Healthcare Solutions

Poirier Laurent

Phoenix Controls

Regional sales Manager

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Agenda

- Issues impacting HVAC in hospitals
- Current design methodology
- Hospital design guidelines and trends
- Current design challenges
- Healthcare products and applications



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Why Improve Ventilation in the Hospital Environment?

- **Energy efficiency**
  - Ability to implement setback strategies during unoccupied periods without compromising environmental integrity.
- **Hospital-acquired infections**
  - Better airborne infection control
- **Operational efficiency**
  - Flexibility of switching from a normal patient room to a negative surge capacity room.
- **Healing environment for patient**
  - More effective comfort control for faster patient recovery

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Hospital Owner Issues

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Primary Hospital Facility Issues

- Health and safety
  - infection control
  - emergency response
  - worker productivity
  - patient satisfaction
  - equipment performance
- Operational costs
  - HVAC maintenance
  - HVAC energy demand
- Regulatory compliance
  - federal, state and local
  - commissioning, testing and balancing
- Market Differentiation

American Hospital Association

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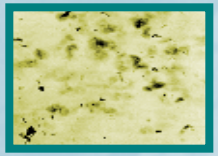
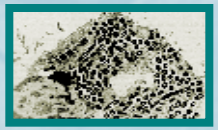
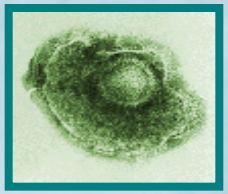
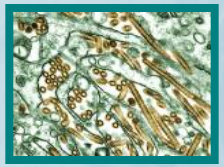
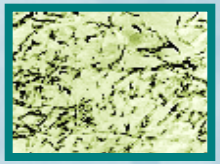
Typical Airborne Pathogens

- Methicillin Resistant Staphylococcus Aureus (MRSA)
- Mycobacterium Tuberculosis (TB)
- Aspergillus
- Avian Flu (H5N1)
- Severe Acute Respiratory Syndrome (SARS)
- Varicella-zoster (Chickenpox)



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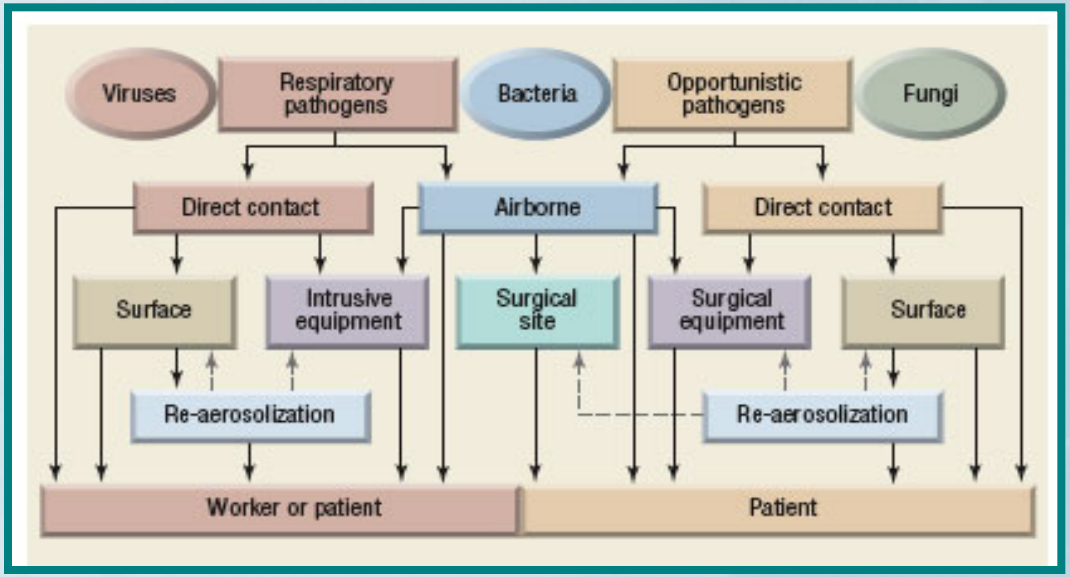
How Are Viruses Transmitted?

- Estimated airborne-related Nosocomial infections: 10-20%
  - Hand washing and routine vaccinations of healthcare workers does not eliminate risk.



- Patients/visitors bring airborne infections into waiting areas.
- TB infections in healthcare workers associated with inadequate ventilation in patient rooms.



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HPAC Engineering, January 2007, Air-Treatment Systems for Controlling Hospital- Acquired Infections

Energy Costs

- Hospitals as energy consumers
  - Over $8.3 billion annually
  - Natural gas and electricity—highest utilization

- Second highest energy density per building type
- Operates 24/7



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Hospital Energy Trends

- Regulatory, technology, and other environmental pressures sending consumption up
  - advancements in diagnostic and treatment
  - more technology per square foot
  - increased demand for improved IEQ
- Internal environment is driving up demand for HVAC systems
- Engineers design for peak load



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Energy Efficiency

- "…for energy conservation, the air-conditioning system should allow a reduction in the air supplied…space pressure must be maintained at reduced air volumes…" (ASHRAE)
- "During unoccupied hours, operating and delivery room air change rates may be reduced, provided the positive room pressure is maintained…" (AIA 2006)
- Hospitals run 24/7—many opportunities to save energy!



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Infection Control Survey

- Surveyed over 2000 infection control practitioners
- Hospital infectious disease emergency preparedness

- Over 20% say they lack a comprehensive emergency preparedness plan for their facility.
- Over one-third say they don't have enough negative surge capacity rooms.
- Over 40% say there are not enough isolation rooms for everyday patient use.

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Pandemic Preparedness Survey

- Survey by the non-profit, Trust for America's Health
  - Overall preparedness for pandemics among U.S. hospitals is at an unacceptable level.
  - 25 states would run out of beds within two weeks of a severe flu outbreak.
    - Outbreak like 1918 flu outbreak would result in 47 states out of capacity within two weeks.

States with lowest scores

CA, IA, MD,NJ

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Maintenance Challenges

- For optimum performance of the HVAC system, exhaust flow sensors should be cleaned every quarter.
  - On average, it takes 60-90 minutes to clean a cross flow sensor.
  - Increased risk of airborne contaminants
  - 300 VAV units, 2x cleaning @ $50/hr = $30,000 annually
  - Largest disease hospitals today have deferred maintenance

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Owner Issues Summary

- Health and safety enhancements
  - infection control systems
  - emergency response methods
  - equipment performance
- Operational cost reduction
  - decreased HVAC maintenance
  - less HVAC energy demand
- Regulatory compliance
  - fewer test and rebalance requirements
  - federal, state and local assurance

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Current Methods in Ventilation Design

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Typical Critical Environments

- Isolation rooms
- Operating rooms
- Emergency
- Specialty spaces
  - pharmacies, autopsy, morgue
- Critical care areas
  - surgery, transplant, cardiovascular
  - neonatal, pediatrics, birthing
  - burn, oncology, respiratory
- Laboratories
- Patient Rooms
  - qualify today as critical spaces

Ventilation Design

- Typical isolation room
  - maintain continuous negative air pressure
  - monitor air pressure periodically (daily) or with permanent visual monitoring mechanism
  - ensure rooms well-sealed/no leakage
  - self-closing devices on exit doors
  - > 12 ACH for renovated or newly constructed rooms; or > 6 ACH for existing rooms
  - direct exhaust air outside, away from intake
  - HEPA filtration and/or UVGI filtered exhaust

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Ventilation Design

- Typical operating room
  - positively pressurized space
  - 25 ACH when using return air
  - 15 ACH if is using 100% outside air
  - typically runs at constant volume
  - during surgery temperature range 60-65°F
  - humidity 30-60%
  - operates 24 hours a day

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Ventilation Design

- Typical patient room
  - Approximately 70-80% of hospital space
  - Neutral to slightly positive
  - Supply unit, ducted exhaust
  - 6 ACH with 2 ACH OSA
  - Typically CV, but shifting towards VAV
  - Temperature range 70-75°F
  - Humidity 30-60%
  - Bathroom 100% exhaust

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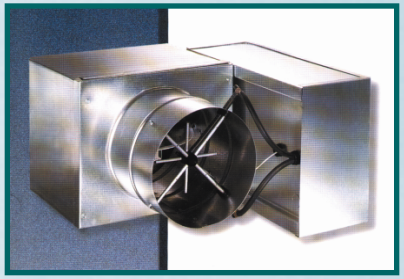
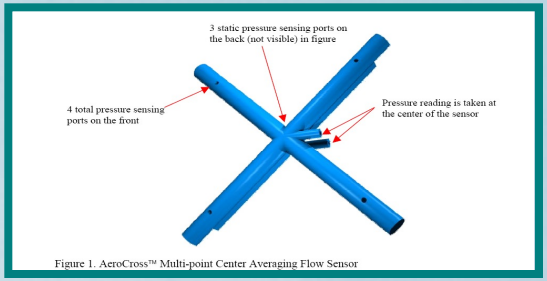
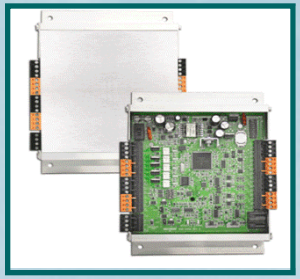
Ventilation Design

- Traditional HVAC equipment approach







- Single zone/standalone air terminal units (ATU)
- ATU flow sensors
- Temperature control
- Room pressure monitor
- VAV Control supplied by BMS

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Guidelines and Evolving Hospital Design Trends

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Design Guidelines

- "Guidelines for Design and Construction of Health Care Facilities" (The American Institute of Architechs, 2006)
  - public comments for 2010 Guidelines closed out September 30th
- ASHRAE-proposed new "Standard 170; Ventilation of Health Care Facilities"
  - increase in room pressurization requirements
- USP 797-pharmacy requirements-compounding
- Individual state requirements may be more stringent



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Increase in Pressurized Spaces

Table 6.1

Function of Space	Pressure Relationship to Adjacent Areas (a)	Minimum Air Changes of Outdoor Air per Hour (b)	Minimum Total Air Changes per Hour (c)	All Air Exhausted Directly to Outdoors (m)	Air Recirculated With In-Room Units (d)	Relative Humidity (n) (%)	Design Temperature (o) (degrees F/C)
SURGERY AND CRITICAL CARE							
Class B and C Operating room (e),(p),(q) (r)	P	4	20	-	No	30-60	68-75
Operating/surgical cystoscopic rooms (e), (p), (q) (r)	P	4	20		No	30-60	68-75
Delivery room (Caesarean) (p),(q), (r)	P	4	20	-	No	30-60	68-75
Recovery room	-	2	6	-	No	30-60	70-75
Critical and intensive care	P	2	6	-	No	30-60	70-75
Wound Intensive Care (Burn Unit)	P	2	6		No	40-60	70-75
Newborn intensive care	P	2	6	-	No	30-60	72-78
Treatment room (s)	-	2	6	-	-	30-60	70-75
Trauma room (crisis or shock) (f)	-	3	15	-	No	30-60	70-75
Anesthesia gas storage (aa)	N	-	8	Yes	-	-	-
Endoscopy	N	2	6	-	No	30-60	68-73
Bronchoscopy (q)	N	2	12	Yes	No	30-60	68-73
ER Waiting Rooms(ab)	N	2	12	Yes	-	30-60	70-75
Triage(ab)	N	2	12	Yes	-	30-60	70-75



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Source: ASHRAE "Standard 170P"

Evidence-based Design

- Evidence-based designs are used to create environments that are therapeutic, supportive of families, and efficient for staff.
- 12 outcome-linked environmental factors impact the healing environment:

– single patient rooms	– windows	– access to nature
– flooring materials	– building layout	– furniture
– positive distractions	– noise	– light
– air quality	– way finding	– ergonomics

- Universal or acuity adaptable rooms
  - designed to be versatile—can be a patient room, easily converted into an intensive care room, and vice versa



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Current Methods Design Challenges

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Airflow Control

- Inadequate ventilation design or poor equipment performance can place occupants at risk.
- VAV airflow rate affects acoustics, ventilation, occupant comfort and energy use.
- Proper airflow and pressurization requires:
  - equipment pressure independence
  - accurate airflow measurement
  - speed of response with stability
  - correct calibration and balancing



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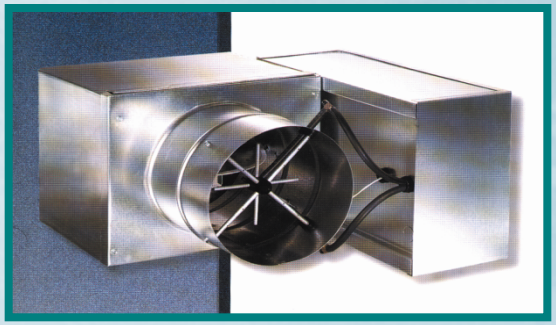
Airflow Measurement Accuracy

10-inch duct 0-0.25-inch transducer 1% F.S. accuracy



CFM	FPM	ACTUAL VP	XDCR ERROR	MSRD VP	MSRD FPM	MSRD CFM	ERROR
1000	1833	0.2095	0.0025	0.2120	1844	1006	1%
200	367	0.0084	0.0025	0.0109	418	228	14%
100	183	0.0021	0.0025	0.0046	271	148	48%

Velocity = Volumetric Flow / Area Velocity Pressure = $(\text{Velocity}/4005)^2$

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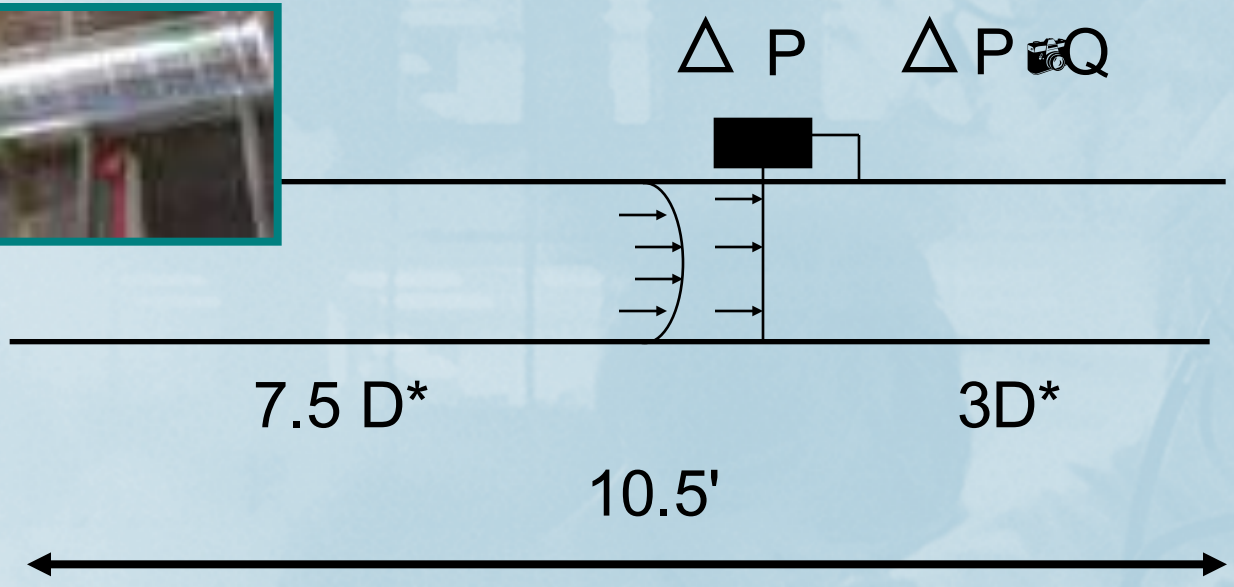
Straight Duct Requirements



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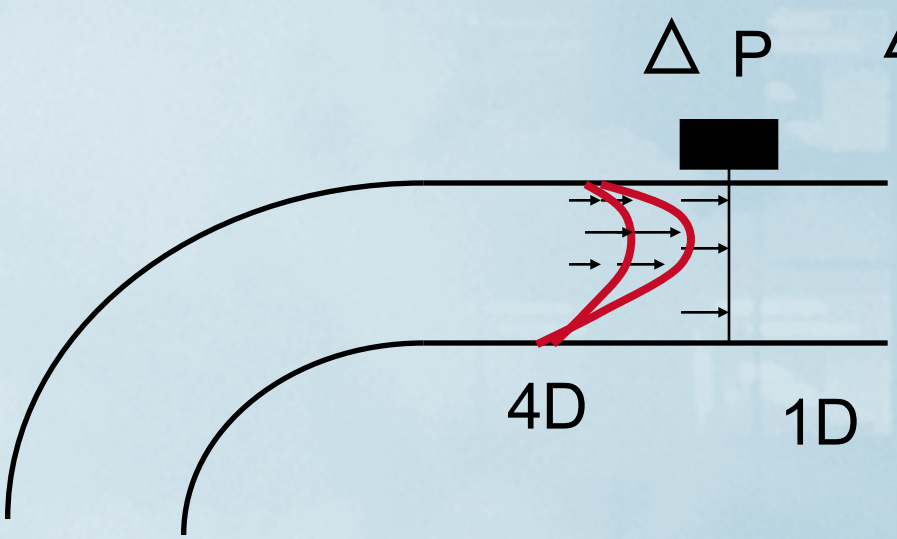
Source: ASHRAE Handbook—Fundamentals

Field Calibration Challenges



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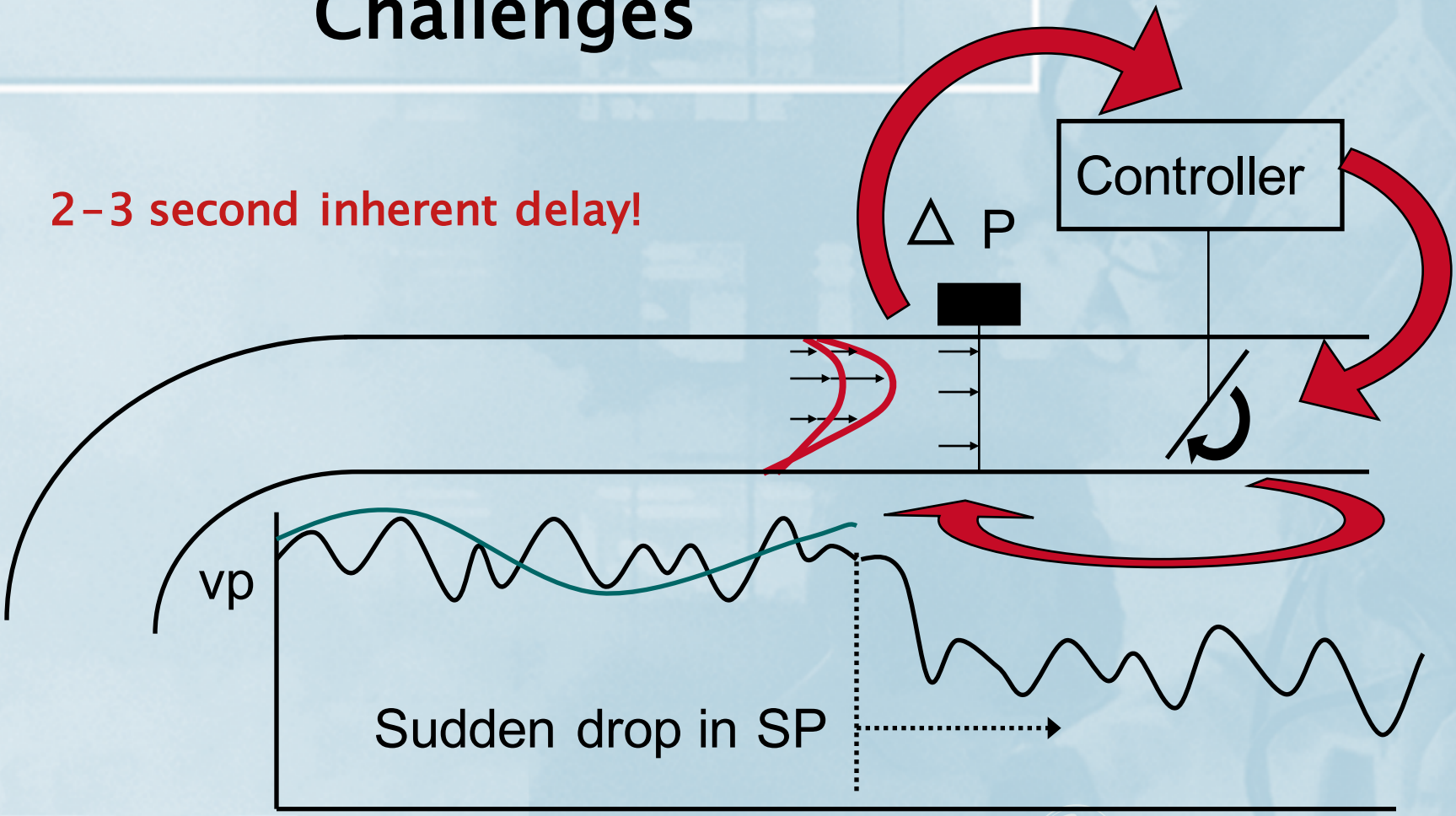
Source: ASHRAE Handbook—Fundamentals

Speed and Stability Challenges

2-3 second inherent delay!



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Maintenance Challenges

Optional removable SP300 Sensor is available and suggested for hospital grade jobs where sensor needs to be removed and periodically cleaned due to build up of lint.

All Metric dimensions [ ] are soft conversion.
Imperial dimensions are converted to metric and rounded to the nearest millimetre.

F-17

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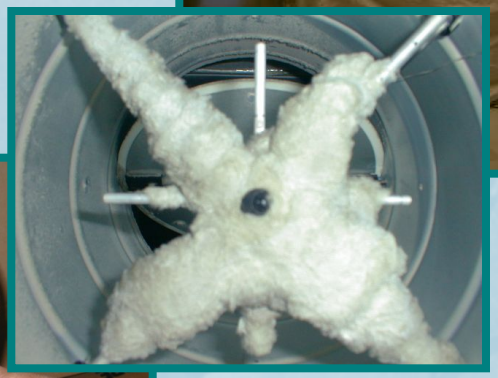
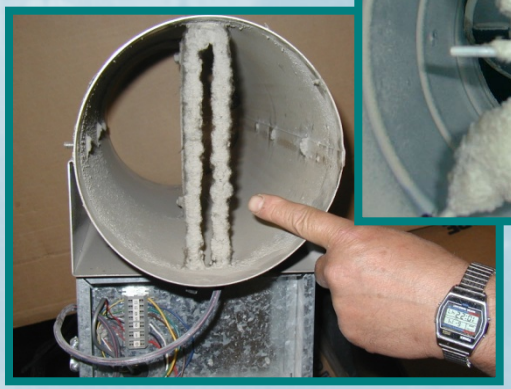
Maintenance Challenges

- Maintenance cost
  - exhaust flow sensor cleaning (2-4 times per year)
- Safety integrity via loss of room pressure
  - increased risk of HAIs
- Energy waste
  - flow rate





"Biggest disease hospitals have today is deferred maintenance." - Unknown

Design Summary

- Hospitals require ventilation systems that provide:
  - accuracy and stability for infection control and occupant safety
  - system adaptability for emergency response
  - elimination or reduction of maintenance
  - correct balancing and calibration
  - energy efficient operation
- VAV terminal boxes do not provide any of these attributes



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Phoenix Controls Solutions

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Phoenix Controls Corporation

A Worldwide Leader

- Founded in 1985
- Focus on critical environments
- VAV system performance leader
- Manufacturing and testing facilities
- 7000+ lab installations worldwide
- Provides the lowest life cycle costs
- Hundreds of thousands of valves installed
- Market coverage with the best partners in industry
- Local sales, application and service support

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Theris Experience

USA Installations

- Mayo Clinic, AZ
- Children's Hospital, Orange, CA
- City of Hope, CA
- Covidien, CO
- Florida Hospital, FL
- Ty Cobb Healthcare System, GA
- Madison Hospital, ID
- Carle Foundation Hospital, IL
- Riley Children's Hospital, IN
- Lake Regional Medical Center, KS
- Clark County Hospital Assoc., KY
- Children's Hospital, Boston, MA
- John Hopkins, MD
- Foote Health Systems, MI
- Cook Hospital, MN
- University Hospital Columbia, MO
- VA Medical Centers-National
- Memorial Mission Hospital, NC
- Lovelace Health Systems, NM
- Memorial Sloan Kettering Cancer Center, NY
- Nationwide Children's, Columbus, OH
- Sayre Memorial Hospital, OK
- Providence Health, OR
- Hershey Medical Center, PA
- Anderson Medical Center, SC
- St. Jude Children's Hospital, TN
- Texas Children's Hospital, TX
- Howard Hughes Medical Institute, VA
- Fletcher Allen Hospital, VT
- St. John's Hospital, WA
- Black River Falls Hospital, WI
- Benefis Hospital, MT



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Theris Experience

Worldwide Installations

- Alfred Hospital, Sydney, AUS
- Centre Hospitalier de la Sagamie, Sagamie, CAN
- East Kootenay Regional Health Centre, Cranbrook, CAN
- Toronto General Hospital, Toronto, CAN
- Jewish General Hospital, Montreal, CAN
- Lions Gate Hospital, Vancouver, CAN
- Manitoba Cancer Treatment and Research Foundation, Winnipeg, CAN
- Institute of Child Health, London, GBR
- Mater Misericordiae University Hospital, Dublin, IRL
- Haddassah Medical Center, Tel Aviv, ISR
- Treviso Hospital, Treviso, ITA
- Hima Healthcare, San Juan, PR
- Singapore General Hospital, Singapore, THA

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Theris Advantages

- Solutions for Healthcare
  - Lowest life cycle costs
    - lower installation and commissioning costs
    - lowest energy costs
    - minimal maintenance
  - IEQ/IAQ
    - quiet systems
  - Integration with BMS

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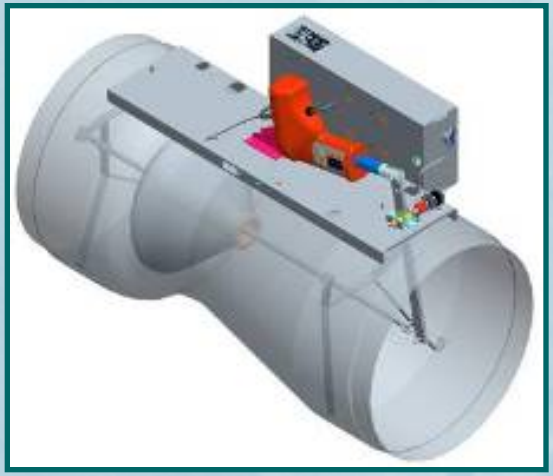
creating healthy environments



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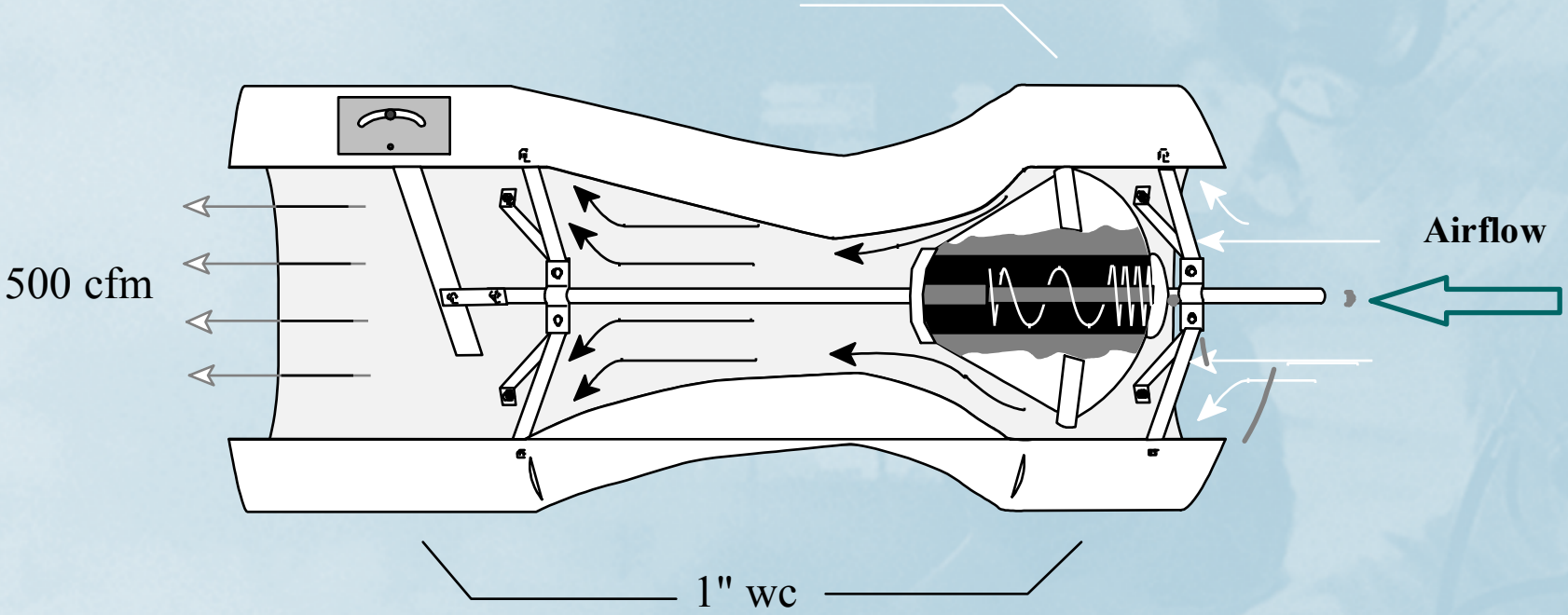
How Does the Phoenix Venturi Valve Work?





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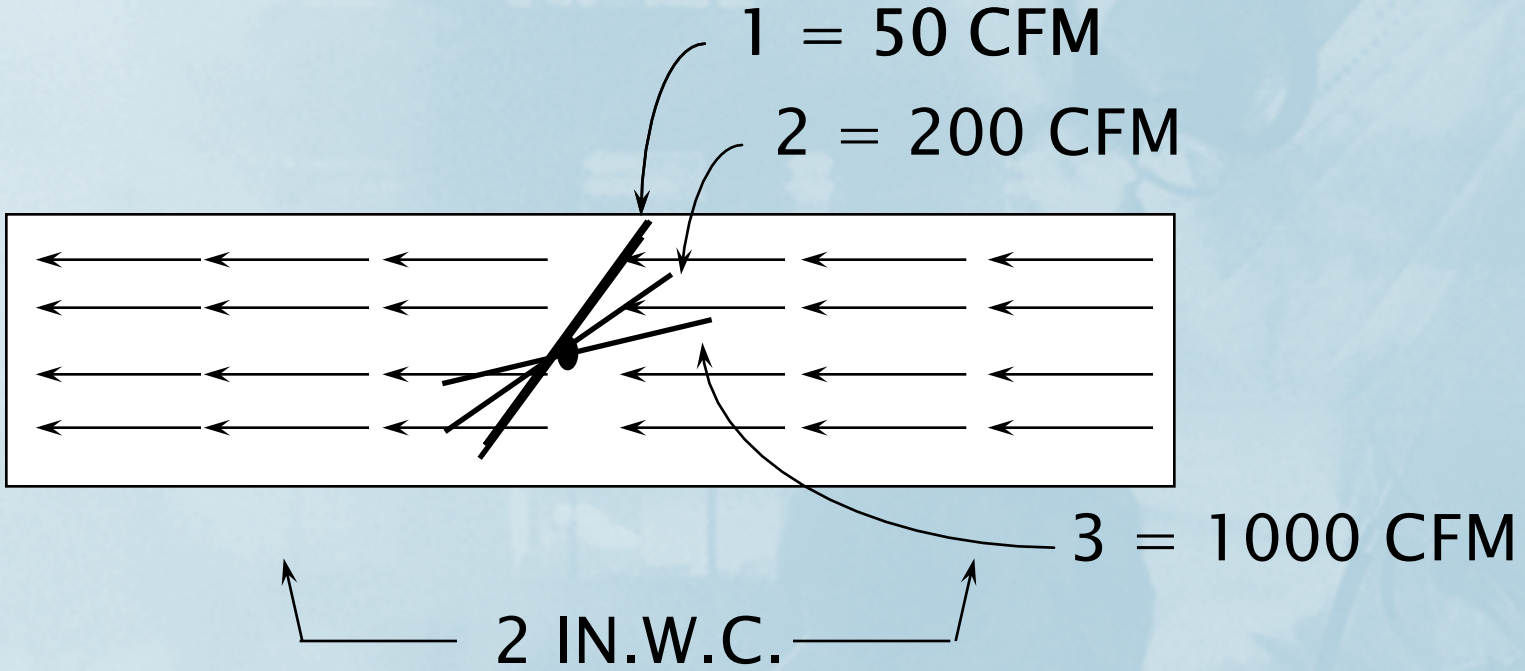
Manual Positioning



This pressure remains constant



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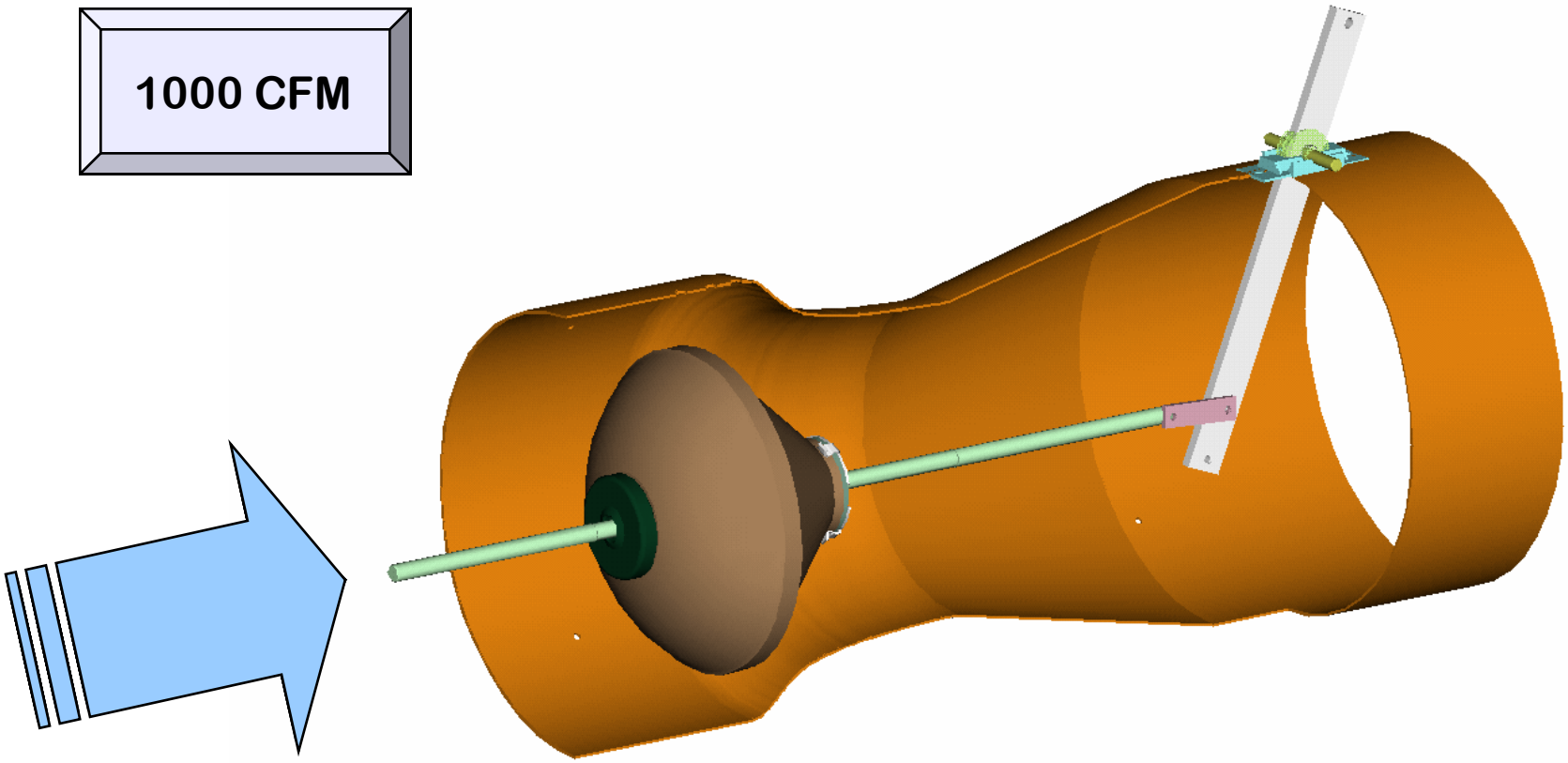
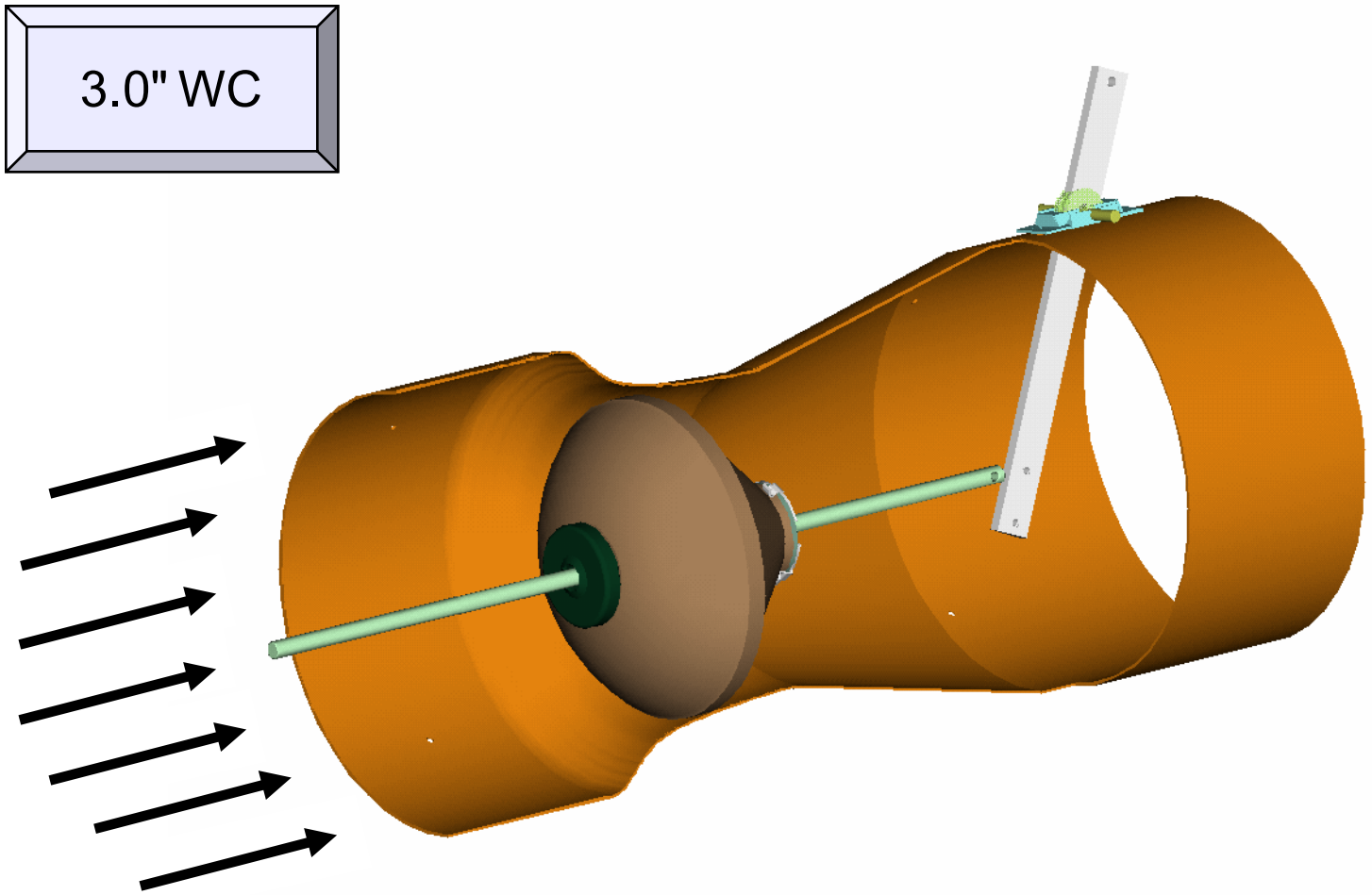
Flow Metering for Control

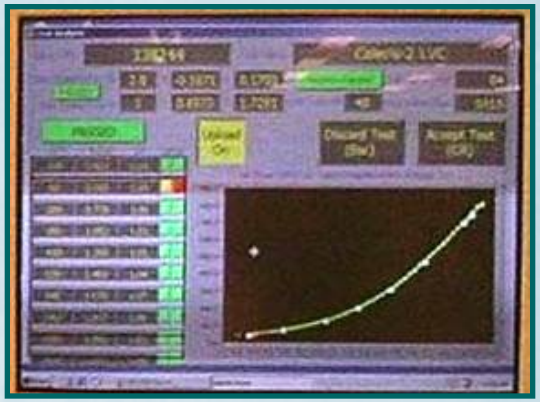


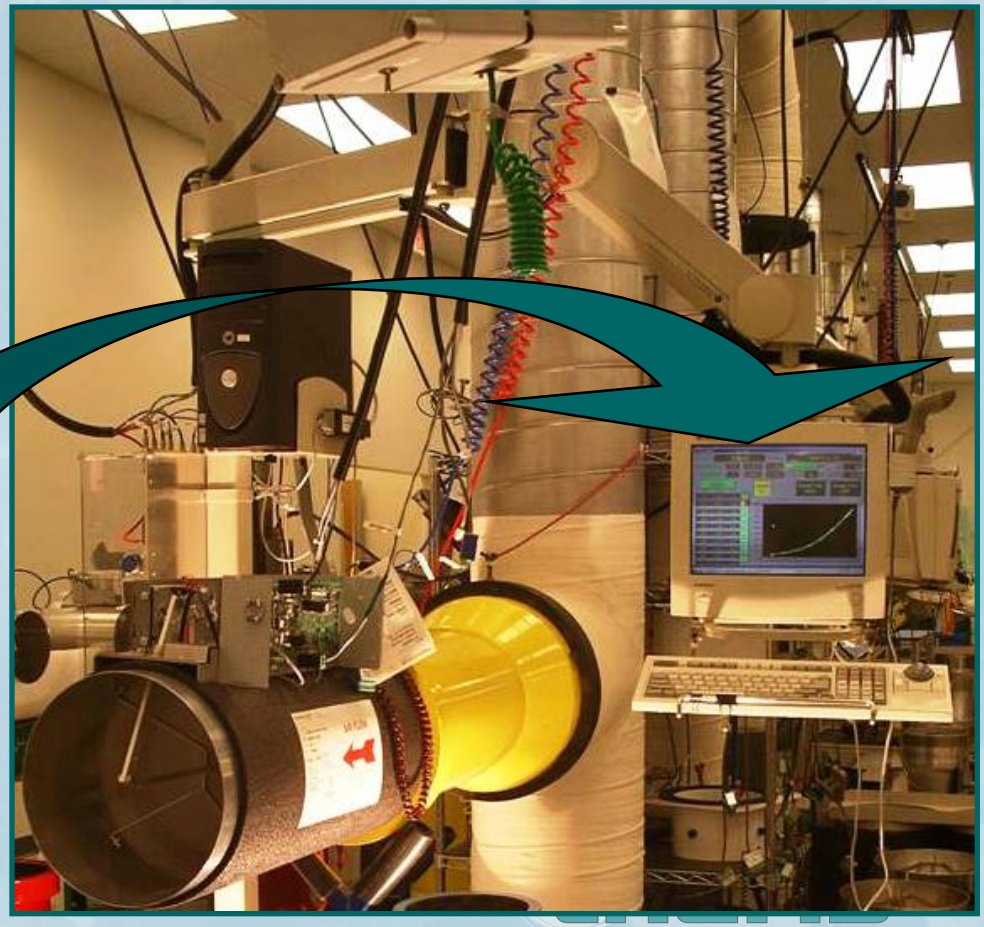
Pressure Independence



Factory Characterization

- NIST traceable air stations
- Digital characterization
- Reduces startup time
- Improves accuracy
- Simplifies balancing





Duct Insensitivity

- No flow measurement
- No straight duct runs required
- Inlet/exit insensitive
- Reduces required ductwork up to 30%
- Simplifies installation



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Theris Products

Theris-TX

- Tracking pair
- Pandemic mode
  - Shutoff
- Optional Add 2 UI
  - Humidity control
  - Pressure monitoring

- Isolation room
- Operating room
- Pandemic patient rm
- Hospital pharmacy

Theris-TP

- Tracking pair
- Pandemic mode

- Isolation room
- Pandemic patient rm
- Hospital pharmacy

Theris-SO

- Supply-only
- Ducted exhaust
- No ability to track exhaust

- Standard patient rm

Theris-CV

- Constant volume
- Theris branded

- Isolation room
- Patient room



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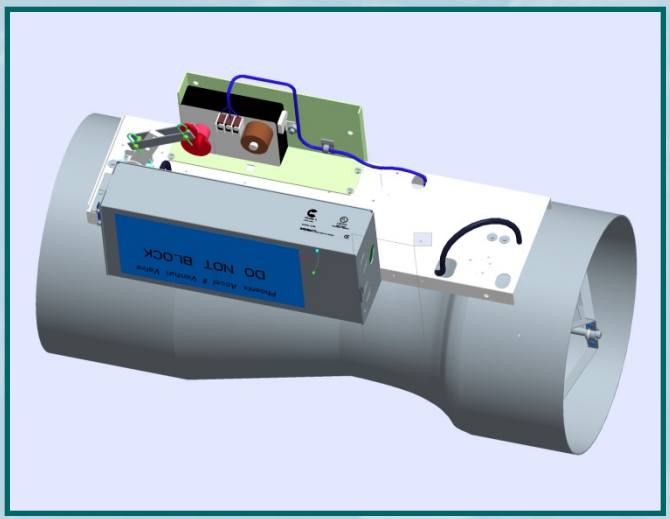
Built-in Control Functions

- Primary and secondary temperature control
- Humidity control
- Occupancy
- Emergency modes
- Pandemic mode
- IAQ control
- Adaptive offset control
- Decontamination sequence



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Room Applications

Typical Hospital
Critical Environments

- Isolation rooms
- Operating rooms
- Emergency
- Specialty spaces
  - pharmacies, autopsy, morgue
- Laboratories
- Patient rooms, pandemics areas
  - qualify today as critical spaces



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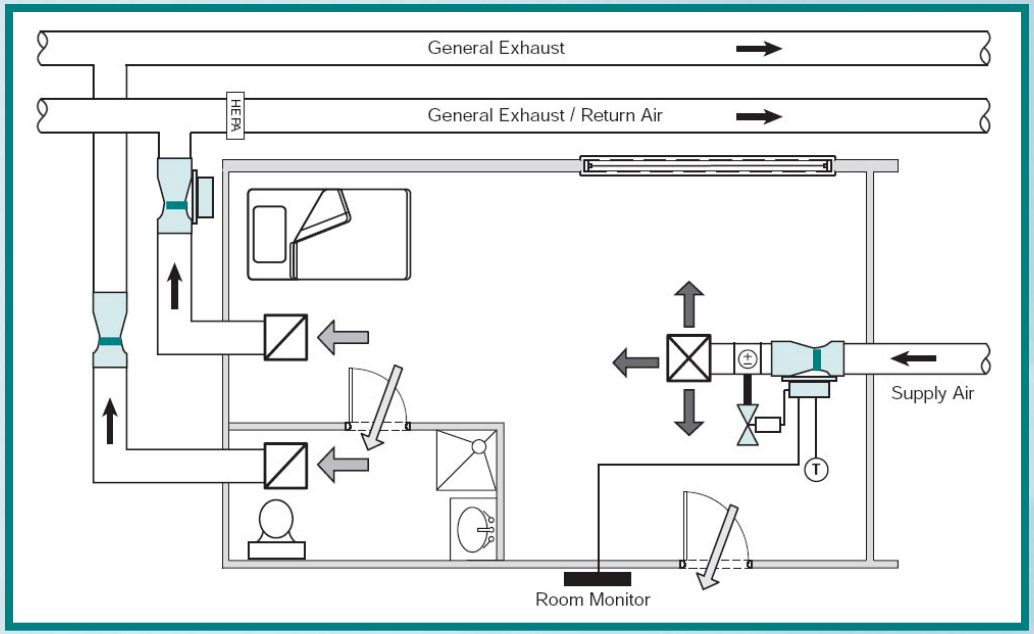
Pressurized Applications

Cystoscopic procedure	P	Radiology waiting room	N
Triage	N	ER waiting room	N
Intensive care	P	Medication room	P
Burn unit	P	Physical therapy	N
Laser eye room	P	Laundry	N
Endoscopy	P	Janitor's closet	N
Endoscope cleaning	N	Soiled supply room	N
ER decontamination	N	Clean workroom	P
Radiology X-ray catheterization	P	HazMat storage	N
Newborn intensive care	P	Linen shute	N
Trauma room	P	Darkroom	N
Delivery room (Caesarean)	P	Medical gas room	N
Pharmacy	P	Autopsy	N
Toilet	N	Body-holding	N
Bathing	N	Hydrotherapy	N
Bronchoscopy	N	Sterilization equipment room	N

Click here for details

Isolation Rooms—TX



Customer Benefits

- Tracking pair with extended features
- Higher turndown than box
- Support for room pressure monitor
- Shut-off valve bodies for decontamination



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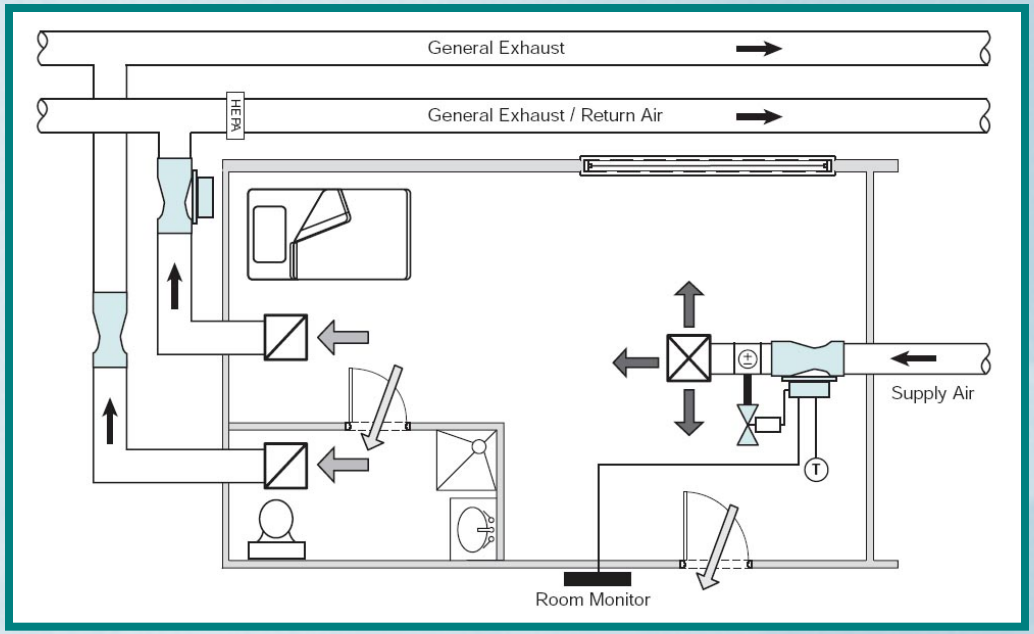
Isolation Rooms—TP



Customer Benefits

- Standard tracking pair
- Higher turndown than box
- Support for room pressure monitor is possible

Missing Features

- No shut-off available in Theris-TP
- Discharge air (used for APM)—must map and scale pressure monitor input



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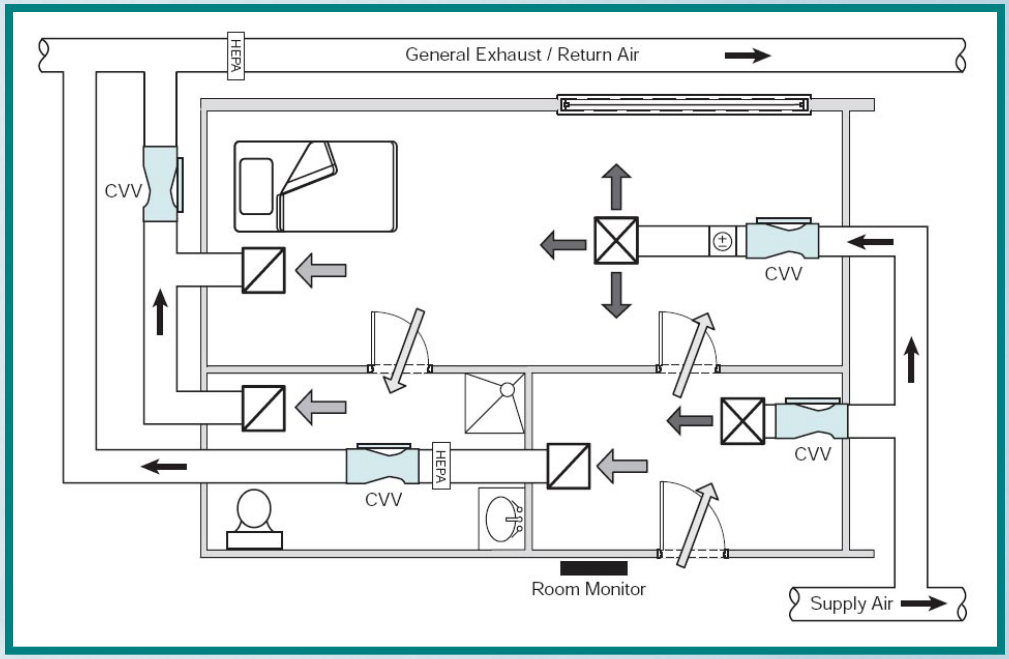
Isolation Rooms—CV



Customer Benefits

- Constant volume ensures directional airflow
- PTC100 room temperature control
- Lowest cost

Missing Features

- No turndown to save energy
- Pressure monitor integrated directly to BMS
- Added cost of PTC100
- No shut-off capability



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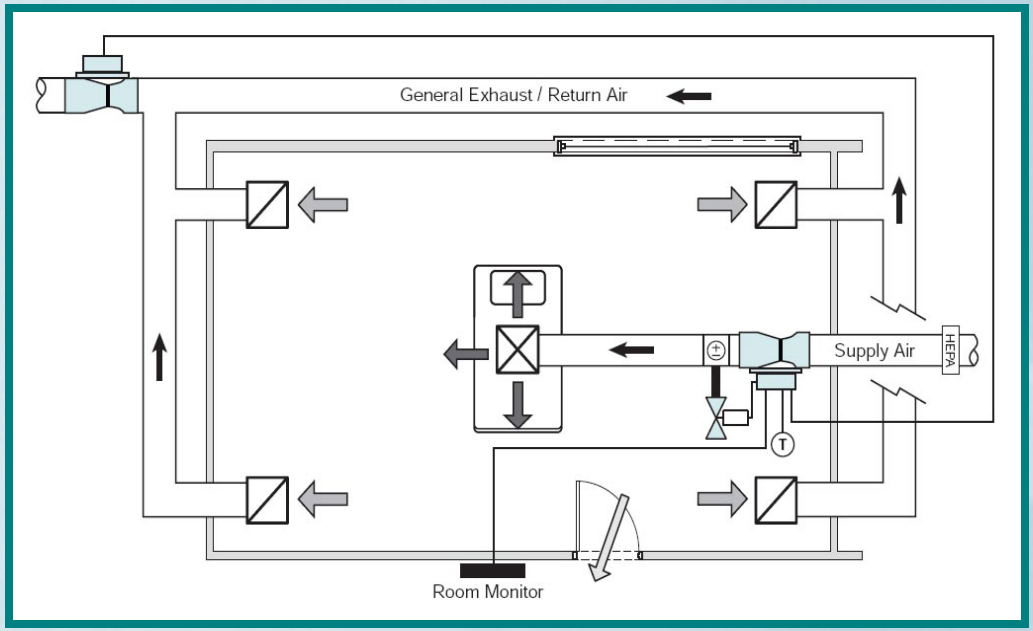
Operating Room—TX



Customer Benefits

- Tracking pair extended features
- Higher turndown than box
- 14" valve means 2,500 CFM
- Support for humidity monitor
- Support for room pressure monitor
- Shut-off valve bodies for decontamination



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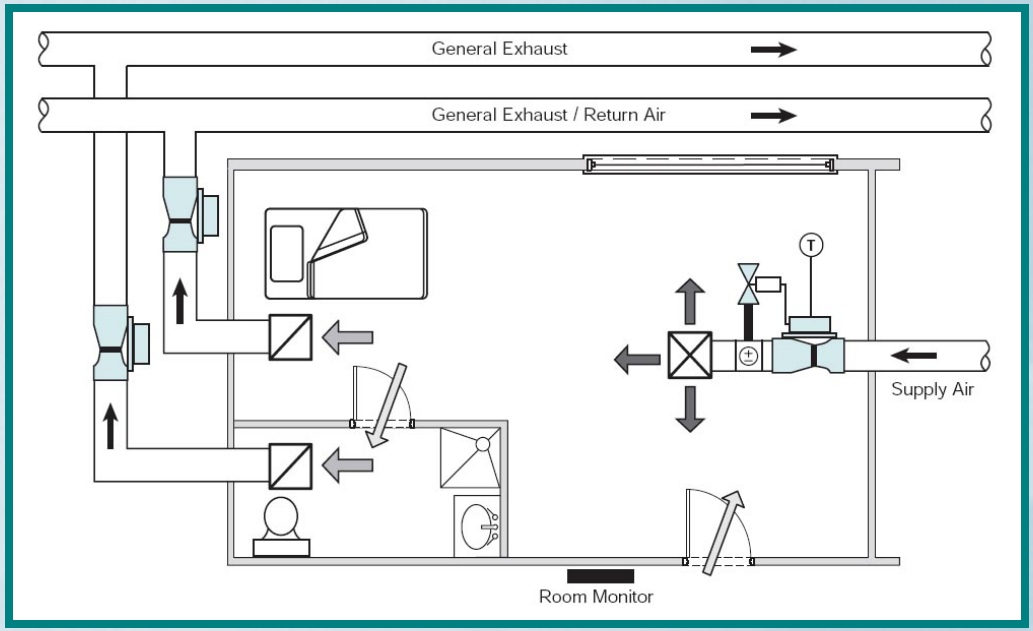
Pandemic Patient Room—TX



Customer Benefits

- Tracking pair extended features
- Switchable rooms for pandemic events
- Open LON® means BMS can activate pandemic sequence
- Shut-off valves for decontamination



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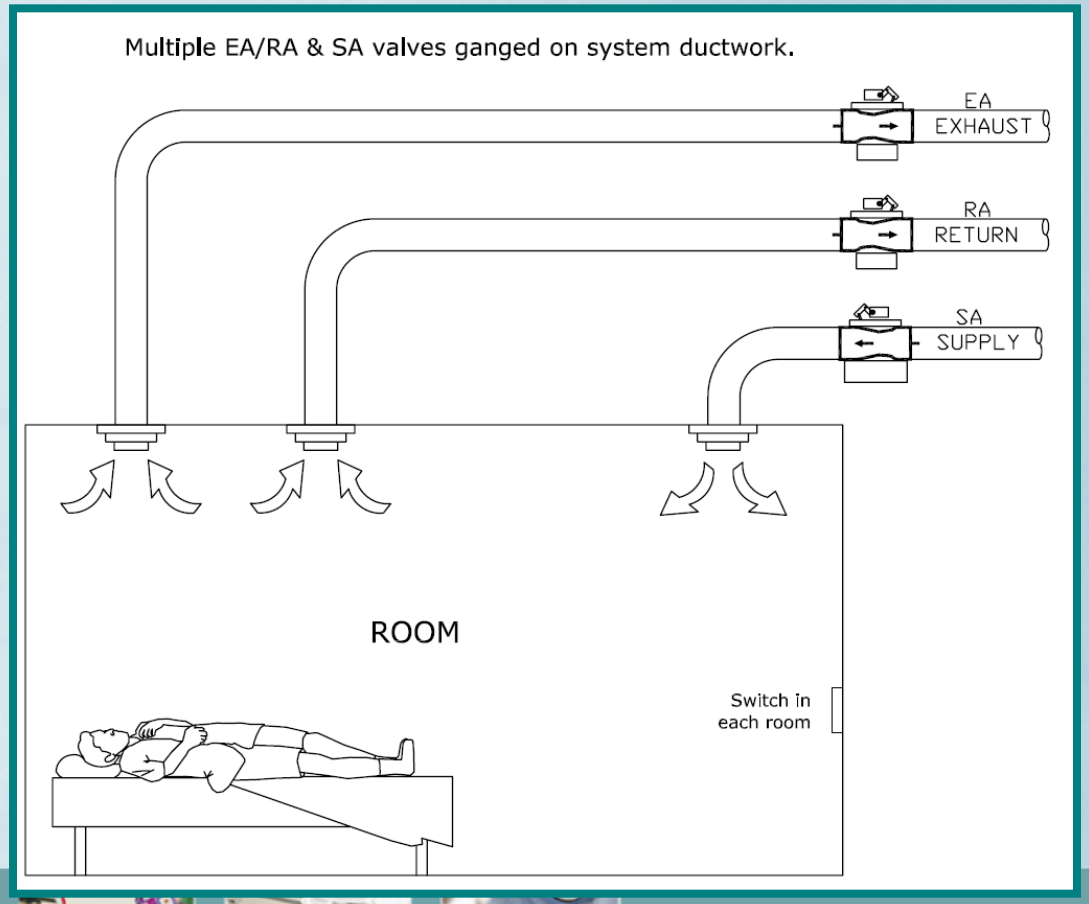
Pandemic TX Sequence

Dual Duct Exhaust



- **Normal Mode**
  SA and RA track for negative offset and temperature control. EA shuts off tight.
- **Pandemic Mode**
  When a switch is depressed, the RA shuts off and the SA and EA track to maintain a negative offset. In all other rooms EA remains shut off while SA and RA track for positive offset and temperature control.

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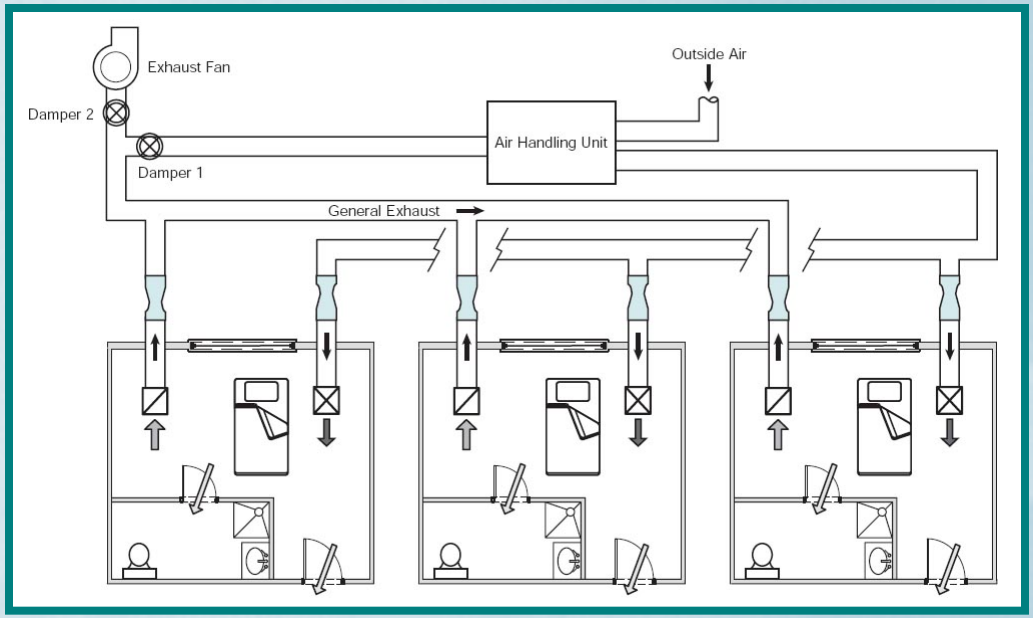
Pandemic Patient Room—TP



Customer Benefits

- Standard tracking pair
- Higher turndown than box
- Switchable rooms for pandemic events
- Open LON means BMS can activate pandemic sequence

Missing Features

- No shut-off with Theris-TP
- Need dampers to control sequence
- Need dampers to close for decontamination



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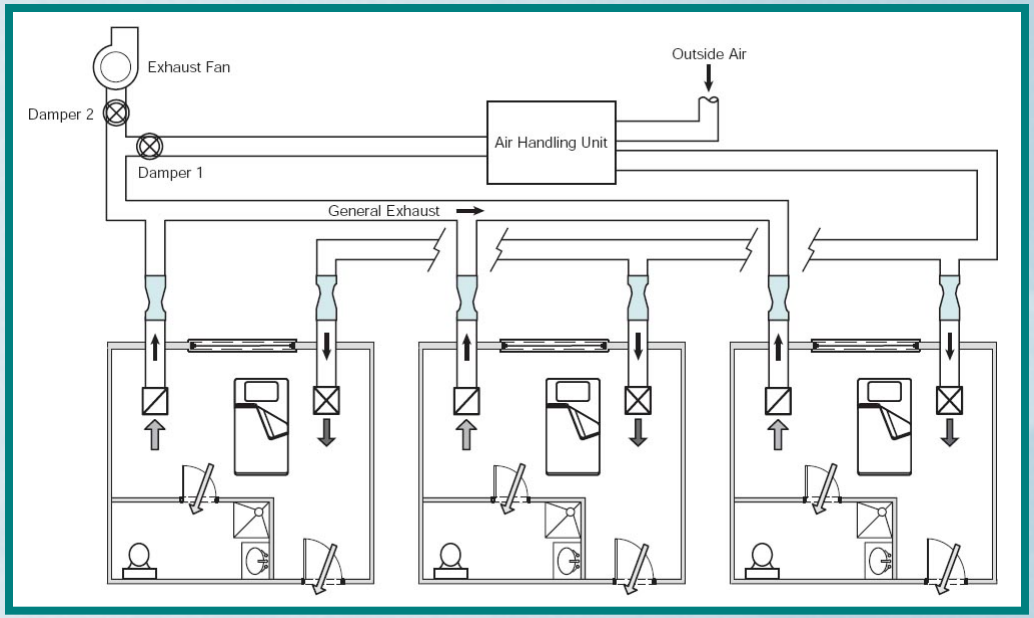
Pandemic TP Sequence

Common Duct Exhaust



- **Normal Mode**—SA and RA track for negative offset and temperature control. EA shuts off tight.
- **Pandemic Mode**—When a switch is depressed, the RA shuts off and the SA and EA track to maintain a negative offset.
  In all other rooms, EA remains shut off while SA and RA track for positive offset and temperature control.



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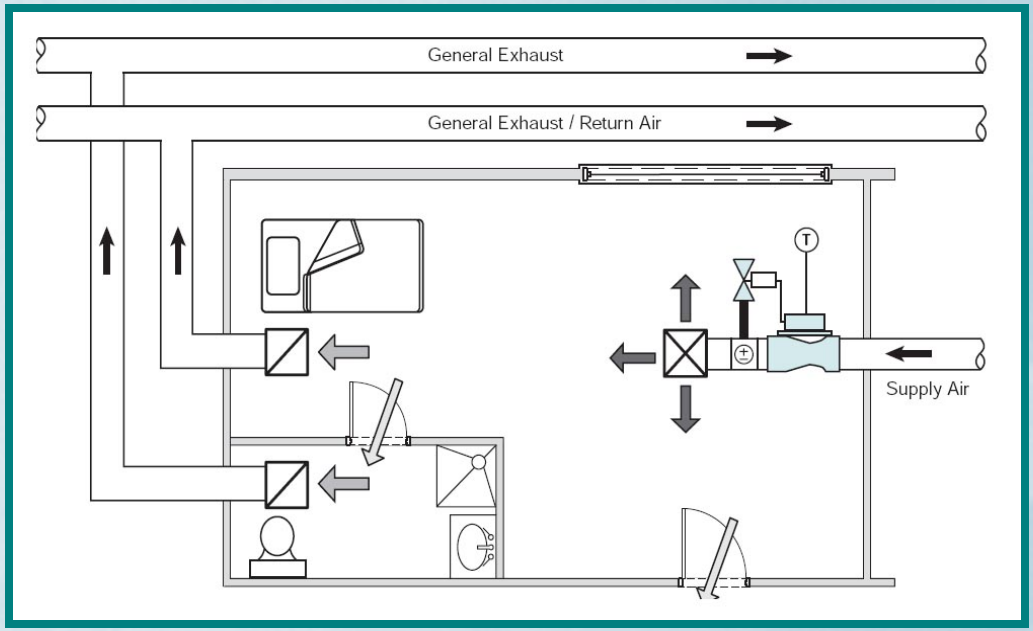
Standard Patient Room—SO



Customer Benefits

- Cost effective supply valve for ducted exhaust applications
- Meets minimum AIA guidelines

Missing Features

- No pressurization
- Not upgradable to tracking pair



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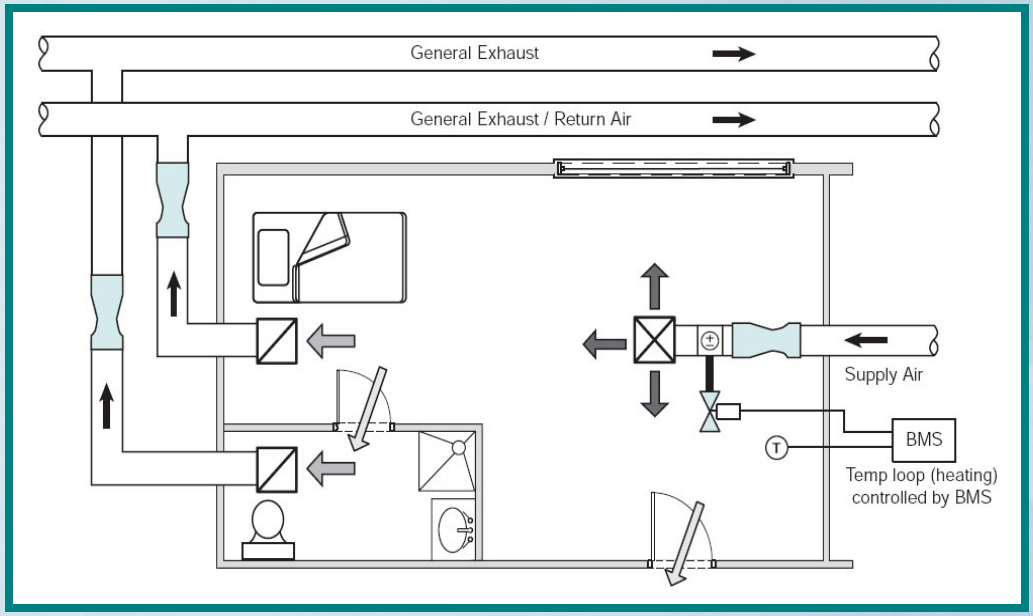
Standard Patient Room—CV



Customer Benefits

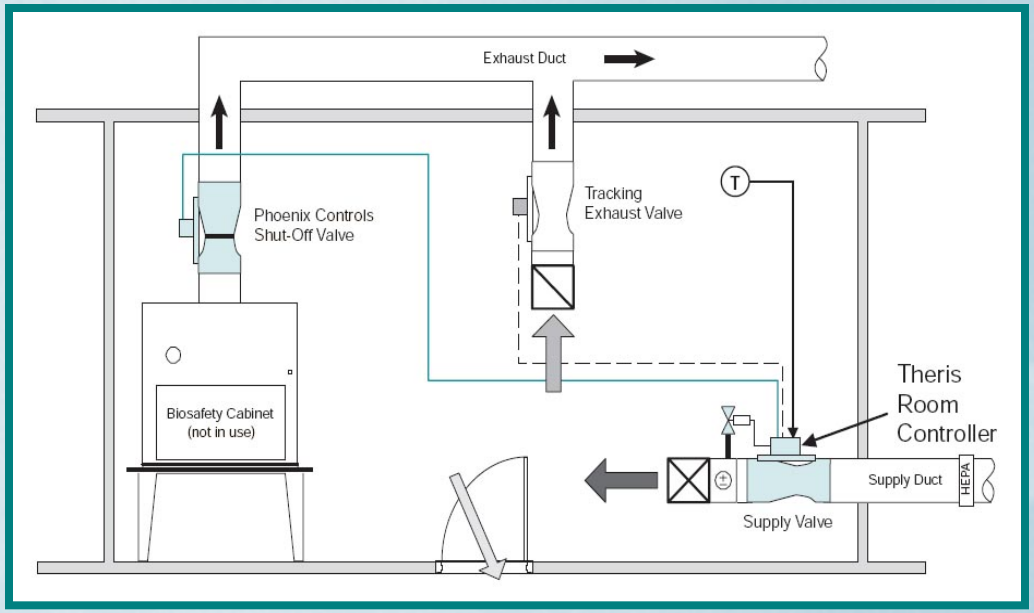
- Constant volume ensures directional airflow
- PTC100 room temperature control
- Lowest cost

Missing Features

- No turndown to save energy
- Added cost of PTC100



Hospital Pharmacy
TP and TX



Customer Benefits

- Standard Tracking Pair
- Higher turn-down than box
- Directional airflow important for compound preparation
- Theris-TX valve on BSC can be driven to shut-off when not in use



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Sensors and Monitors

- Temperature and humidity sensors
- Thermostats
- Pressure monitors
- Local display units

Click here for details



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Active Pressure Monitor

Advanced Pressure Monitor 2

- **Identification de la pièce**
  Nom de pièce sur mesure
- **Pressurisation de la pièce**
  Positive, Négative, neutre ou ''en attente''
- **État de la pièce simplifié**
  Normal, Avertissement ou Alarme
- **Pression actuelle**
  Pouces d'eau (''H_20) ou Pascal (Pa)
- **Barre de déplacement de pression**
- **Menu de programmation**
- **Affichage des conditions de la pièce**



Temperature Control—VAV

- Temperature and temp/humidity sensors
  - Display
  - Override
  - Setpoints
  - Different enclosure options
  - Wall and duct mounting
  - Washdown option

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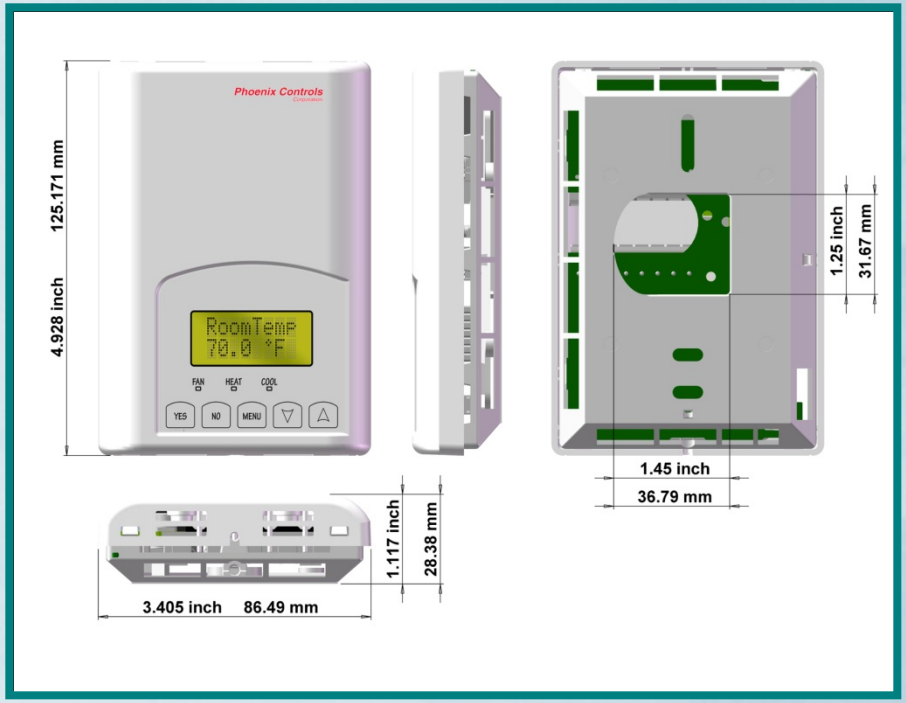
Temperature Control—CV



- Temperature control for constant volume applications
- PTC100 communicating thermostats
  - zone reheat control
  - floating or analog
  - LON
  - BACnet



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Local Display Unit

- Local display panel
- Read/write any point on the Theris system
- 24 Vac/Vdc operation
- Flush or surface mount options
- 3 levels of password protection
  - None
  - Read only
  - Full access



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Integration

- LonMark® Certified solution
  - Theris is LonMark certified
  - Direct LON integration
- BTL Certified BACnet solution
  - Theris via Phoenix Controls Servers
- All points and I/Os are available to the BMS

Click here for details



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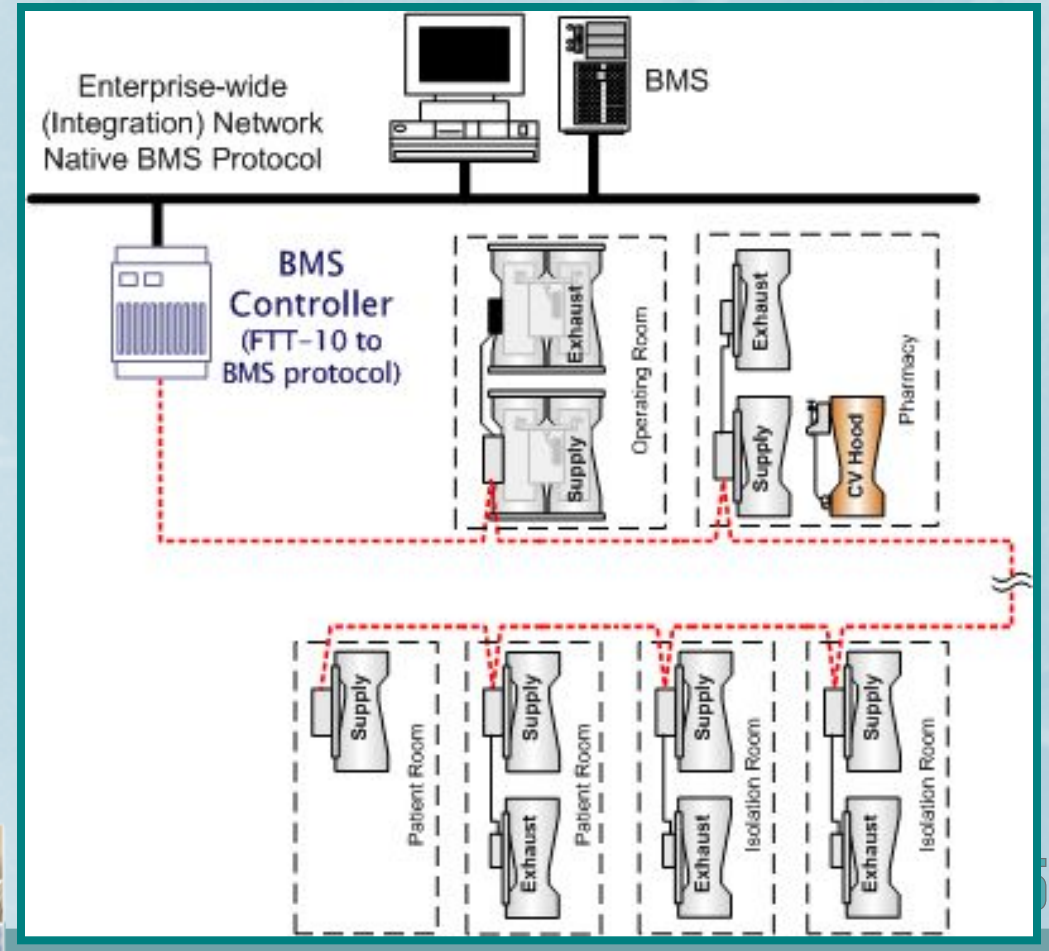
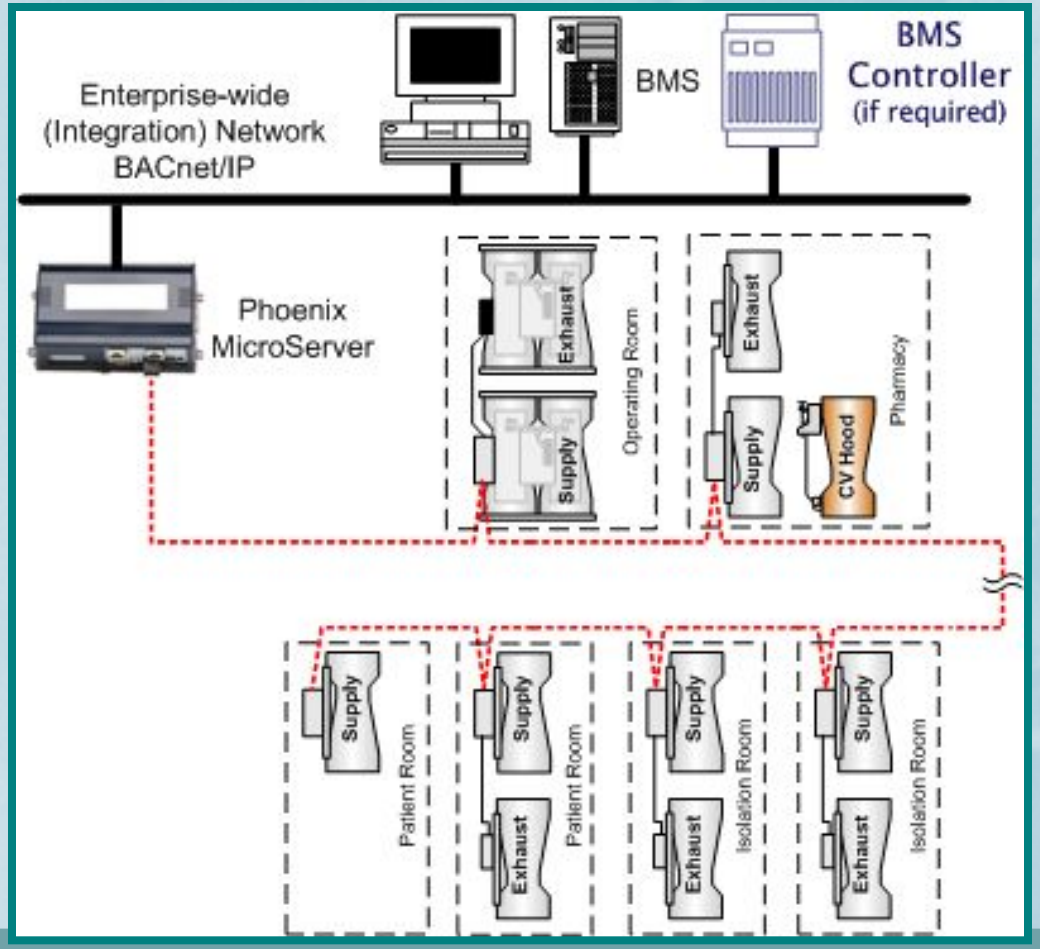
LON® Integration

- Remote I/O
- Open to BMS
- LonMark Certified



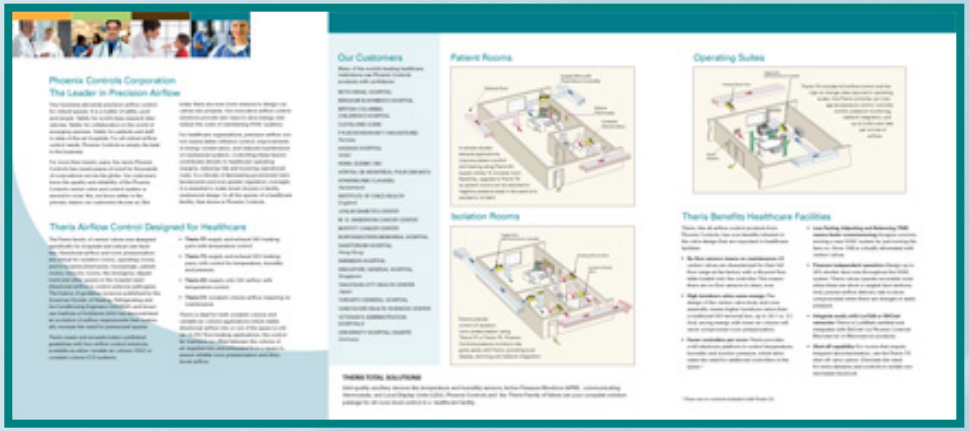
BACnet Integration

- BTL Certified BACnet IP/ Ethernet solution
- MacroServer for large systems
  - up to 6000 points
- MicroServer for small or modular systems
  - 350 points per device



Design Tools

- Healthcare sourcebook
- Theris brochure
- Healthcare Guidelines Comparison Chart



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Theris Advantages

- No flow sensors ensures VAV can be done without compromising directional airflow
- Higher turndown ratio than VAV box saves more energy
- Pressure independence means directional airflow maintained
  - when HEPA filters get loaded
  - under emergency power when static pressure is lower
- Full room control means fewer vendor controllers
- Factory characterized valves
  - projects stay on schedule
  - faster commissioning, less balancing
- Built-in control functions means less programming and healthcare specific sequences
- LonMark certified eases BMS integration



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Summary

- Phoenix Controls enables hospitals to:
  - reduce energy costs
  - reduce the airborne transmission of HAIs (healthcare associated infections)
  - reduce maintenance costs related to terminal devices
  - increase design flexibility to meet recent guidelines and evolving design trends



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Thank You!

Laurent Poirier

Phoenix Controls

Sales Engineer

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