ASHRAE London Canada Chapter

An integrated approach to **“Critical Controlled Environments”** to help our customer’s business grow into a **greener** future

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I am a **Procrastinating**, **Inquiring**, **Theorist**, who asserts reality through story telling, founding ESC in 1983 and leading through the pivots along our journey.

48+ years experience in the Industrial HVAC/R / Temperature / Humidity Control and 38+ years in Cleanrooms and Biological Safety Containment for a wide range of industries.

ESC ENVIRONMENTAL SYSTEMS CORPORATION
CREATING ENVIRONMENTS FOR SUCCESS

WHY? Everything we do stems from our **passion** to improve current methodologies and our curiosity to question & challenge existing theories.

HOW? By continually innovating design & delivery.

WHAT? – ESC delivers a **Vertically Integrated** approach to **sustainable Critical Controlled Environments.**

Cleanrooms

ALUMA1™ Modular Cleanroom Wall System

SMARTCRITICAL

Innovative HVAC/R

SMARTAHU™

SMARTHEPA™

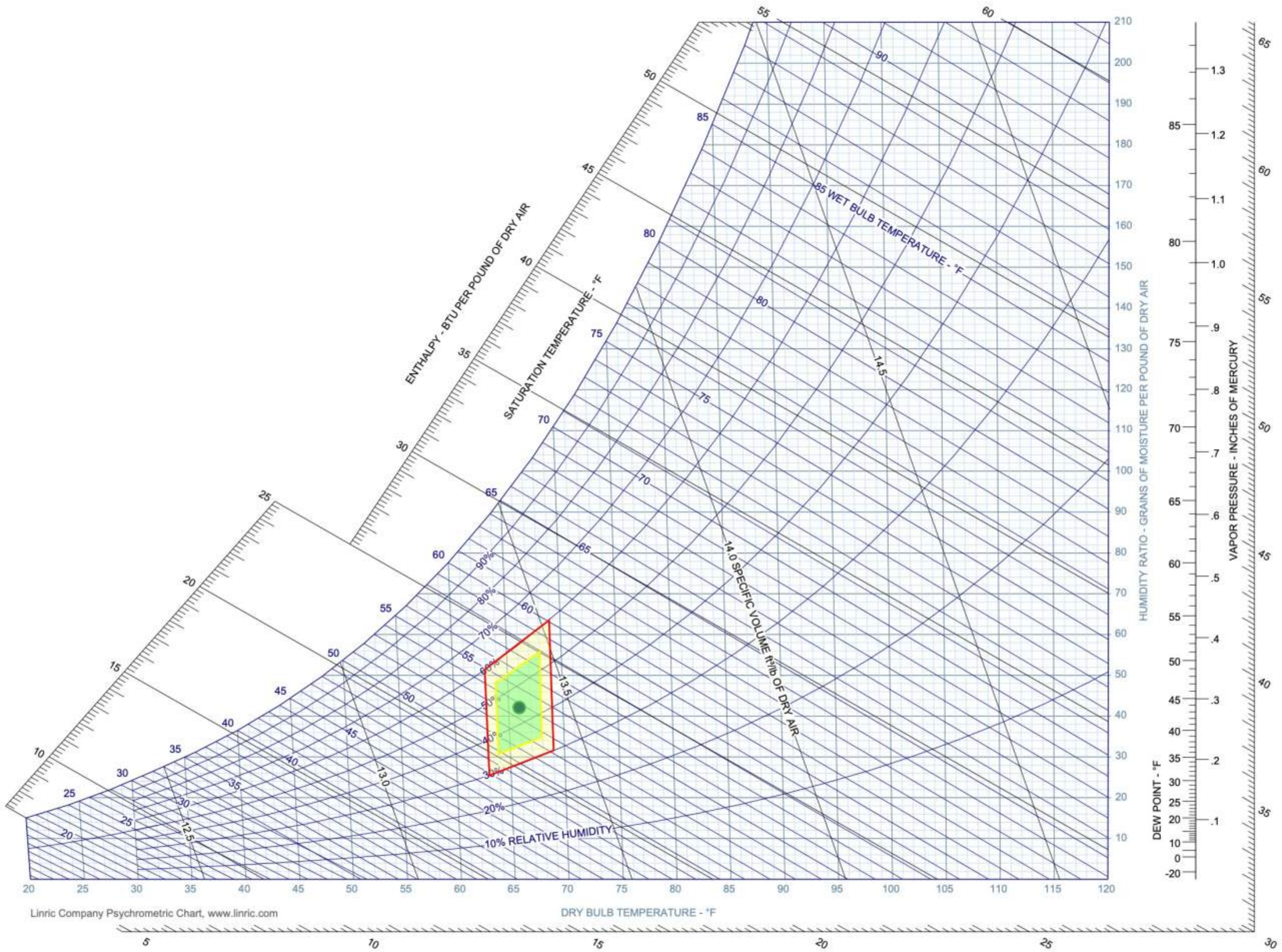
IoT - I4.0 - P4.0

SMARTCRITICAL+

SMARTCRITICALe

ACCUTROL LLC

Temperature & Humidity



Setpoint = 66°F / 18°C & 45% RH

Range = +/- 2°F / 1°C & 4% RH

Alarm = +/- 3°F / 1.5°C & 8% RH

Lessons Learned: Know the Setpoint, Range and Alarm Points. In Cleanrooms be aware that the setpoint temperature should be lower as the team members will be gowned up. **Discuss this with the client, they may not be aware, and no one wins if this is wrong**.

In physics the relationship in the properties of "Air" are shown on a "Psychometric Chart"

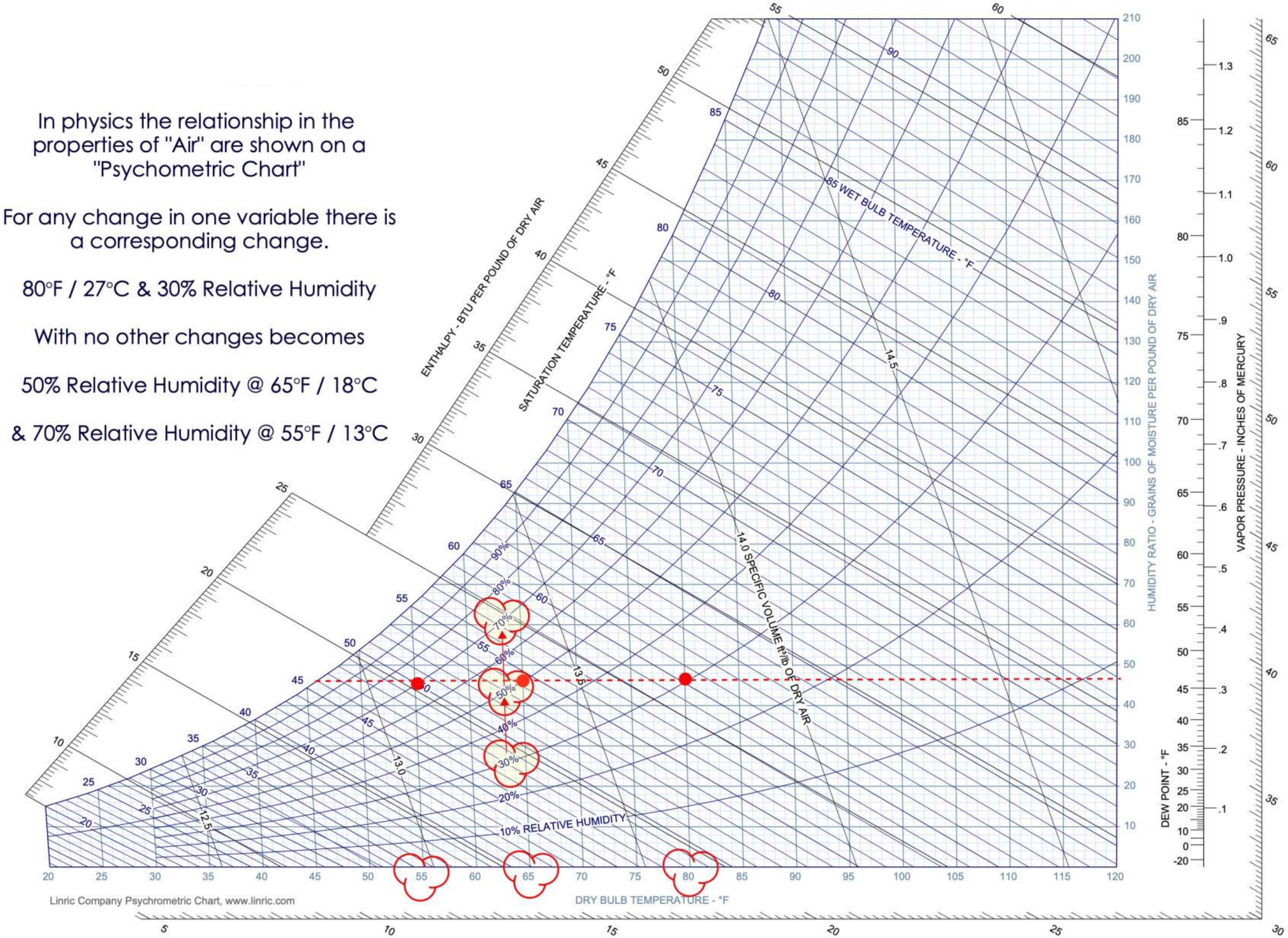
For any change in one variable there is a corresponding change.

80°F / 27°C & 30% Relative Humidity

With no other changes becomes

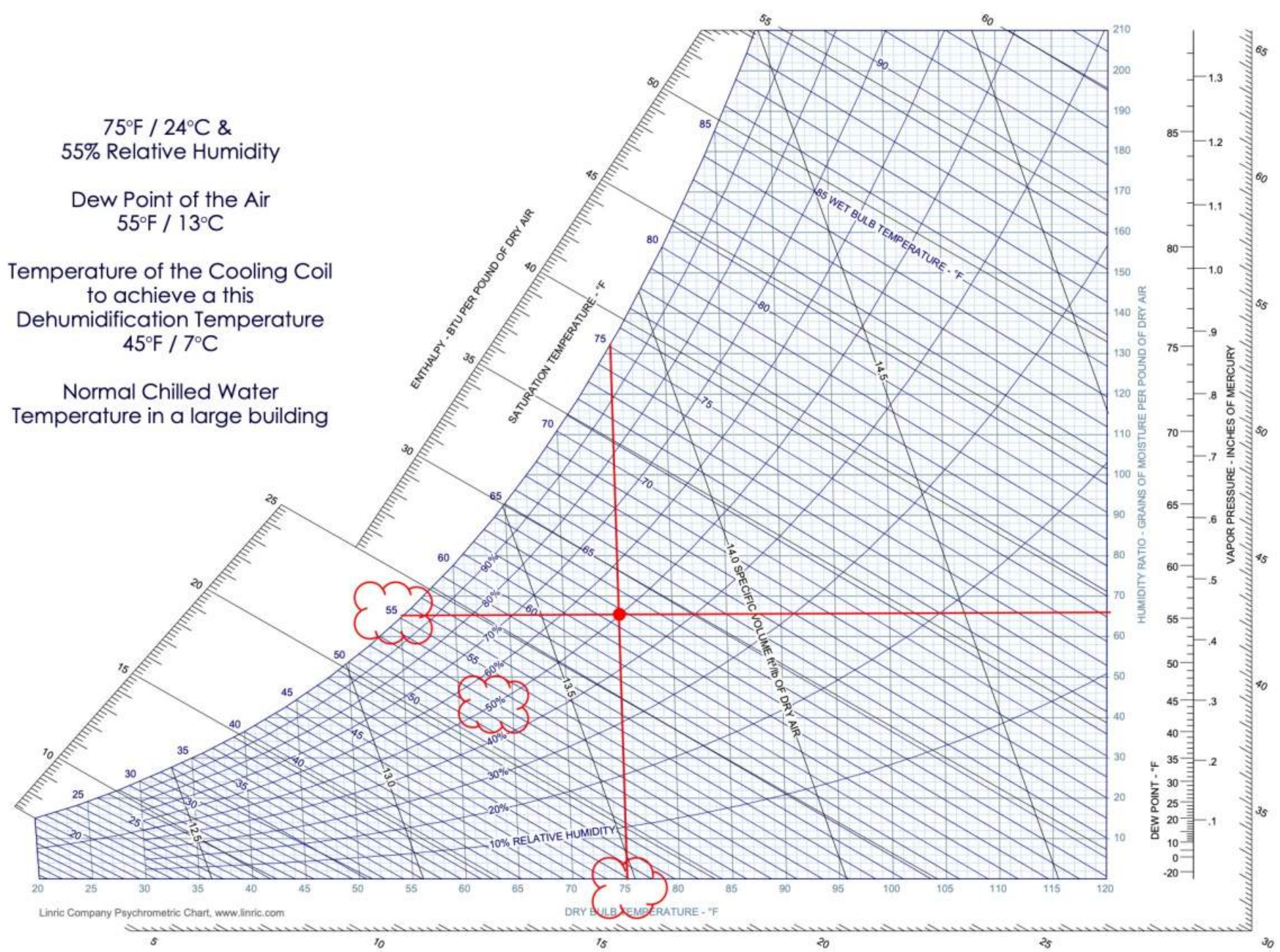
50% Relative Humidity @ 65°F / 18°C

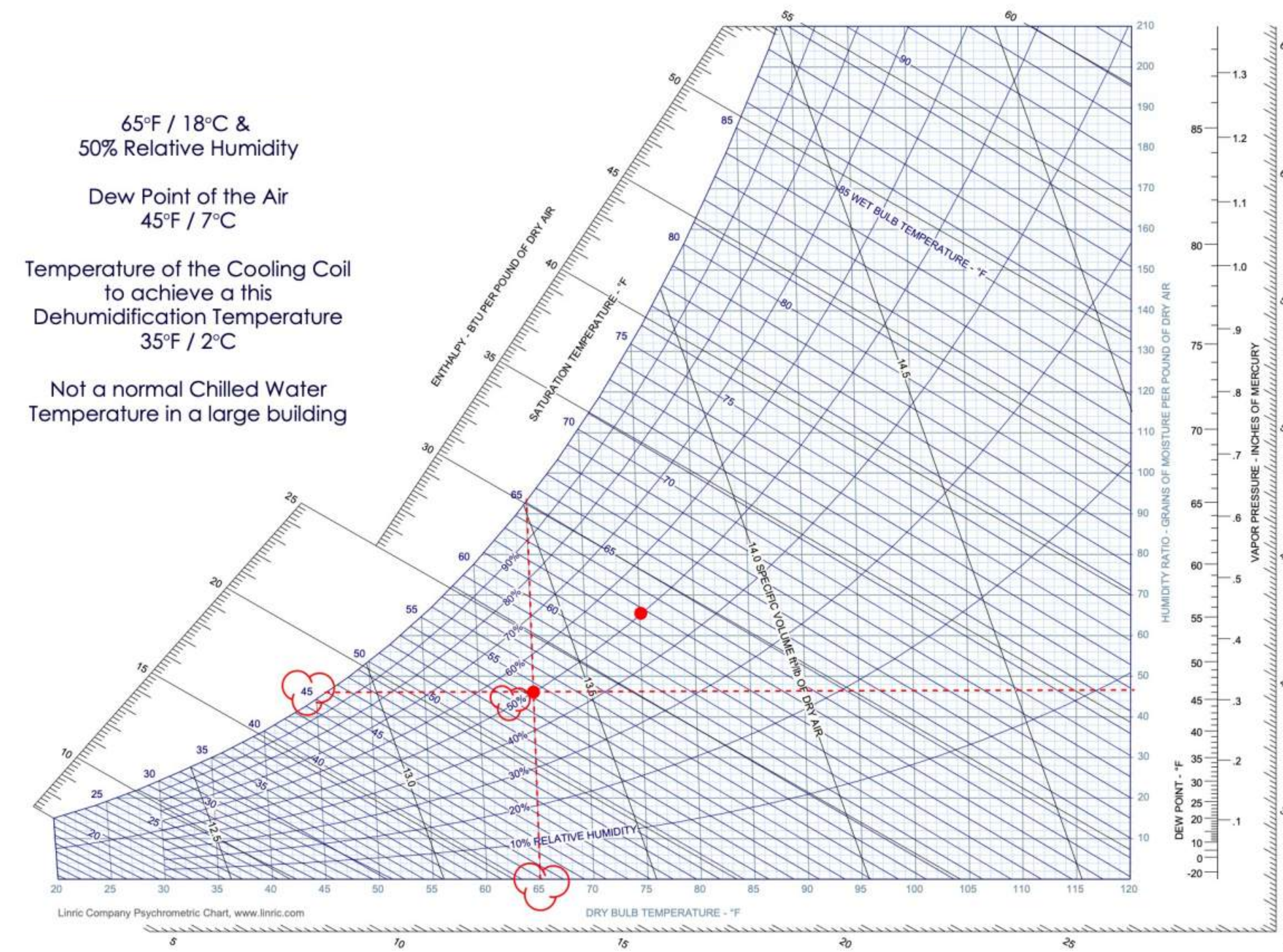
& 70% Relative Humidity @ 55°F / 13°C



Physics: Know the **Psychrometric Chart** and the relationship between temperature and humidity

Temperature & Humidity





Physics: The dewpoint of the air is determined by the chilled medium and the coil "approach" (the difference between the coil and the leaving air) temperature. Chilled water cannot be cold enough to dehumidify a Cleanroom, as typically coil temperatures need to be slightly above freezing.

Very Low-Pressure Drop for Energy Savings

Reducing energy consumed requires changing one of three variables

- Fan system efficiency
- Airflow
- System pressure drop

Minimum Possible Pressure Drop Provides Maximum Operational Cost Reduction

Energy Efficient Design Concepts
REDUCE – System Air Pressure Drop

System Components		Common
Face Velocity (Components)	FPM (m/s)	500 (2.5)
AHU Pressure Drop	"WC (Pa)	2.7 (670)
Energy Recovery		1.0 (250)
VAV Control Devices		2.0 (500)
SA / RA / EA Duct & Devices Pressure Drop		4.5 (1120)
Noise Control Silencers		1.0 (250)
Total		11.2 (2290)
Fan Power	W/CFM	2.4

Physics: Pressure drop drives Efficiency & Noise!

Energy Efficient Design Concepts
REDUCE – System Air Pressure Drop

System Components		Common	Better
Face Velocity (Components)	FPM (m/s)	500 (2.5)	400 (2.0)
AHU Pressure Drop	"WC (Pa)	2.7 (670)	1.7 (425)
Energy Recovery		1.0 (250)	0.6 (150)
VAV Control Devices		2.0 (500)	0.6-0.3 (150 – 75)
SA / RA / EA Duct & Devices Pressure Drop		4.5 (1120)	2.3 (570)
Noise Control Silencers		1.0 (250)	0.25 (60)
Total		11.2 (2290)	5.3 (1320)
Fan Power	W/CFM	2.4	1.2

Physics: Pressure drop drives Efficiency & Noise!

Energy Efficient Design Concepts
REDUCE – System Air Pressure Drop

System Components		Common	Better	Best
Face Velocity (Components)	FPM (m/s)	500 (2.5)	400 (2.0)	300 (1.5)
AHU Pressure Drop	"WC (Pa)	2.7 (670)	1.7 (425)	1.0 (250)
Energy Recovery	"WC (Pa)	1.0 (250)	0.6 (150)	0.35 (90)
VAV Control Devices	"WC (Pa)	2.0 (500)	0.6-0.3 (150 – 75)	0.1 (25)
SA / RA / EA Duct & Devices Pressure Drop	"WC (Pa)	4.5 (1120)	2.3 (570)	1.1 (275)
Noise Control Silencers	"WC (Pa)	1.0 (250)	0.25 (60)	0.0 (0)
Total	"WC (Pa)	11.2 (2290)	5.3 (1320)	2.6 (650)
Fan Power	W/CFM	2.4	1.2	0.6

Physics: Pressure drop drives Efficiency & Noise!

LABS FOR THE 21ST CENTURY®

Calculations Based on 12,000 CFM 100% MUA Unit 98DB/84WB OA to 42°F Supply Air	Air Intake @ 150 FPM	Dampers	MERV 8 Filtration @ 2X	MERV 15 Filtration @ 2X	Pre Heat Glycol Coil	Cooling Coil A	Cooling Coil B	DX Coil	Reheat Glycol Coil	Humidifier	Cabinet	MUA Total
500 FPM	0.05	0.05	0.5	0.8	0.13	1.16	1.79	0.41	0.18	0.01	0.5	**5.58**
300 FPM	0.03	0.03	0.1	0.4	0.05	0.63	0	0.13	0.06	0.005	0.2	**1.635**

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500 FPM	0.05	0.05	0.5	0.8	0.13	1.16	1.79	0.41	0.18	0.01	0.5	**5.58**	**29.3%**
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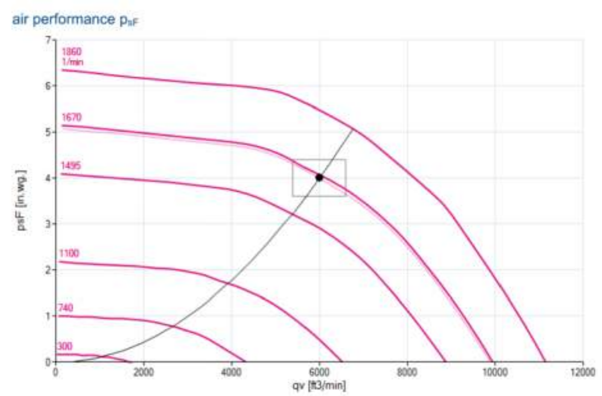
300 FPM	0.03	0.03	0.1	0.4	0.05	0.63	0	0.13	0.06	0.005	0.2	**1.635**	
					$ 2,973	$ 12,478	$ 11,446	$ 5,350	$ 3,431			$ 35,678	**83.3%**
					$ 4,119	$ 15,484		$ 6,265	$ 3,853			$ 29,721	
					139%	124%		117%	112%			83%	

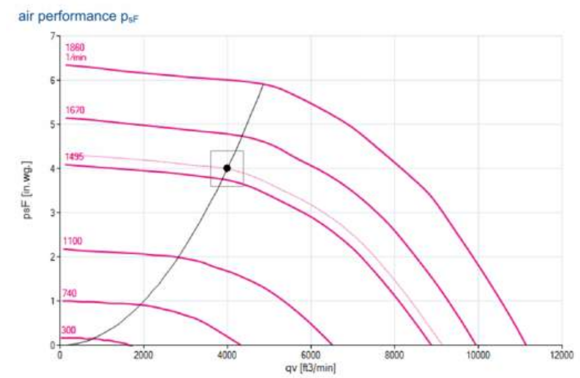
ECM Fan @ 6,000 CFM & 4" TSP (2 Required)



kW / Fan	4.2
Fans Required	4
System kW	16.7
Annual kW	146,012

100%

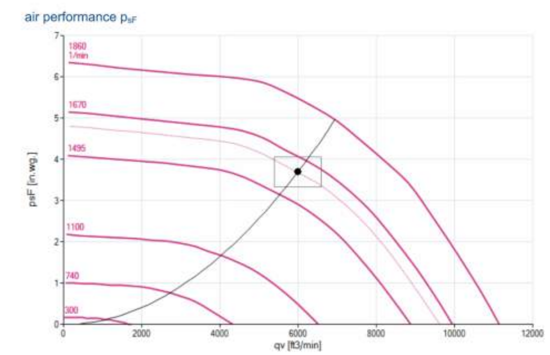
ECM Fan @ 4,000 CFM & 4" ESP (2 Required)



kW / Fan	3.1
Fans Required	4
System kW	12.3
Annual kW	107,993

74%

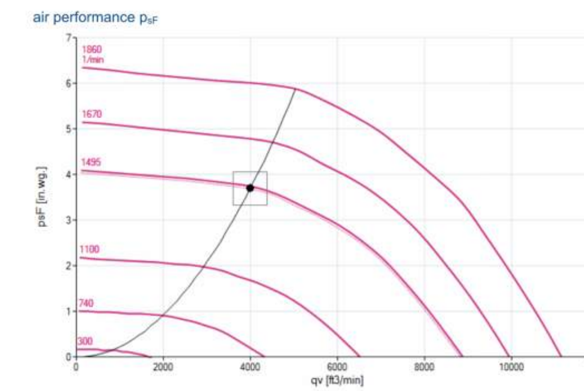
ECM Fan @ 6,000 CFM & 3.7" TSP



kW / Fan	3.8
Fans Required	2
System kW	7.7
Annual kW	67,364

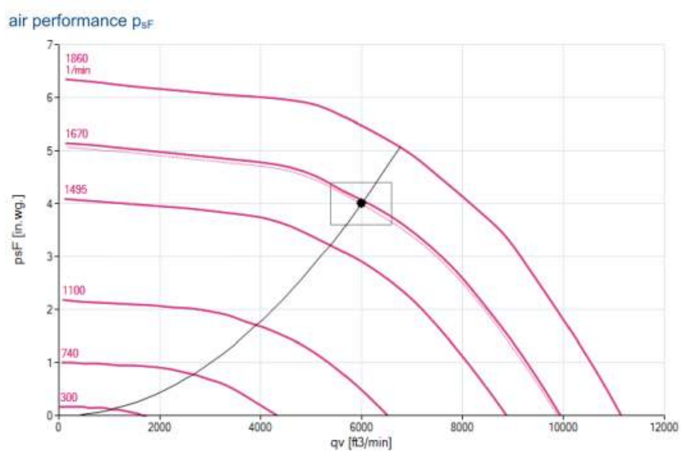
46%

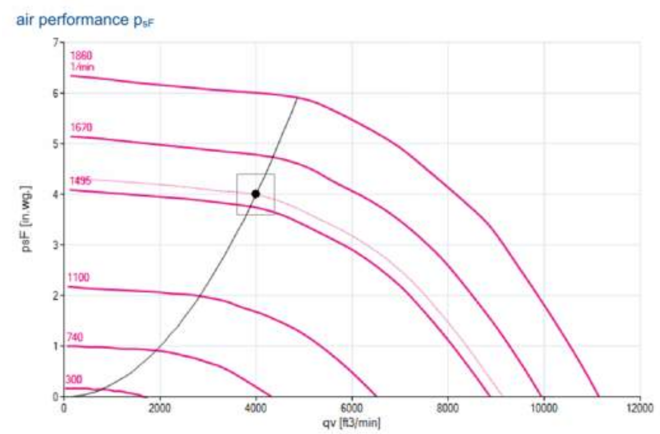
ECM Fan @ 4,000 CFM & 3.7" TSP

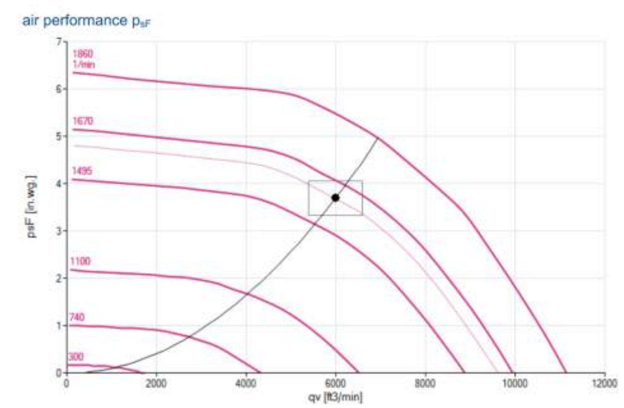


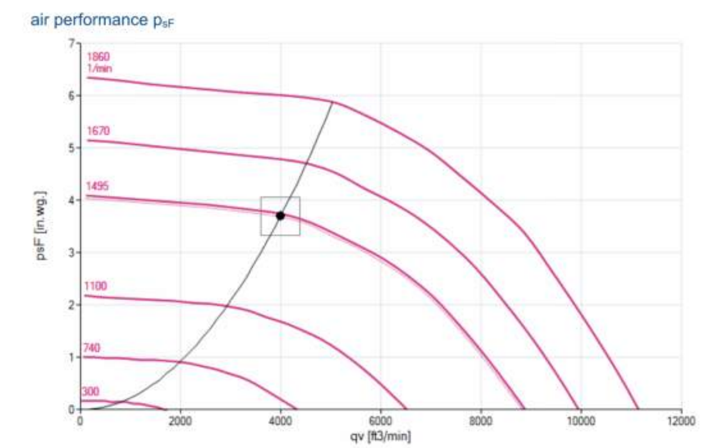
kW / Fan	2.8
Fans Required	2
System kW	5.6
Annual kW	49,389

34%







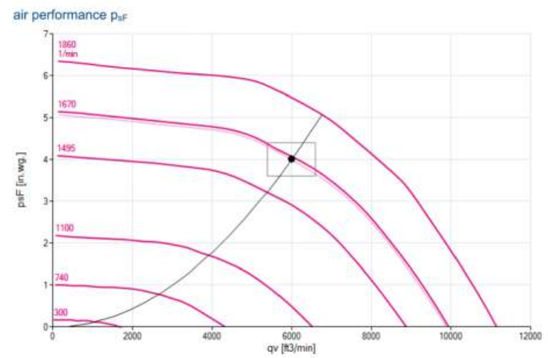


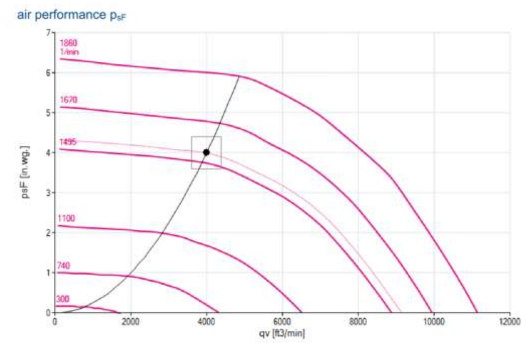
	ECM Fan @ 6,000 CFM & 4" TSP (2 Required)	ECM Fan @ 4,000 CFM & 4" ESP (2 Required)	ECM Fan @ 6,000 CFM & 3.7" TSP	ECM Fan @ 4,000 CFM & 3.7" TSP
kW / Fan	4.2	3.1	3.8	2.8
Fans Required	4	4	2	2
System kW	16.7	12.3	7.7	5.6
Annual kW	146,012	107,993	67,364	49,389

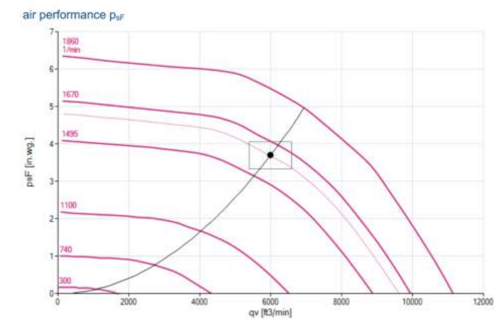
Watts / CFM @ 2" ESP

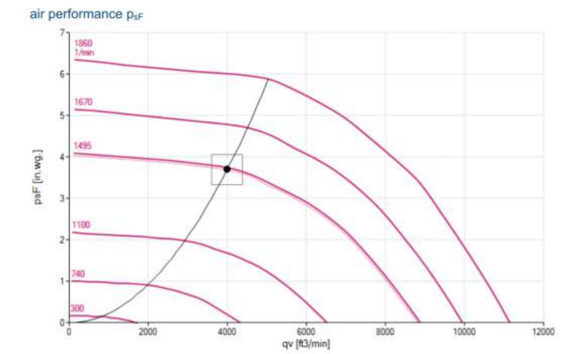
1.39	1.03	0.64	0.47

ECM Fan @ 6,000 CFM & 4" TSP (2 Required)	ECM Fan @ 4,000 CFM & 4" ESP (2 Required)	ECM Fan @ 6,000 CFM & 3.7" TSP	ECM Fan @ 4,000 CFM & 3.7" TSP









	ECM Fan @ 6,000 CFM & 4" TSP (2 Required)	ECM Fan @ 4,000 CFM & 4" ESP (2 Required)	ECM Fan @ 6,000 CFM & 3.7" TSP	ECM Fan @ 4,000 CFM & 3.7" TSP
kW / Fan	4.2	3.1	3.8	2.8
Fans Required	4	4	2	2
System kW	16.7	12.3	7.7	5.6
Annual kW	146,012	107,993	67,364	49,389
	100%	74%	46%	34%

Equivalent gasoline powered passenger vehicles driven for one year

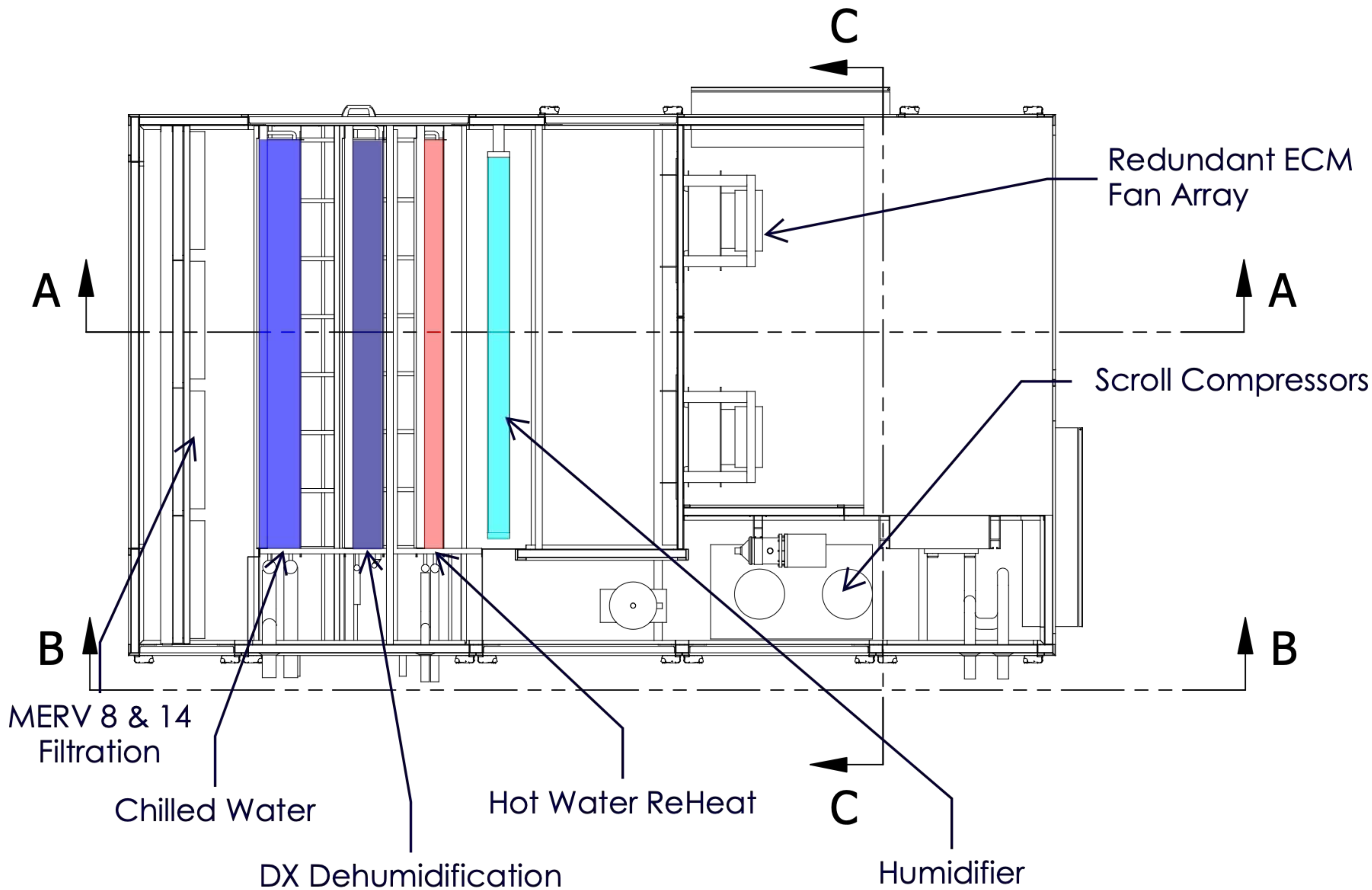
24.3	18	11.2	8.2

Metric Tons of Carbon Dioxide (CO_2) equivalent

102	75.4	47.1	34.5

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results

CHALLENGE: Chilled Water not sufficient for dehumidification.
SOLUTION: DX Dehumidification, using condensing water for reheat, and returning remaining heat to chilled water loop.

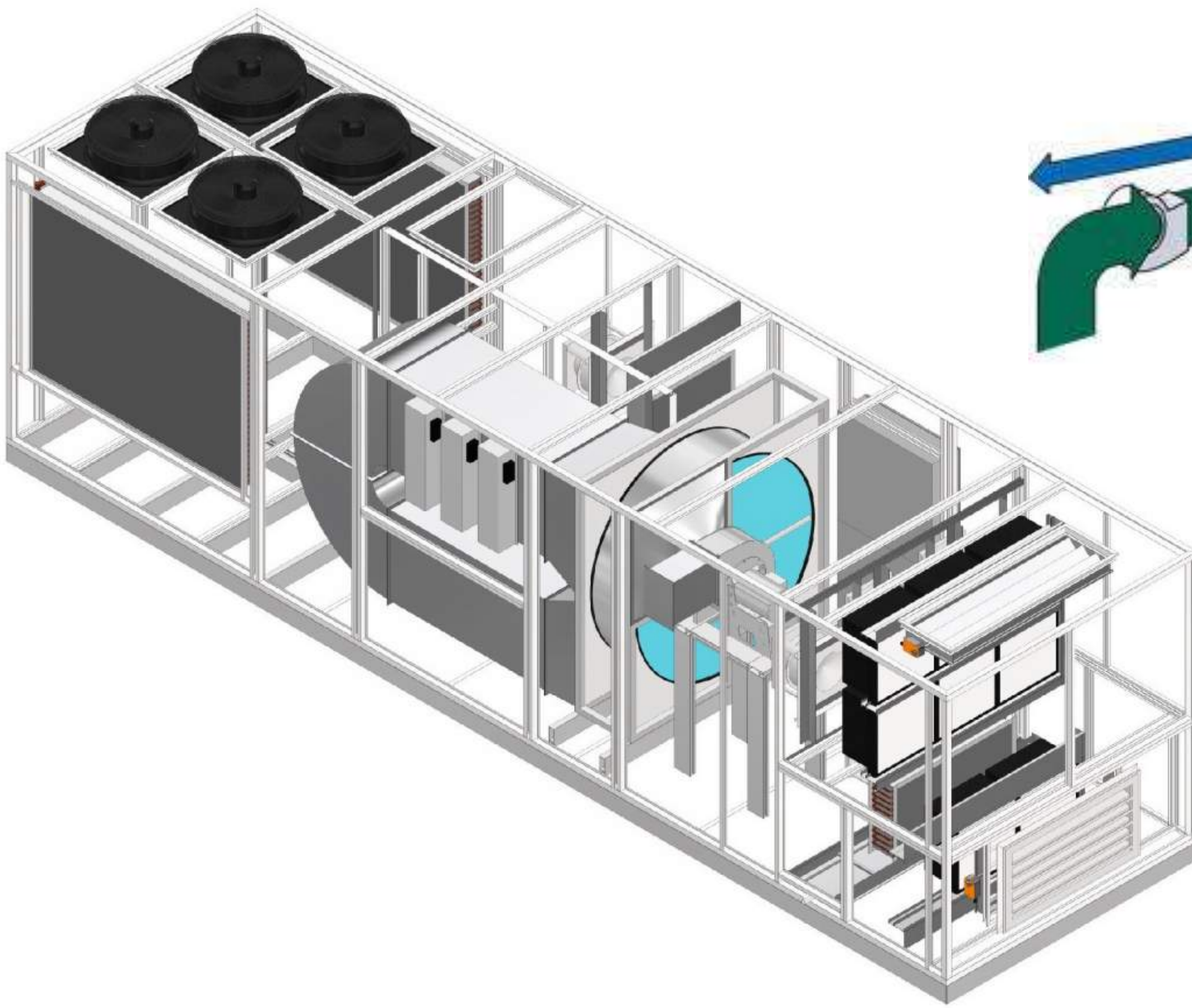


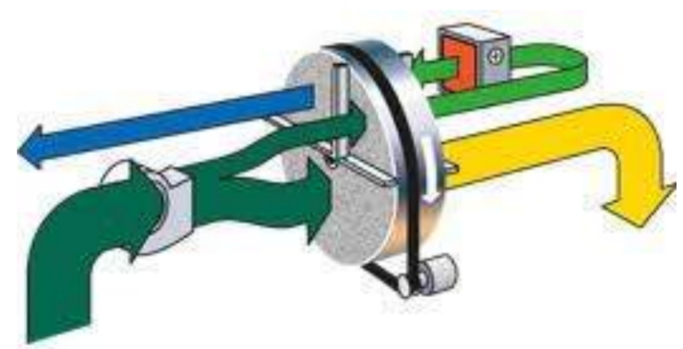
Physics: If a glycol system is not an option, a Direct Expansion Refrigerant coil is, if designed into the system and it can also provide free reheat.

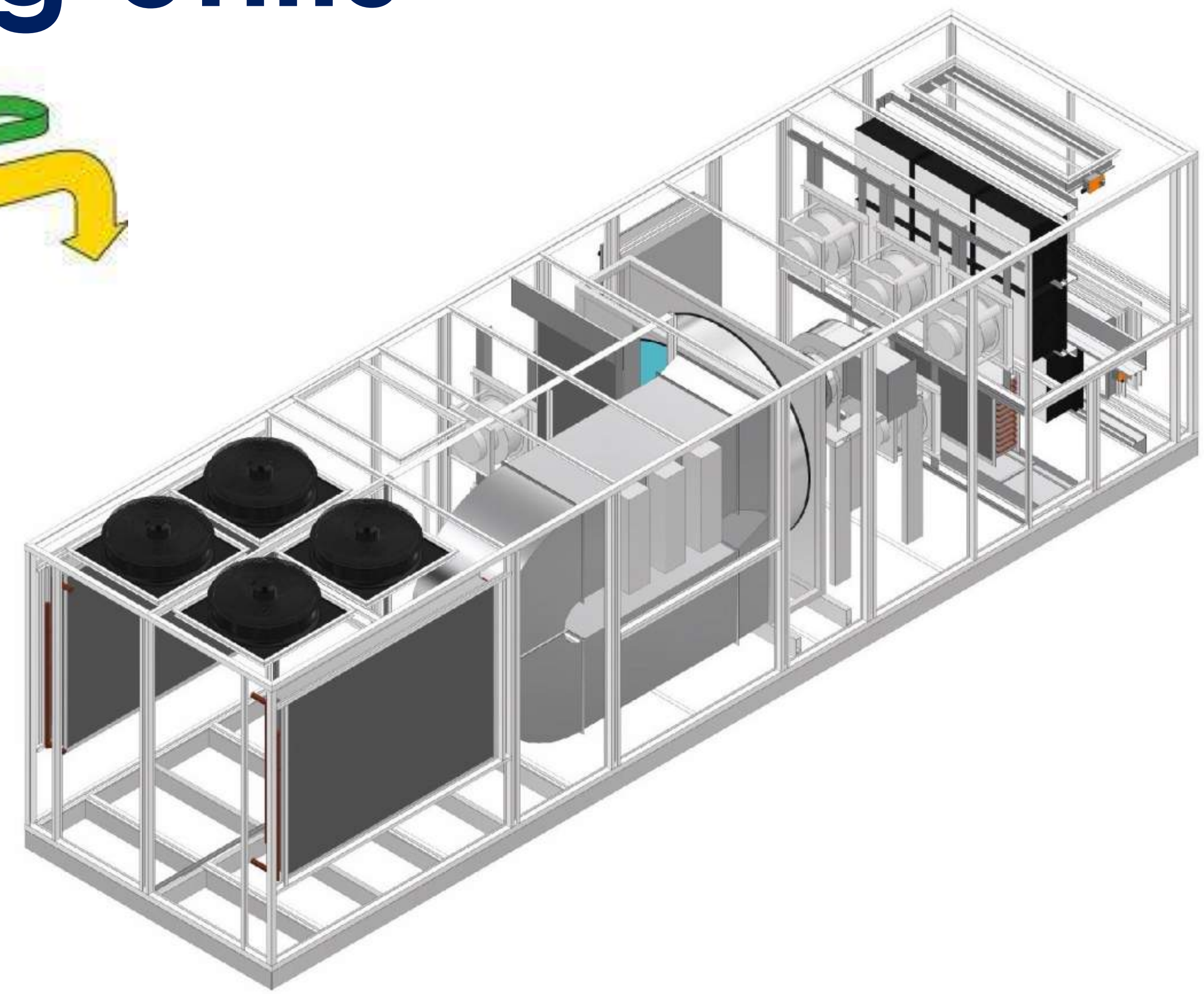
ESC Recent Projects

-80° ULTRA LOW DEW POINT

Air Handling Units







Steam - Electric and Electric Heat Pump Options

SAKUÚ

-80o Ultra Low Dew Point Electric Air Handling Units, with dual zone post cooling

EVONIK INDUSTRIES

DESIGN CHALLENGE: 100% Make Up Air & 80 Air Changes/Hour. Rural area, with power challenges.

SOLUTION: System designed with redundant Supply & Exhaust Fans and Heating Condensing Glycol Boiler on UPS & Generator. Cleanroom could lose humidity and cooling control but never airflow. With air changes every 45 seconds a very consistent supply air +/- 1°F (0.5°C) was important for process and team member comfort.

PharmHouse's vision for an industry first fully automated facility with 42,000 ft^2 cGMP controlled environment facility to process production from 1.3 Million ft^2 of greenhouse growing operations.

Not only would the sheer scale of this project be massive, with 21 air handling units, it also came with a very aggressive timeline, 14 months from initial discussion to validation.

ESC Provided the Make Up Air and Refrigeration equipment for the PAMI Test Chamber, which allows them to run test a combine in -44°C Environment at any time of the year, with a 90kW Combine inside the freezer.

Baylis MEDICAL

Minimizing downtime was Baylis' top priority. Not only would their new Cleanroom need to meet the highest standards for uptime over the long-term, and energy efficiency of three separate cooling zones in one Air Handling Unit

Environment Canada

Based upon the success of providing a solution for Test Cell 4, ESC was awarded the design build to retrofit the Make Up Air for Test Cell 3 by Johnson Controls.

The parameters for both cells is to provide air at any point in a range from 120°F & 80% Relative Humidity to - 20°F.

Utilizing the previous condensing units allowed for a reduced system capital budget.

Steelcase

DESIGN CHALLENGE: Client originally specified 3 different test chambers, one for dry/hot, one for humid hot & cold, and one conventional office temperature / humidity.

SOLUTION: With an integrated design, all three chamber could run any condition, greatly enhancing test flexibility at minimal premium, also offering redundancy.

DESIGN CHALLENGE: Post harvest cooling for lettuce packaging.
SOLUTION: Integrated heat recovery, desiccant rotor, and cooling supply air @ 34°F (1°C), at < 10 Grains of moisture.

Abbott
Point of Care

DESIGN CHALLENGE: Up to $5M in product that must be maintained below 6°C & 20% RH.
SOLUTION: No budget for redundant unit. Designed with redundancy in condenser, cooling tower primary, air cooled secondary. Each chamber with unit coolers and air-cooled condensing units, and bulk nitrogen blanket for redundancy.

therapure BIOPHARMA INC.

DESIGN CHALLENGE: 20,000 CFM Recirculating AHU, becoming a 30,000 CFM MUA.
SOLUTION: Removed the front face, added 4’ to the width, upstream MERV 8 & 14 Filters, dual steam coils chilled water cooling, DX for dehumidification and redundant fan array.

ESC VISION

ROADMAP TO NET ZERO CRITICAL ENVIRONMENTS 2030

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DESIGN

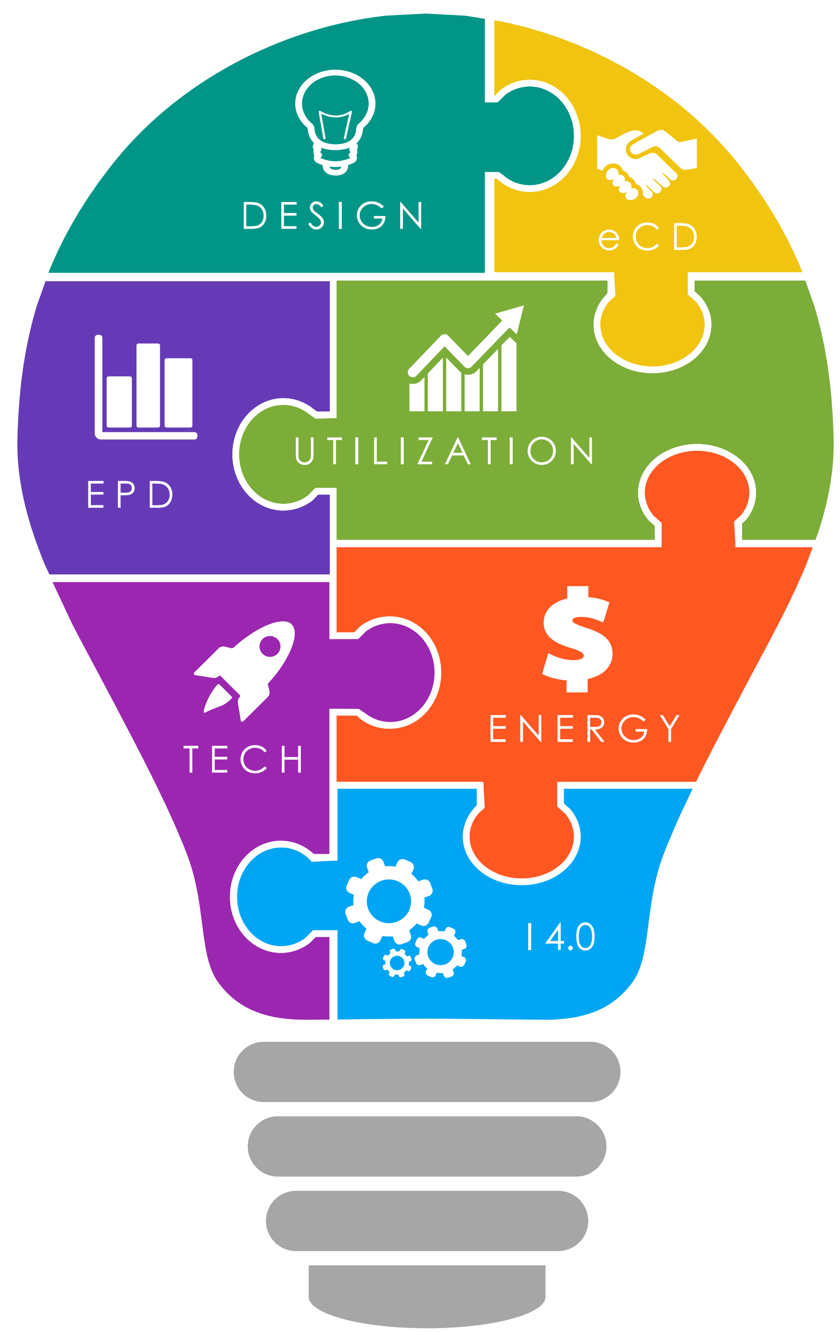
Design to meet safe and effective product manufacturing with operational efficiency & reconfigurability for the future.

ENVIRONMENTAL PRODUCT DECLARATION

Reducing Upstream
Environmental Impact Packaging & Transportation
Material Impact Choices
Reuse & Recyclability

NEW TECHNOLOGY

Adoption of technology that improves the impact while improving reliability & energy utilization.



eCD DESIGN

Design as a Partnership with stated goals and objectives to meet the project timelines & objectives. Speed to market with Team of Teams Collaboration

UTILIZATION

"Wheels Up" mentality to optimizing efficient manufacturing scheduling to deliver more from existing assets.

ENERGY EFFICIENCY

Thoughtful initial design selections to meet operational parameters while reducing energy waste and providing options to match production realities.

RELIABILITY, Industry 4.0 & AI

Acquiring the "right" data needed to make human or AI Model decisions to improve reliability & efficiency

Today's Presenter

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