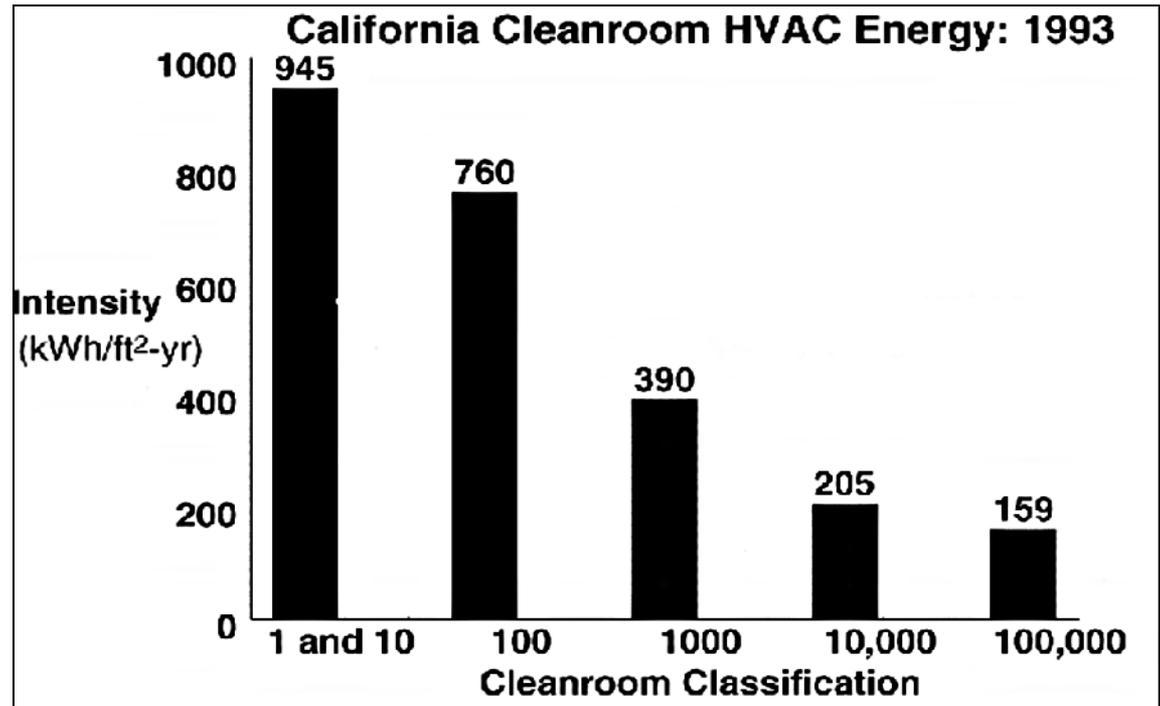


Source: Supersymmetry

# Why Cleanrooms and Lab-Type Buildings?

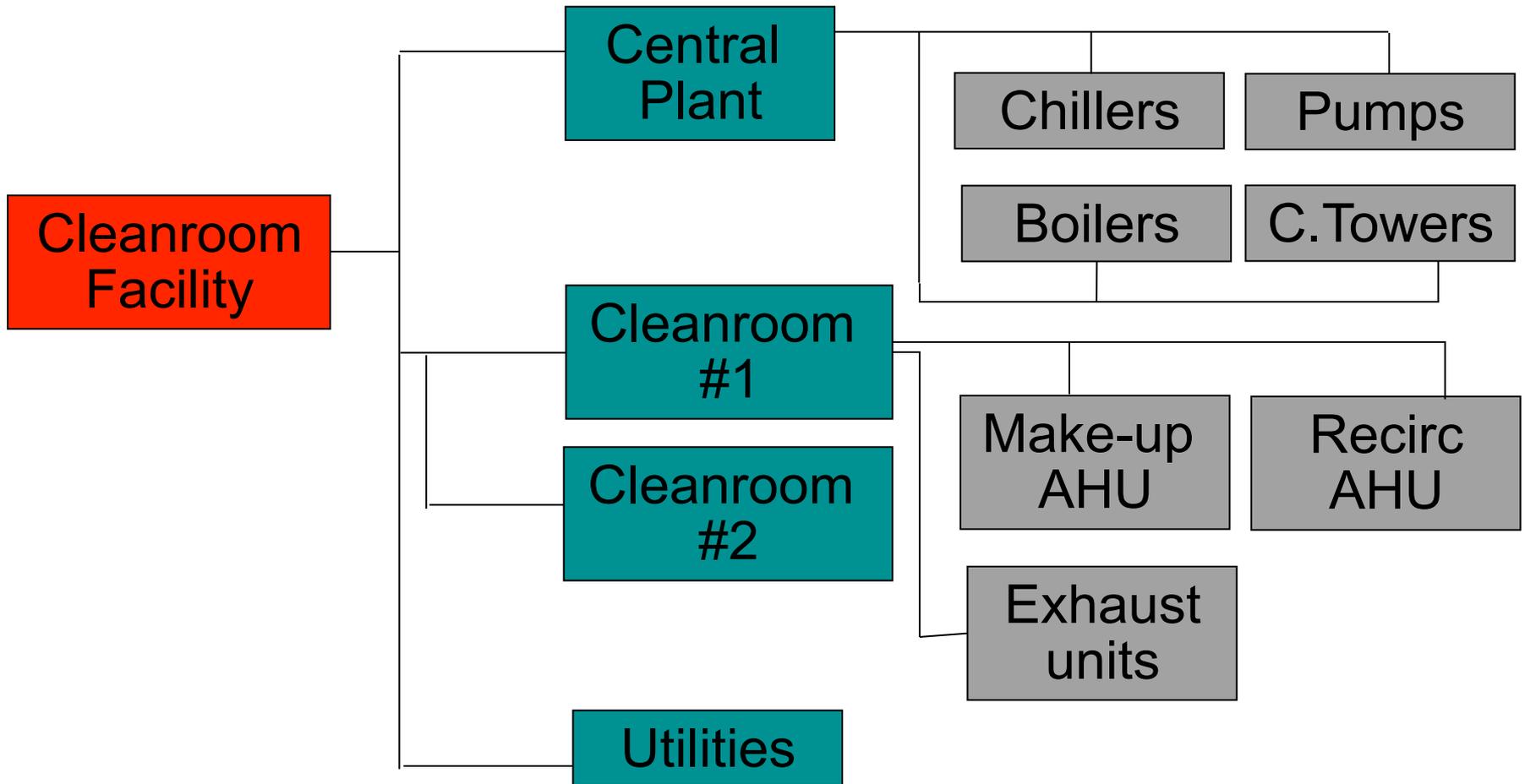
Very energy intensive

High energy-use characteristics



High airflows/exhaust rates  
Strict filtration needs  
Tight temperature/humidity requirements

# Cleanroom Benchmarking Database Schematic





Building 3

Cleanroom Name: Class 10 Cleanroom

Cleanroom ID: 3

Facility ID: 6

Primary Cleanroom Area: 25600 sf

Secondary Cleanroom Area: 24700 sf

Building Area: 129000 sf

Class: 1 to 10

Annual Hours Use: 8760 Hrs

Fan Type: Pressurized Plenum

Heat Recovery:  Raised Floor:

Design Measured

Lighting Power: 46 46.1 kW

Process Power: 200 180 kW

Other Power: 60 kW

Ceiling Velocity: 90 fpm

Room Pressurization: 3 3.46 in. w.g.

Tolerance

Cleanroom Temperature: 68 °F ± 2 °F

Humidity Conditions: 50 % ± 5 %

Recirculation Air Exhaust Makeup Air

Recirculation Air Description:

Monitoring End Date: 6/15/2000

Monitoring Start Date: 6/29/2000

Makeup Air

Recirc Air

Exhaust



# Benchmark Database

- **Access Data base for reporting and categorizing data**
- **Future ease of comparison**
- **Future automatic Report generation**
- **Web access for easy comparison**
- **Possible use for self entry and evaluation**

**How Do you compare**

**?**



# A-Team

Lawrence Berkeley National Laboratory  
Environmental Energy  
Technologies Division

## Energy Efficient Design Applications

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A-Team Activities

Philosophy

The Team

Career Opportunities

Contact the Ateam



Methods of conserving energy through new designs for implementation in high tech industries are detailed in this guide. Energy efficient devices featured such as fume hoods and cleanrooms offer operational efficiency in laboratories.

[A Design Guide for Energy-Efficiency Research Laboratories](#)

**Other helpful links:**

[Labs for the 21st Century](#)

[Cleanrooms by LBNL](#)

[Fume Hood - Student Web Sites](#)

[High Tech Building Research and Development](#)

# Cleanrooms Website

<http://eetd.lbl.gov/cleanrooms/>

