Applied Products Group

WELCOME

Demand-Controlled Fan Coils Williams

Managing fan and pump horsepower

Applied Products Group

ONDemand

Fractional horsepower
blower motors
Circulators
– NO control valves
- NO terminal balancing valves

WILLIAMS RE-ENGINEERING COMFORT FOR THE 21ST CENTURY

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WILLIAMS HEADQUARTERS – COLTON, CALIFORNIA

- General Management
- Accounting
- Human Resources
- Distributor Channel Management
- Product Engineering
- Factory Management

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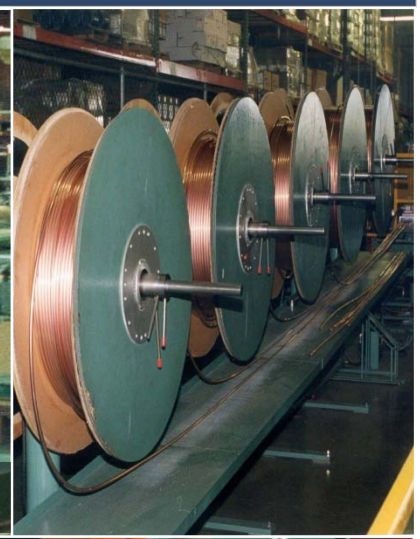
VERTICALLY INTEGRATED MANUFACTURING



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- **Flexible Coil Design Capabilities**
  - **Coil Construction Standards & Options**
    - **½" Copper Tubes**
    - **Aluminum or Copper Fins**
    - **Galvanized or Stainless Steel Coil Casings**
    - **Phenolic Coated**
  - **Hot Water, Chilled Water, DX or Low Pressure Steam, Freeze Proof Coils**

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APPLIED PRODUCTS HEADQUARTERS – OKLAHOMA CITY

- Customer Service
- Technical Services
- Application Engineering
- Product Engineering
- Product Management
- Sales Management

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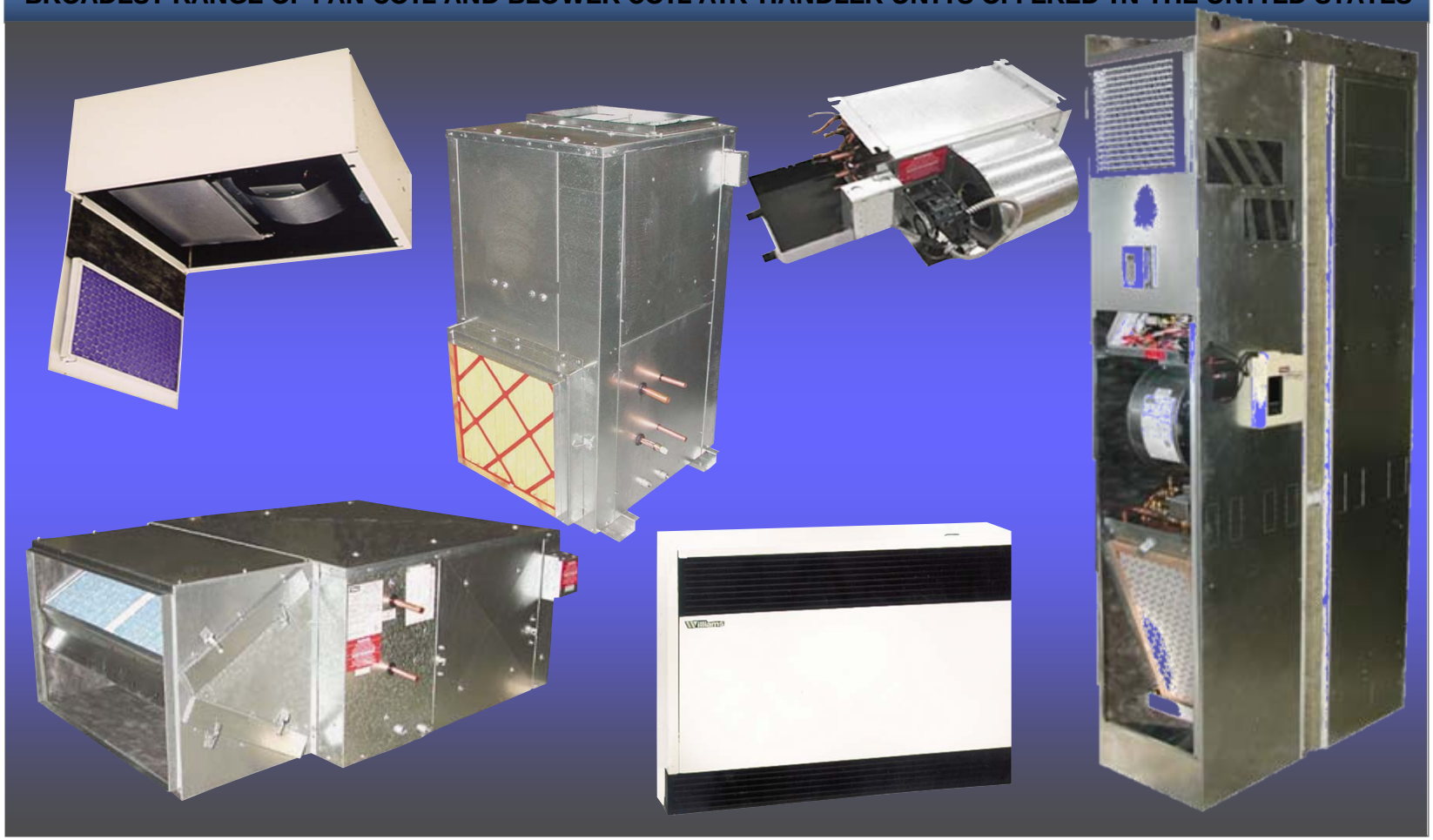
BROADEST RANGE OF FAN COIL AND BLOWER COIL AIR-HANDLER UNITS OFFERED IN THE UNITED STATES



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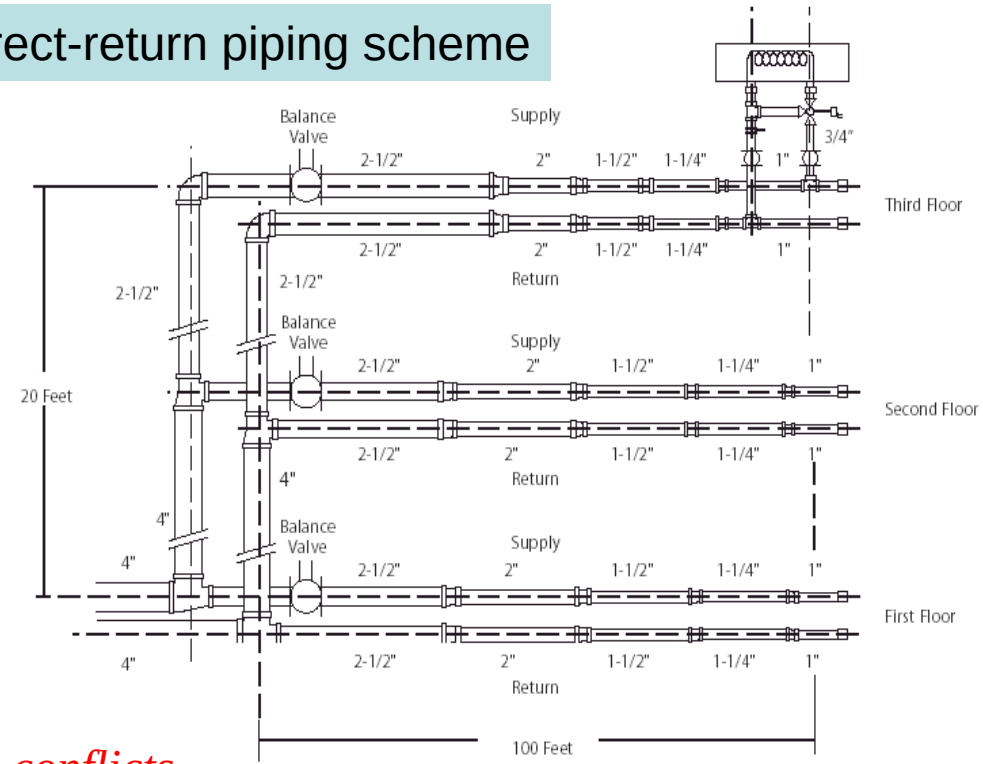
Management of low flow to Fan Coils

Conventional Pipe Sizing Exercise

1. Define zones
2. Select equipment
3. Record GPM
4. Size Pipe
5. Manage
   Flow
   Pressure
6. Size Pump(s)

Direct-return piping scheme



Creates pressure and flow conflicts

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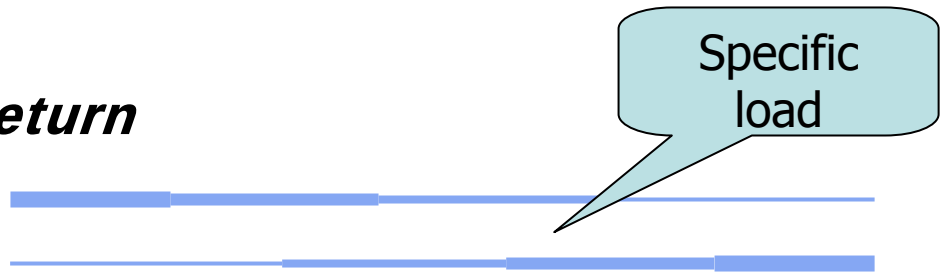
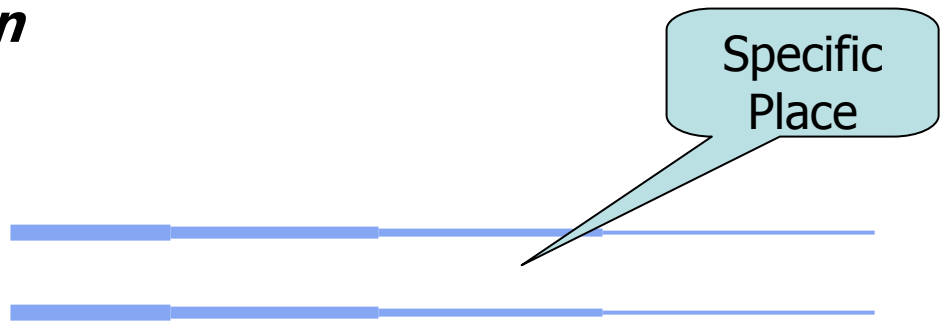
Conventional Design Process

Parallel Piping Systems

- ***Reverse Return***



- ***Direct-return***



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Pump logic

- **Parallel pumps**
- **Ride the curve**
- **VFD**
  - **Where to sense pressure**
  - **Pressure by-pass, does it work?**
  - **50% flow reduction, 75%?, 90%????**
- **Where does that water go?**
  - **2-way control valves – off? Pressure Builds**
  - **3-way valves?**
  - **Circuit setters?**
  - **Automatic Flow Limiting Devices?**

Control valve Differential Pressure ??

Resolution of pressure and flow conflicts

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How is ONDemand – Simpler?

Typical zones – select a package with a constant speed circulator

Critical performance

- Package with variable speed circulator
- Engineered selection with variable speed
- Parallel pipe; if constant EWT required

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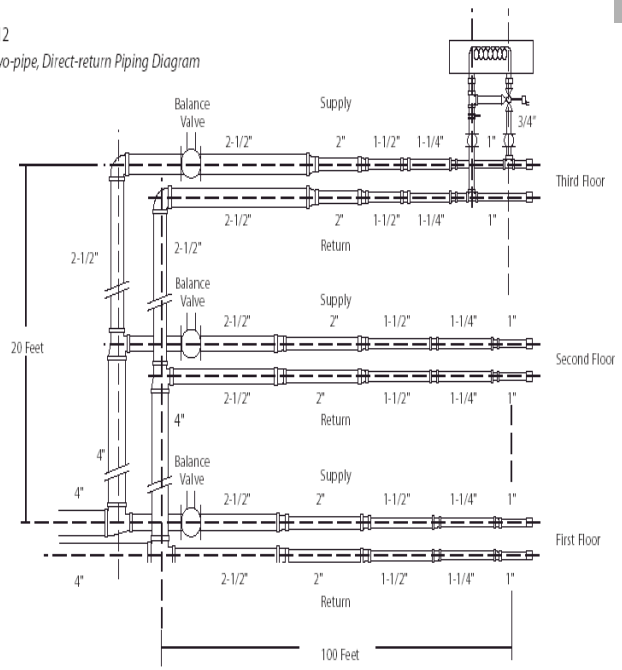
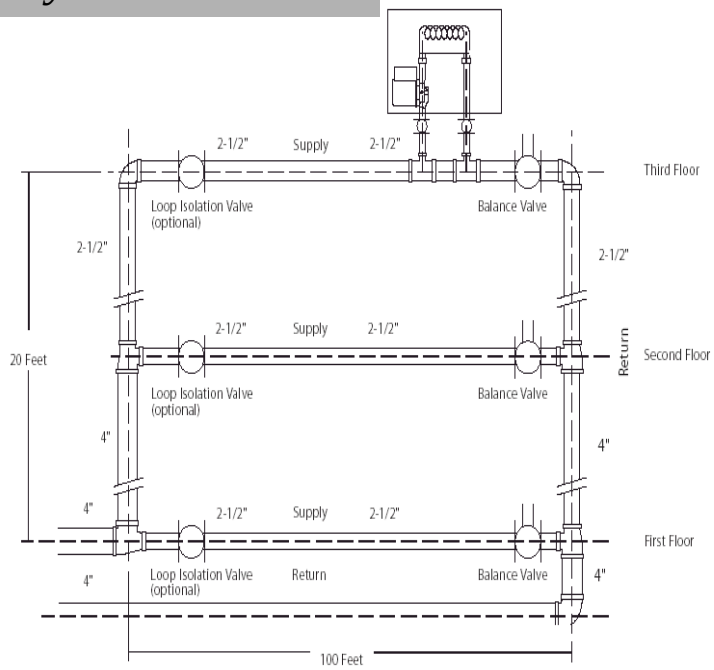
which BOM do you want to manage?

Flexible hydronic solution

Figure 12
Basic Two-pipe, Direct-return Piping Diagram





Compare design, installation, operation and FLEXIBILITY

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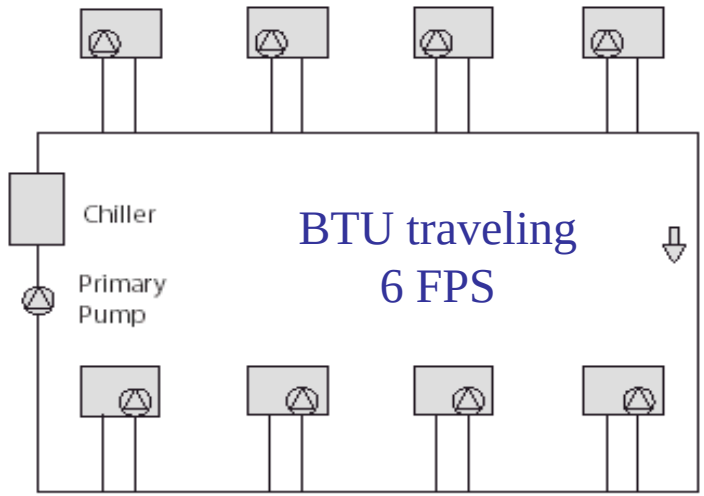
Terminal System Diversity – Capacity vs. actual

Performance versus design capacity

- ***Exposure***
- ***Occupancy***
  - **School classroom vs. Common areas**
  - **Hotel room vs. meeting/convention**
  - **Offices vs. conference**
  - **Usage patterns, time of day**
- ***Run Time***
  - **Actual operation**
  - **30% annually**
  - **20 minutes per hour**
  - **Unit unloading – 40%**
  - **Fan speed – 50%**



Simultaneous operation?

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What is ONDemand? The System

LoadMatched™ pumping initial development

Prior to 1991

Goal Simplify hydronic systems:

Primary concern was high head caused by adding automatic flow controls to every unit to balance system – manually it was just difficult.

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Goals

- **Self-Balancing**
- **Reduce pressure drop**
- **Simplify**

Results

- Self-Balancing & Reduced pressure drop
- Lower installed cost
- Lower operating cost

BONUS

- A simple flexible hydronic system

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- ONDemand System Details

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- ASHRAE describes as:

Series flow diverting with load pumps

A block of zones are served by a single pipe for heating and a single pipe for cooling.

A 4-pipe system with 2x4-pipe distribution

The mechanical room and mains are 4-pipe

The units are 4-pipe units

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- What is ONDemand? The Fan Coil Unit
  - Fractional horsepower fan motor
  - Fractional horsepower circulator
  - Heating coil
  - Cooling coil

    - Eliminate valve package
      - Control valves, close off pressure, Cv selections
      - Flow controls
      - Test ports, strainers
        - » REDUCES SYSTEM HEAD PRESSURE

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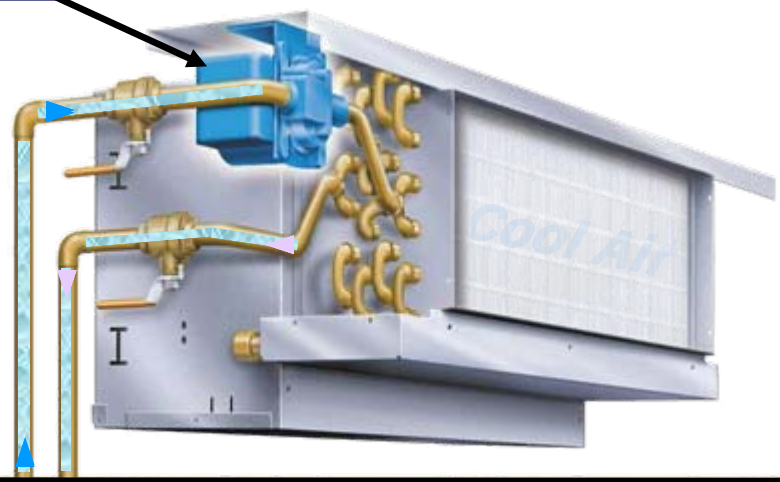
Integrated Circulator Creates Specific Flow On Demand



Primary Circuit Water Flow

BTU Flow @ 4-8 FPS

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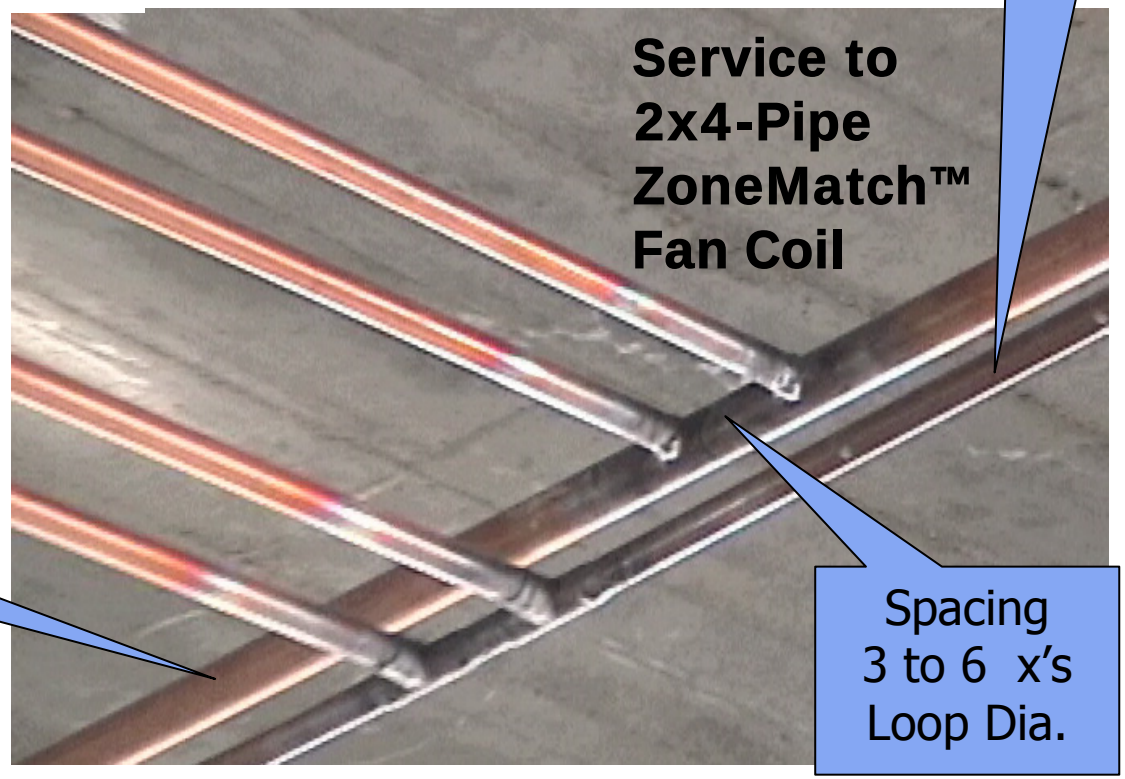
GPM =
Capacity / 500 x Delta T



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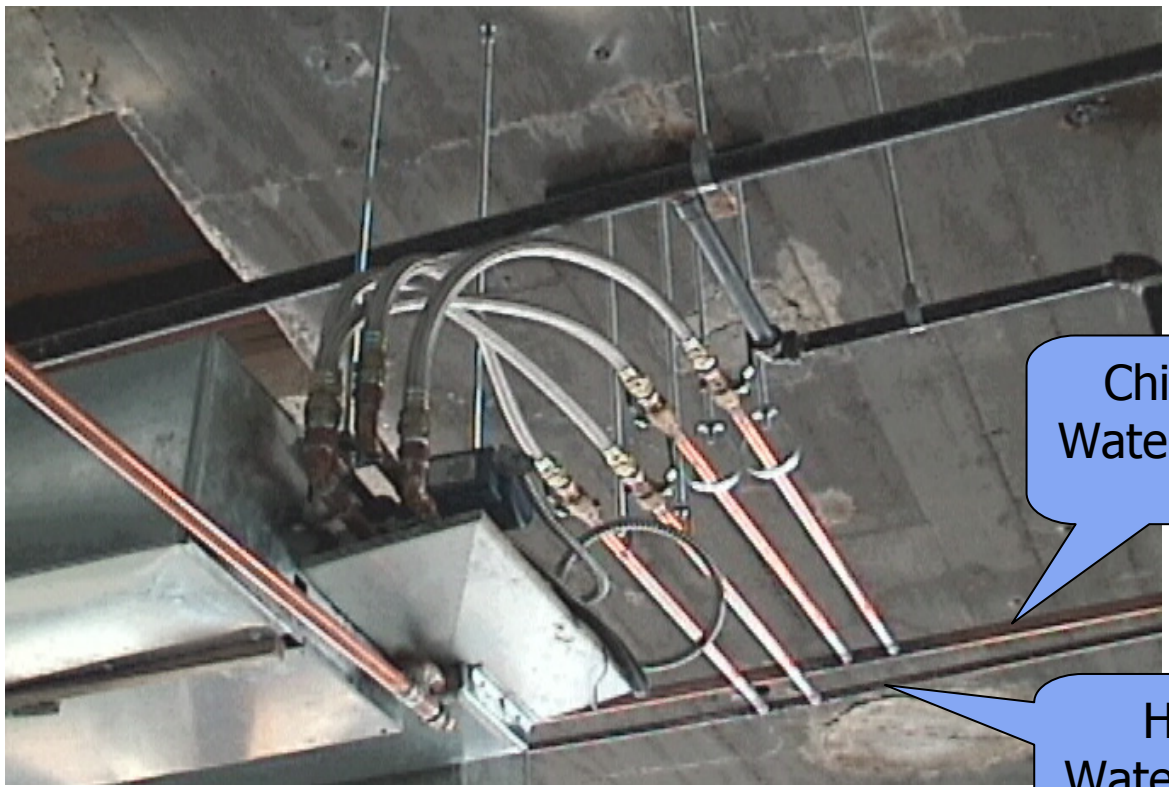
2x4-Pipe ONDemand

A flexible hydronic solution



Before Insulation applied

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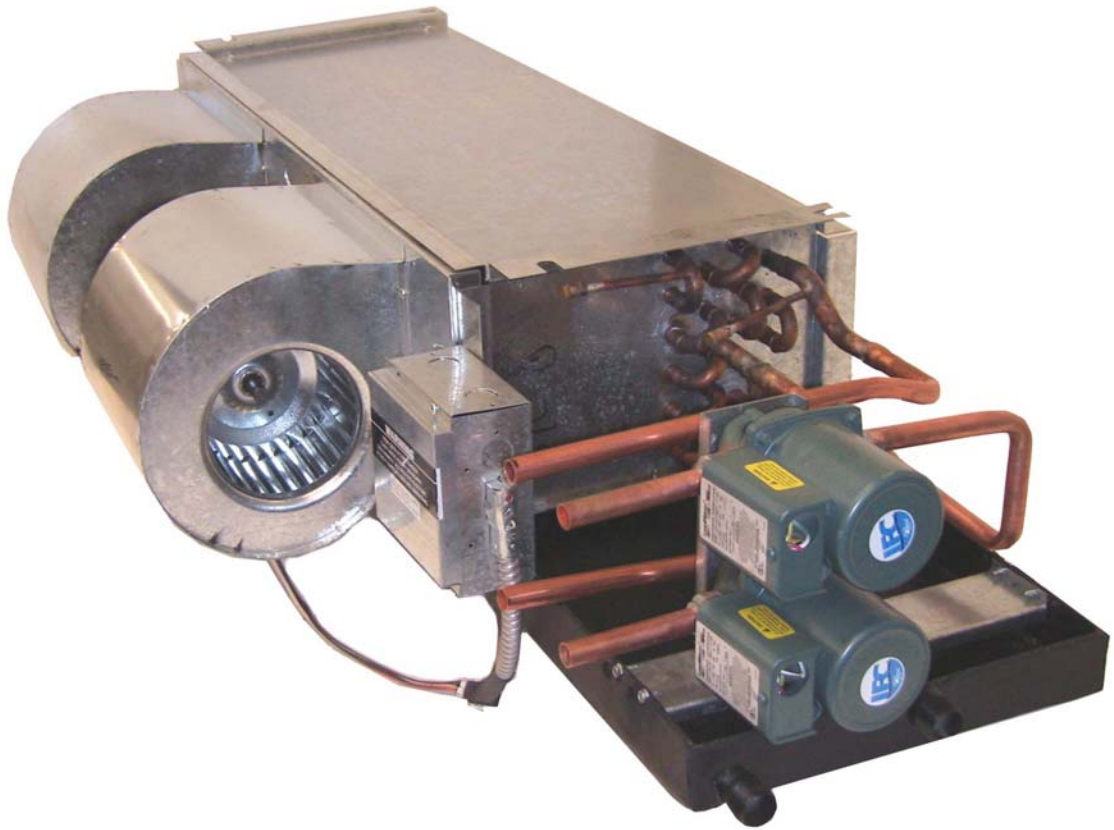
ONDemand - LH



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Wet Rotor Circulator

LoadMatch™ Series

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- **Features**
  - Based on "00" water lubricated wet rotor circulator w/ 3 year cartridge warranty.
  - **Integral flow check.**
    - **Eliminates gravity and circulator off cycle circulation.**
  - **Integral condensate baffle.**
    - **Eliminates condensation on motor housing down to 38F chilled water**
  - 200 psi standard pressure rating.
  - UL label.

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- Circulator Start-up
  - No Balancing
  - Performance matched by Williams
  - Installation allowance 20 feet of connecting pipe
- Air Removal – you must prime the circulator
  - open supply valve
  - vent air through coil
  - open return valve

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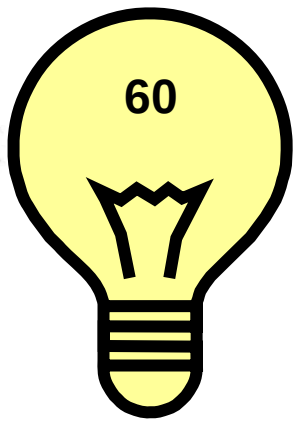
ZoneMatch Circulator - 1/40 HP

- **25 Years In Production**
- **Millions In Use**
- **Quiet Operation**
- **Chilled Water <u>CERTIFIED</u>**



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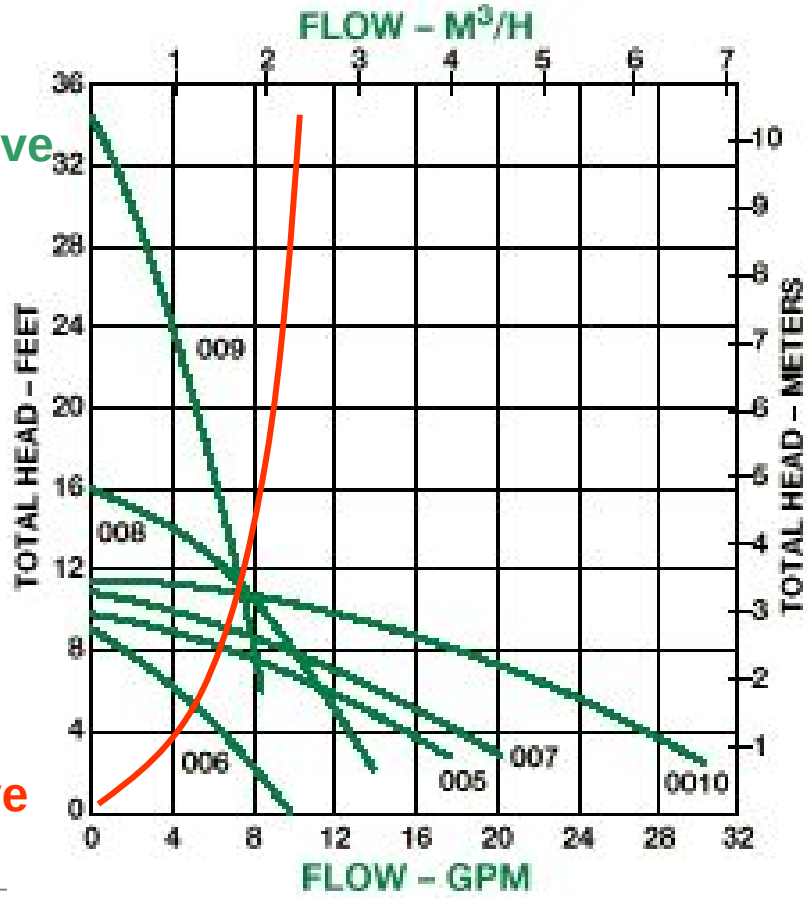
Circulator curve



Coil Curve

"X" Marks the Capacity

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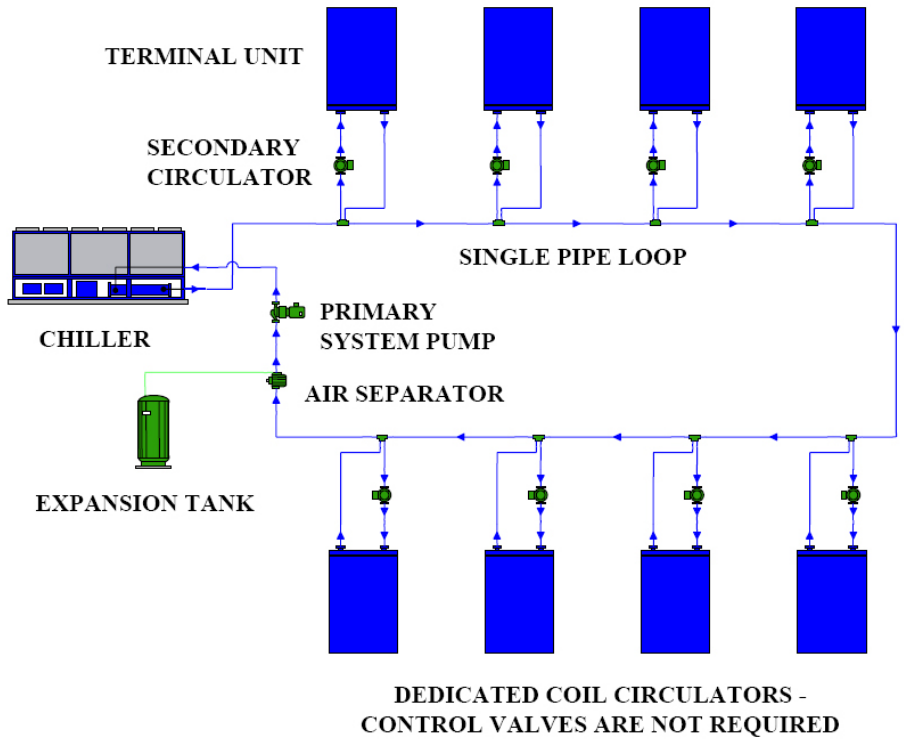
Superior Comfort

- **Self Balancing (Balance by Design)**
  - Insure required flow to all terminal units at all times.
  - Eliminate "tweaking" of water balance and "call backs".
- **System is Forgiving**
  - Diversity available to all terminal units.
  - Secondary circulator always delivers the required or greater flow.



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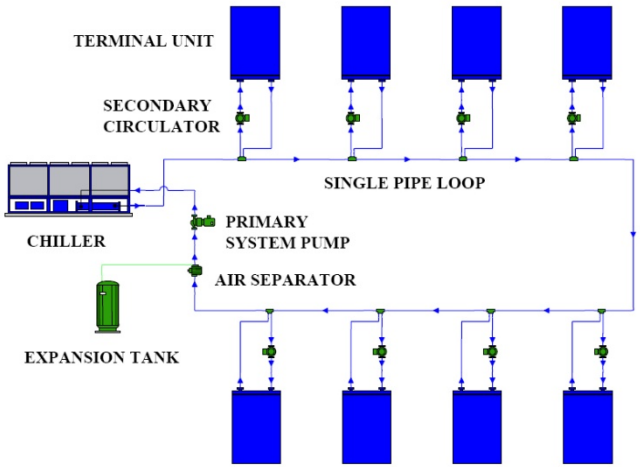
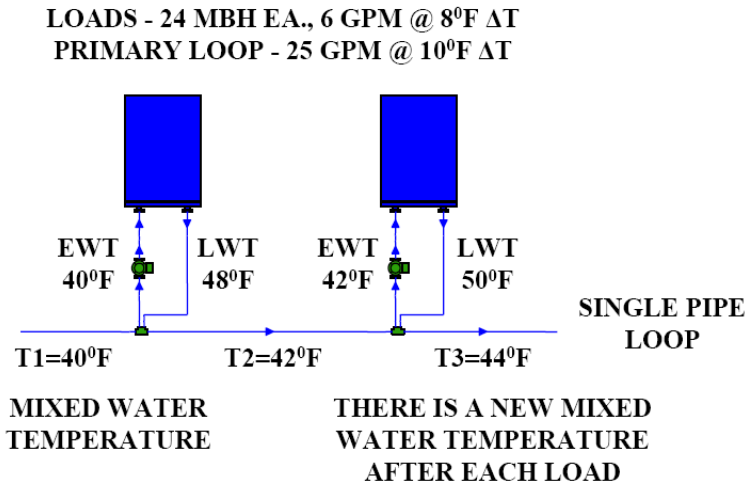
Primary Loop Piping

- **Single Pipe Primary Loop**
  - Simplified layout and design.
- **Self Balancing System**
  - Eliminate almost all balancing.
  - Control energy flow, not fluid flow.





- **Utilize System Diversity**
  - Diversity available to all units without variable speed drives.
  - Design for operating temperature differences with diversity.

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- Why consider ONDemand?
  - Simple system
  - Lowers installed cost
  - Reduces operating cost
- Increased value of the property
  - Reducing "relevant operating cost" increases "Net Operating Income"
  - Reducing installed cost meets the budget

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- Installed cost reductions
  - Easier to manage
    - Simplified BOM
    - Reduces complexity of system
    - Increased flexibility
  - Reduces installed feet of pipe

    Less labor

    Fewer hangers, fittings, valves; less insulation

Self-Balancing reduces commissioning cost

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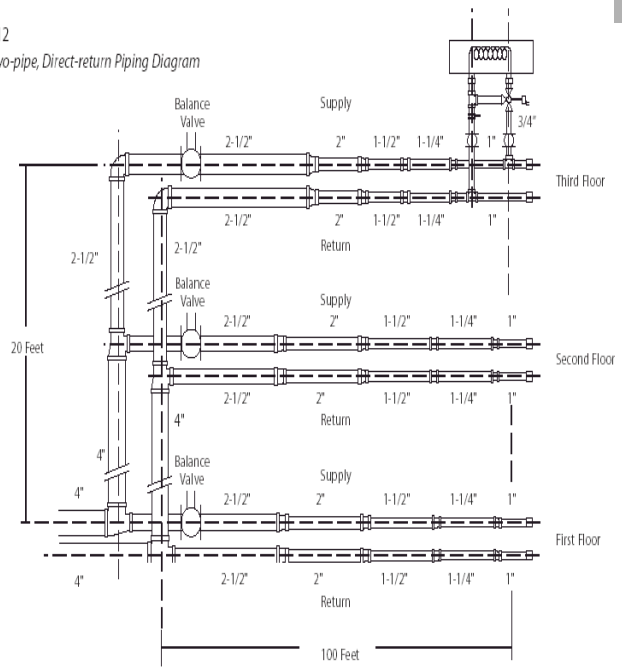
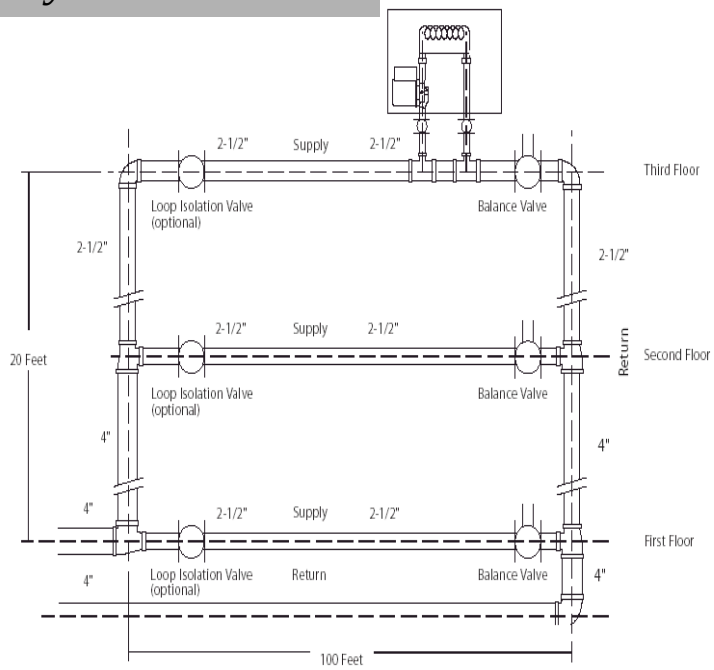
which BOM do you want to manage?

Flexible hydronic solution

Figure 12
Basic Two-pipe, Direct-return Piping Diagram





Compare design, installation, operation and FLEXIBILITY

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- Operating Cost Reductions
  - System Pump horsepower reduced by 50%
    - Decouple terminal unit from central system
    - Eliminate valve package pressure drop
    - Replace Valve Package with fractional HP Circulators
    - Reduce number of transitions and fittings

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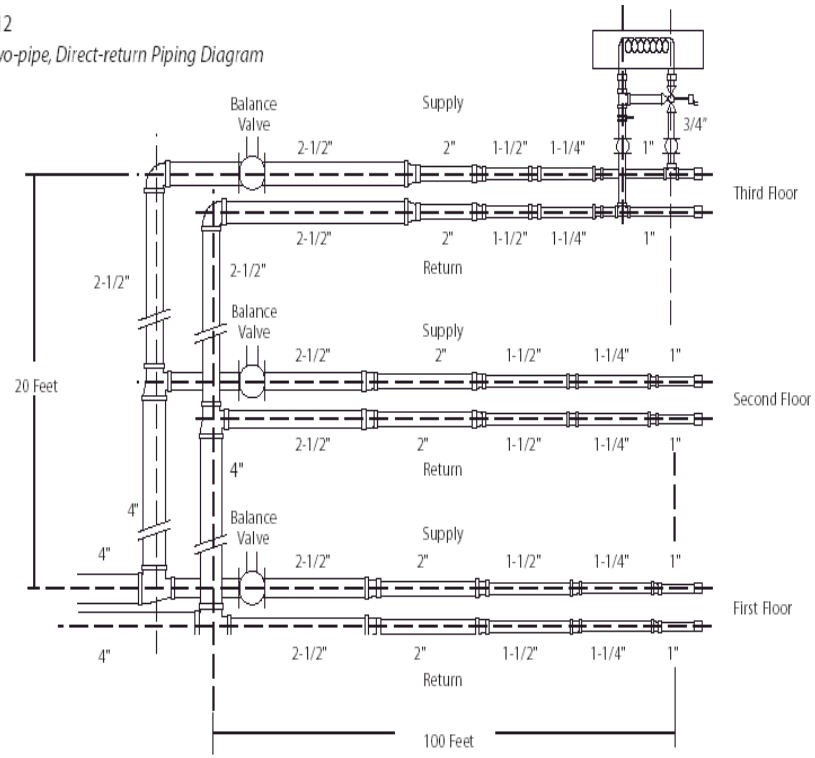
2-Pipe Direct Return – Head loss

S & R piping – 13.6 feet
50% fittings – 6.8 feet
Balance valve – 2.0 feet
Total main – 22.4 feet
Terminal unit – 19.0 feet
Total system – 41.8 feet
15% Safety – 6.2
Total = 48 feet TDH

240 GPM
10 degree delta T

ADD automatic flow control
& Pressure goes up!

Figure 12
Basic Two-pipe, Direct-return Piping Diagram



640 linear feet of pipe

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1x2-Pipe, ZoneMatch – head loss

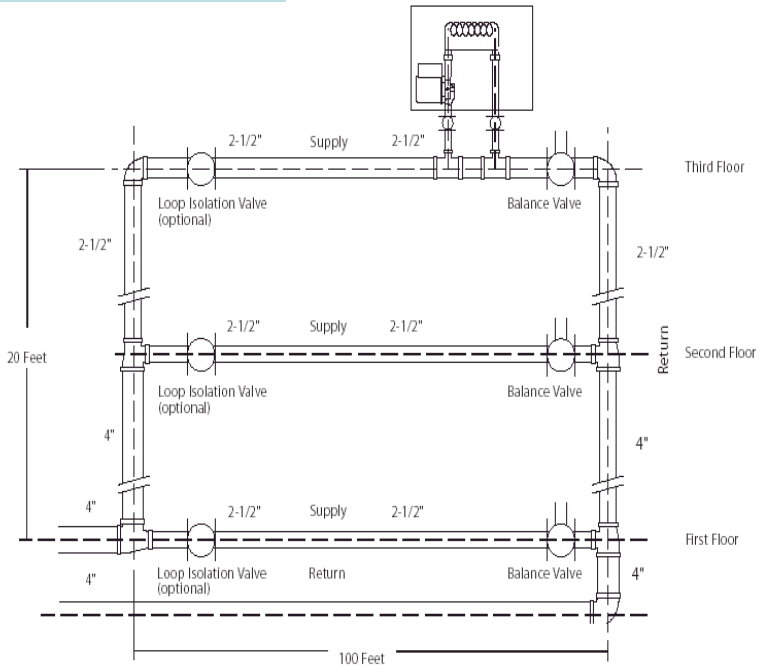
S & R piping – 13.6 feet
50% fittings – 6.8 feet
Balance valve – 2.0 feet
Total main – 22.4 feet

Total system – 22.4 feet
15% Safety – 3.3
Total = 26 feet TDH

240 GPM
10 degree delta T

50% less Horsepower

Flexibility



440 linear feet of pipe; 200 feet less; 24 less fittings

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Operating Horsepower Savings -- de-coupled Fan Coil

- **Horsepower = $\frac{\text{Head x GPM}}{\text{3960 x Efficiency}}$**

Constant GPM but reduced head = reduced Horsepower

Main Pump Head reduced by 1/2 = HP reduced by 1/2

1/40 hp circulators = 40 zones per 1 horsepower
Only consume power when “ON”
Demand Controlled Pump Horsepower

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Direct Return vs. ONDemand

Direct Return	ONDemand
S & R piping – 13.6 feet	S & R piping – 13.6 feet
50% fittings – 6.8 feet	50% fittings – 6.8 feet
Balance valve – 2.0 feet	Balance valve – 2.0 feet
Total main – 22.4 feet	Total main – 22.4 feet
Terminal unit – 19.0 feet	
Total system – 41.8 feet	Total system – 22.4 feet
15% Safety – 6.2	15% Safety – 3.3
Total = 48 feet TDH	Total = 26 feet TDH
240 GPM	240 GPM
10 degree delta T	10 degree delta T

½ the head on the main pump = 50% less Horsepower

640 linear feet vs. 440 linear feet; 24 less fittings

Applied Products Group

- Increase Flexibility at lower Cost
- Opportunity
  - Identify "Typical" spaces.
  - Determine "Critical" spaces
    - Unusual load or location
    - Dedicated performance – special
      - Variable speed circulator
      - Parallel piped

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Increased flexibility

- Flexibility
  - Piping is sized for Block load
    - Actually "block peak load"
    - The number of zones is unlimited
      - Practical limits
        - » Total tonnage and pipe size relationship.
- Total Tons and Zones of control is what we provide – to the owner it is the basis of cost.

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Why does ONDemand™ work so well with Fan Coils?

Multiple Diversity Factors

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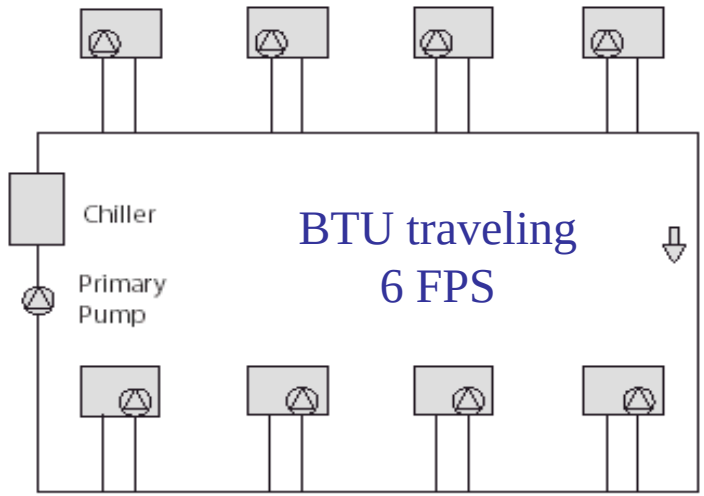
Terminal System Diversity – Capacity vs. actual

Performance versus design capacity

- ***Exposure***
- ***Occupancy***
  - **School classroom vs. Common areas**
  - **Hotel room vs. meeting/convention**
  - **Offices vs. conference**
  - **Usage patterns, time of day**
- ***Run Time***
  - **Actual operation**
  - **30% annually**
  - **20 minutes per hour**
  - **Unit unloading – 40%**
  - **Fan speed – 50%**



Simultaneous operation?

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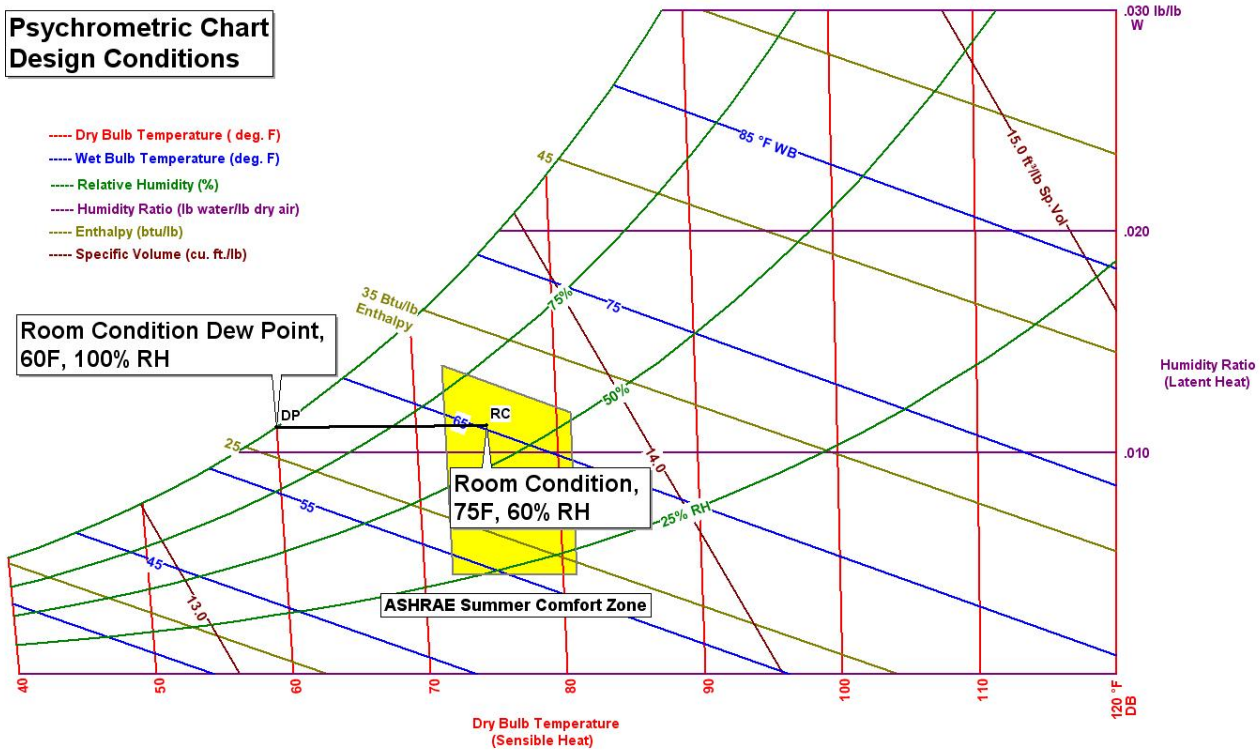
Methods to Achieve Dehumidification

- You can **dehumidify with 50F** entering **water** temperature.



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Cycling in a conditioned space.

- At design conditions the capacity of a fan coil is 100% as selected.
- In a conditioned space – with reduced moisture and EAT the capacity (BTU's pulled from the loop) is reduced to about 70% at High speed.
- At Low speed the capacity can be 50%.

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- Fan Coil Capability - MBH
  - 1 ton package high med low
    - 80/72 – 60% - 19.6/10.0 – 18.2/9.0 – 16.0/7.8
    - 80/67 – 51% - 15.7/11.5 – 14.4/10.2 – 12.5/8.6
    - 78/67 – 57% - 15.5/10.5 – 14.2/9.4 – 12.5/8.0
    - 76/64 – 52% - 13.4/10.5 – 12.2/9.3 – 10.6/7.8
    - 72/60 – 50% - 10.7/9.8 – 9.7/8.6 – 8.3/7.1

Wide Range – three speeds – responds to load

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- Run time
  - Unit circulator "ON"
  - At 1 CFM/sq foot – air turnover = 60/space height
  - LAT in 50's mixes with room air in 70's
    - 20 degree difference
    - % mixed = 1/ceiling height = 1/8 = .125
    - [0.125 x 55 = 6.875] + [0.875 x 75 = 65.625]
    - New mixed air temperature = 72.5 in room

      After first minute; plus heat gain.

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- Unit is "OFF" longer than "ON"
- Typical on for 3 minutes off for 8-11 minutes
  - 20 units – 42 EWT cools space in 3 minutes
    - 44 take 3.6 minutes
    - 46 takes 4.3 minutes
  - 3 minutes expires?
    - ??????????????????

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- 3 Minutes is up
  - 20 units on a 10 degree delta T loop design
  - Each unit affects loop ½ of a degree – at full load!
  - 4 units on before it takes EWT to 44
  - Units 1,2,3,4 off in three minutes
    - How much longer will 5,6,7,8 run? They were scheduled for 3.6 minutes..
  - All units will be off before any units come back on!

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E

- Experience
  - 3 degrees to maximum of 5 degrees
  - Rarely can even 50% be on at one time.
  - Why to VFD's work?
    - Calculation versus operation

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- What if loads are simultaneous? [a school]

Variable speed circulators
with
LAT control

Units early in loop take less GPM to deliver design LAT

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- The ONDemand Loop – the formula
  - Selected with a 10 degree delta T
  - The load served requires knowledge
    - Decisions based on diversity.
  - The cooling loop is selected at 42˚F to 52˚F
  - Calculate Load carrying capacity of water
    - Load/(500 x ΔT) = GPM, select FPS and size pipe
  - Select ONDemand package unit
    - Size at 45˚F EWT; 76/64˚F EAT

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Develop your own Guide – I chose 6FPS not to exceed 10’/100’

10 Degree Delta T

Pipe size	GPM	Tons
– 1”	12	5.0
– 1 ¼	22	9.2
– 1 ½	34	14.2
– 2	58	24.2
– 2 ½”	90	37.5

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- The purpose is to identify where the opportunity exists in a building to apply the alternate piping scheme to:
  - Reduce installed cost
  - Reduce operating cost
  - Increase flexibility
- Hydronic systems reduce cost because we move more BTU's in water then air for less horsepower

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- What is the foot print of the building?
- How long are the loops
- 100 feet in 17 seconds

- The effect of "Run Time" makes it almost impossible for more than 50% of the units to be "ON" at the same time

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- However – all projects are different

You must "know" your loads

A school wing with all classrooms may in fact have instantaneous loads when the bell rings.

Solution: All the loads are similar – size the units for the worst case and apply variable speed circulators controlling to a constant leaving air temperature and size the loop for the load.

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- Not Knowing your LOADS

The advantage of the ONDemand concept is that the loop is sized for the Block load.

Whether it is a building or a block the total tonnage required may not vary, but where the tonnage is concentrated will. The loop is sized for the worst case existing; even FUTURE load and equipment is selected later.

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Where to use Williams' ONDemand System

- **Multiple zones of individual control**
- **Multiple stories, but it could be one**
- **Loop the Thermal Zone and save pipe**
- **When you need increased flexibility**
  zoning unknown or subject to change
- **Building Interface Cost reductions**
  move more BTU economically in pipe
- **Speed is of the essence and change is a given**
- **A solution to a portion of a building**
  an area with multiple small zones
  the usage is undefined or subject to change

WILLIAMS | RE-ENGINEERING COMFORT FOR THE 21ST CENTURY

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www.cristallaseattle.com

22 Stories
Luxury Condominium
Advertised as
"raising the bar"
Includes central gas heat
and chilled water A/C

2x4 pipe Load Matched

"It is simple and installs at a lower cost."
Says Mickey Woo, P.E.
McDonald Miller, Facility Solutions

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Control of humidity is toughest at reduced loads

* **New Orleans Monaco Hotel**
  250 Units
  Historic 1926 Masonic Temple
  Lodge Conversion to a 4-Star Luxury Hotel

"It is hardest to control humidity
At low loads – it where you shine!"

KIMPTON GROUP

Humidity Control in New Orleans

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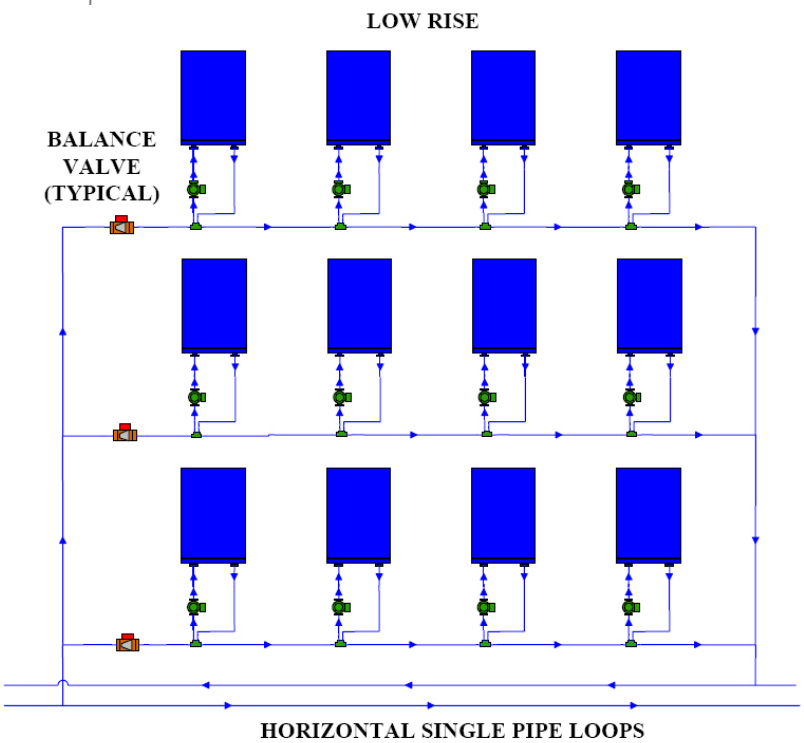
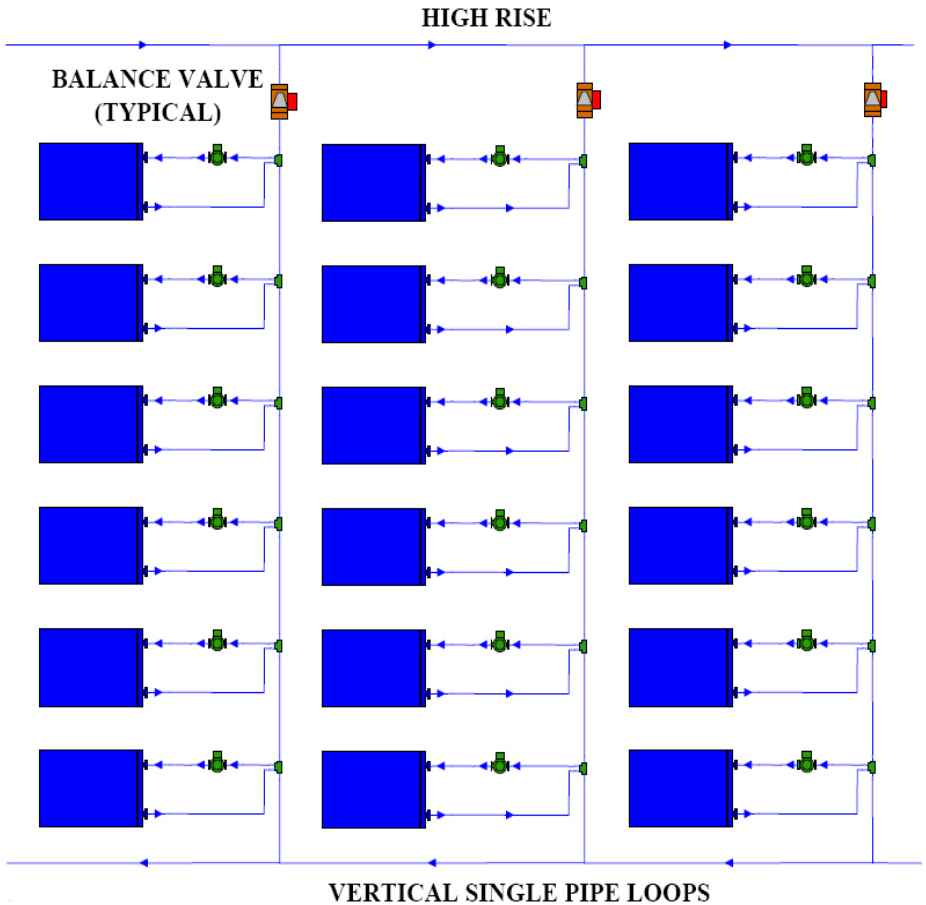
Design Flexibility

- **Utilize Two Pipe and Single Pipe Configurations Where Best Suited**

"Call it 2x4-Pipe"





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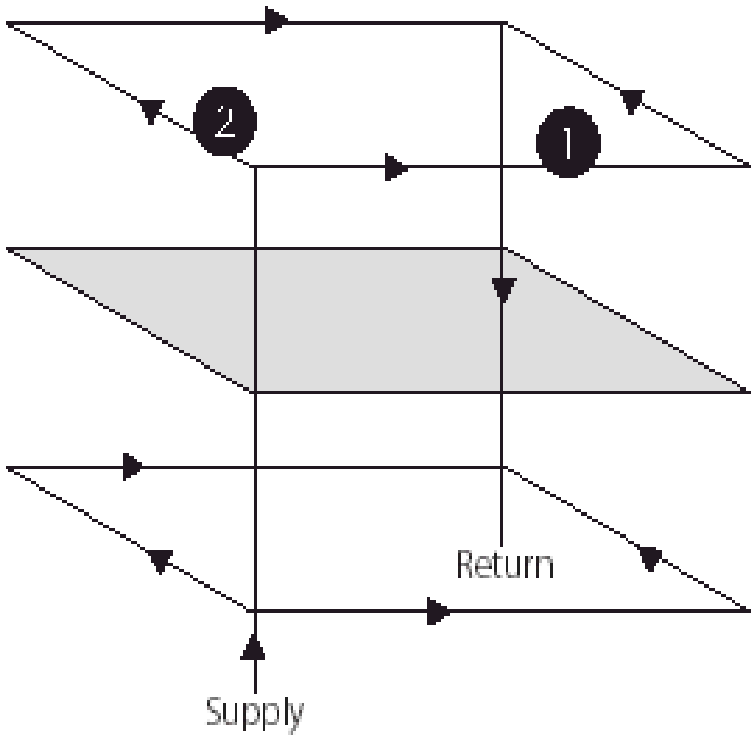
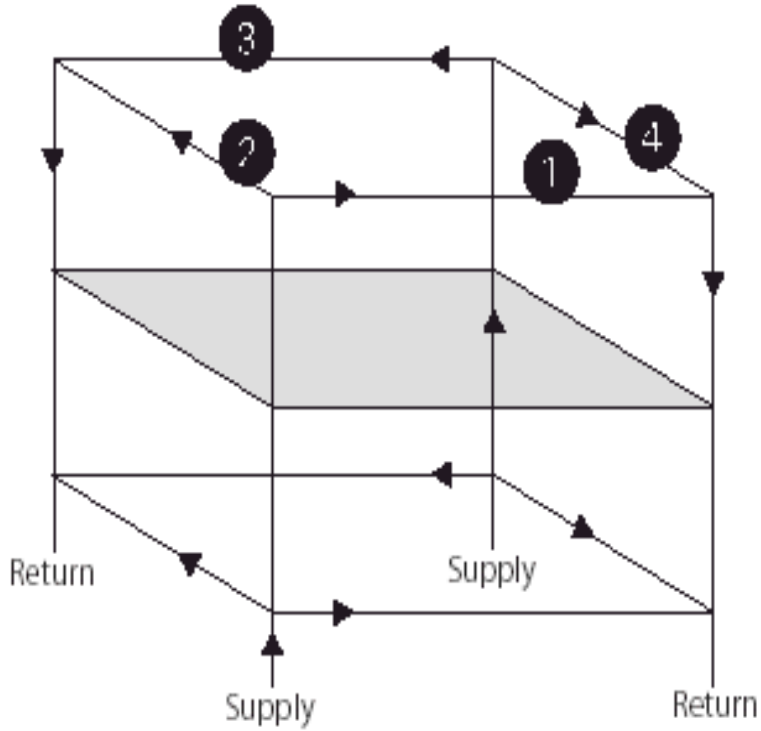
Multiple Loops per Floor



2 Loops per Floor



4 Loops per Floor

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- Simple procedure to size a Block Loop
  - Known:
    - Loop is 10 degree delta T
    - 42 to 52˚F after the last unit

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BTU Flow vs. GPM Flow

- ***Load carrying capacity of water***

500 x Delta T x GPM = Capacity

- ***Select velocity***
- ***Choose pipe size***
- ***Make an economical selection?***

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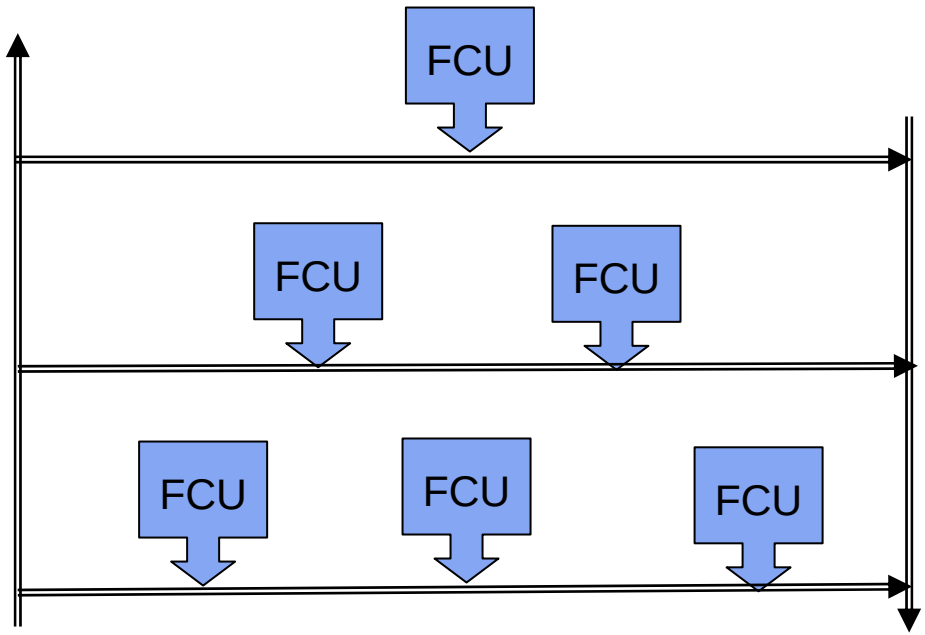
ONDemand Advantage - solves problems

The Loop is sized for the connected Load; not unit capacity

flexibility



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Building a Budget

1. Tons/Floor
2. Total Tons per Building
   - ✓ 10 degree delta T = 2.4 GPM/ton
   - ✓ 8 degree delta T = 3.0 GPM/ton
3. Size risers and determine quantity
4. Layout building scheme
5. Schematic of ZoneMatched loops
6. Price the units
7. Budget

It may not be the final design, but it would work

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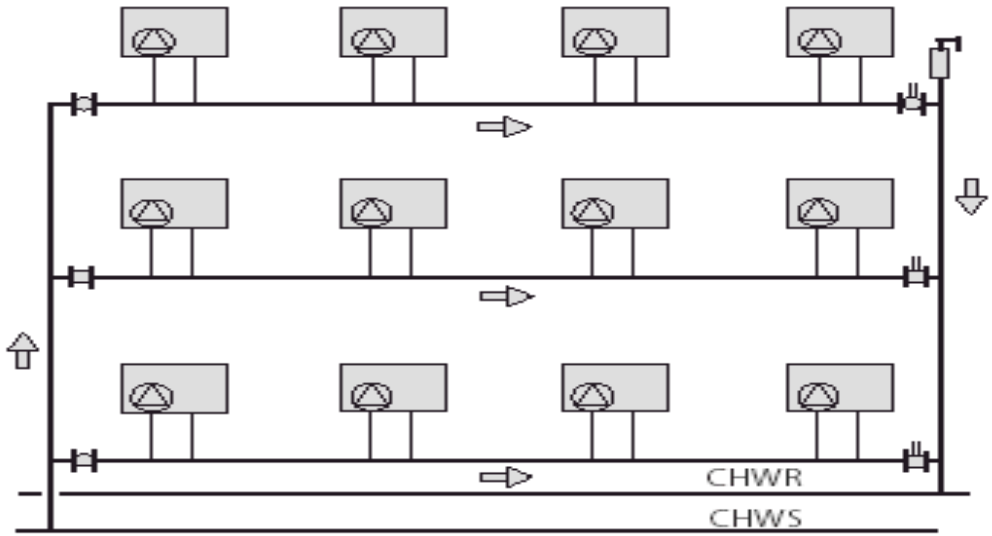
ONDemand™

Vertical Risers with Horizontal Distribution



Pipe size	GPM	Tons
– 1”	12	5.0
– 1 ¼	22	9.2
– 1 ½	34	14.2
– 2	58	24.2
– 2 ½	90	37.5

10 tons/floor

30 tons total

10 tons x 2.4 GPM/ton = 24 GPM; 1 1/2” Loop on each floor.

Riser sized for 24 tons x 3 = 72 GPM; 2 1/2” stepped riser

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- Installation Cost Savings
  - Least expensive – constant flow circulator
  - OPTION
    - Variable speed circulators with LAT control
    - Parallel pipe to dedicated units

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- Taco Energy Analysis program
  - Building profile
  - Location
  - System Analysis
    - Default systems
    - Edit capability
    - Energy use breakouts
  - Annual energy consumption profile

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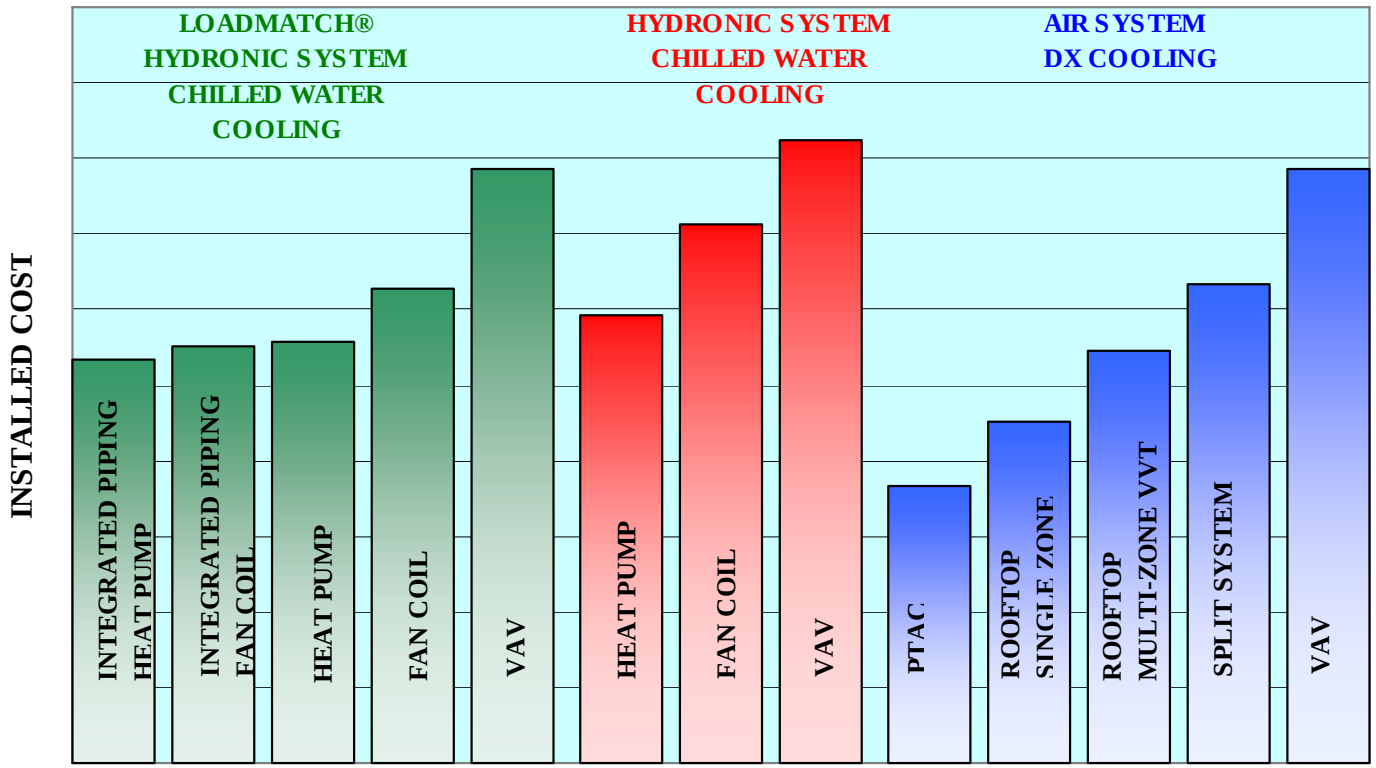
HVAC SYSTEMS INSTALLED COSTS



COSTS BASED ON SUM OF MECHANICAL SYSTEM COSTS AND ELECTRICAL SYSTEM COSTS ASSOCIATED WITH MECHANICAL SYSTEMS

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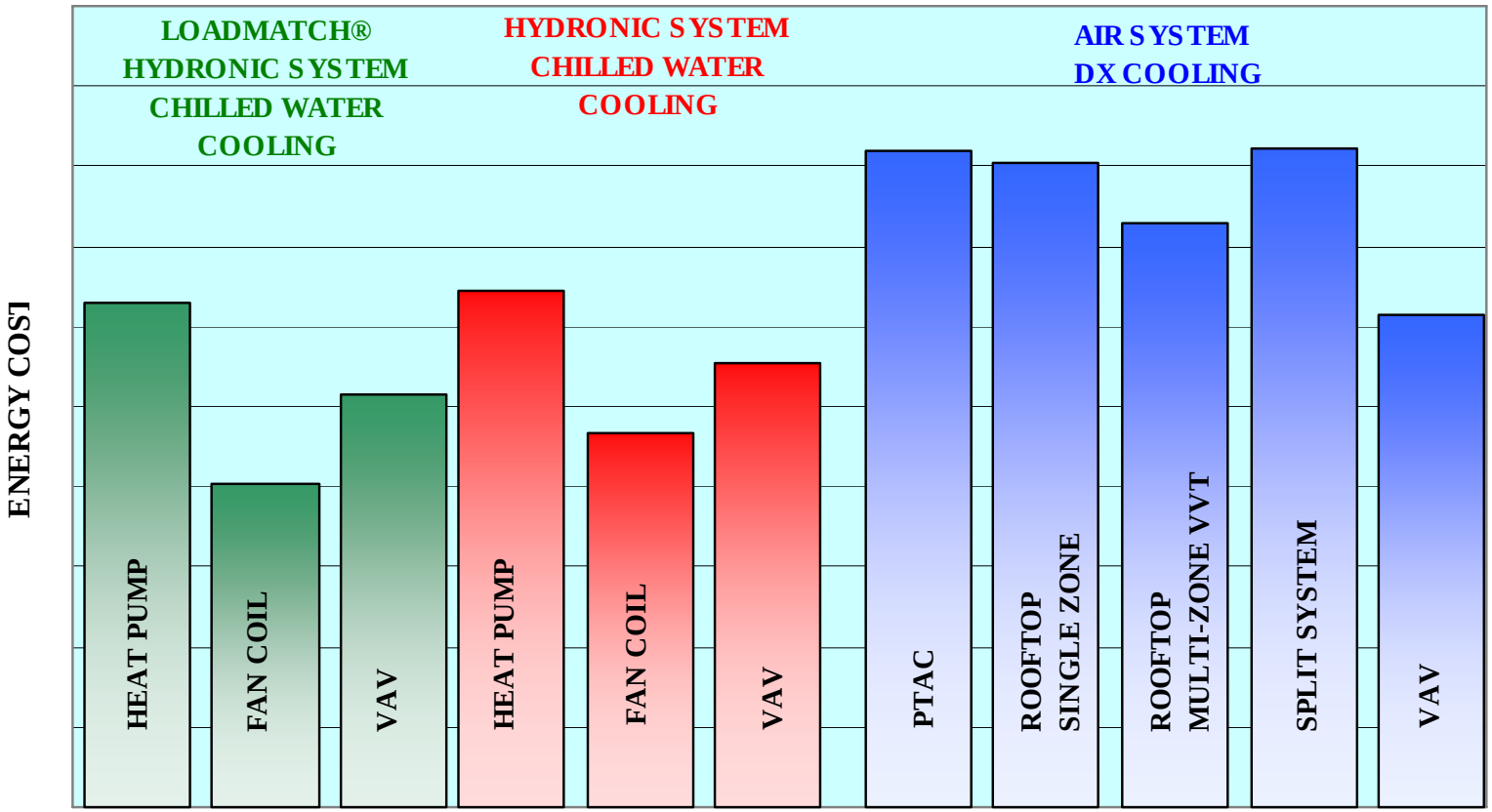
HVAC SYSTEMS ENERGY COSTS



COSTS BASED ON AVERAGE UTILITY RATES FROM APPA
AND AGA AND AVERAGE US CLIMATIC CONDITIONS

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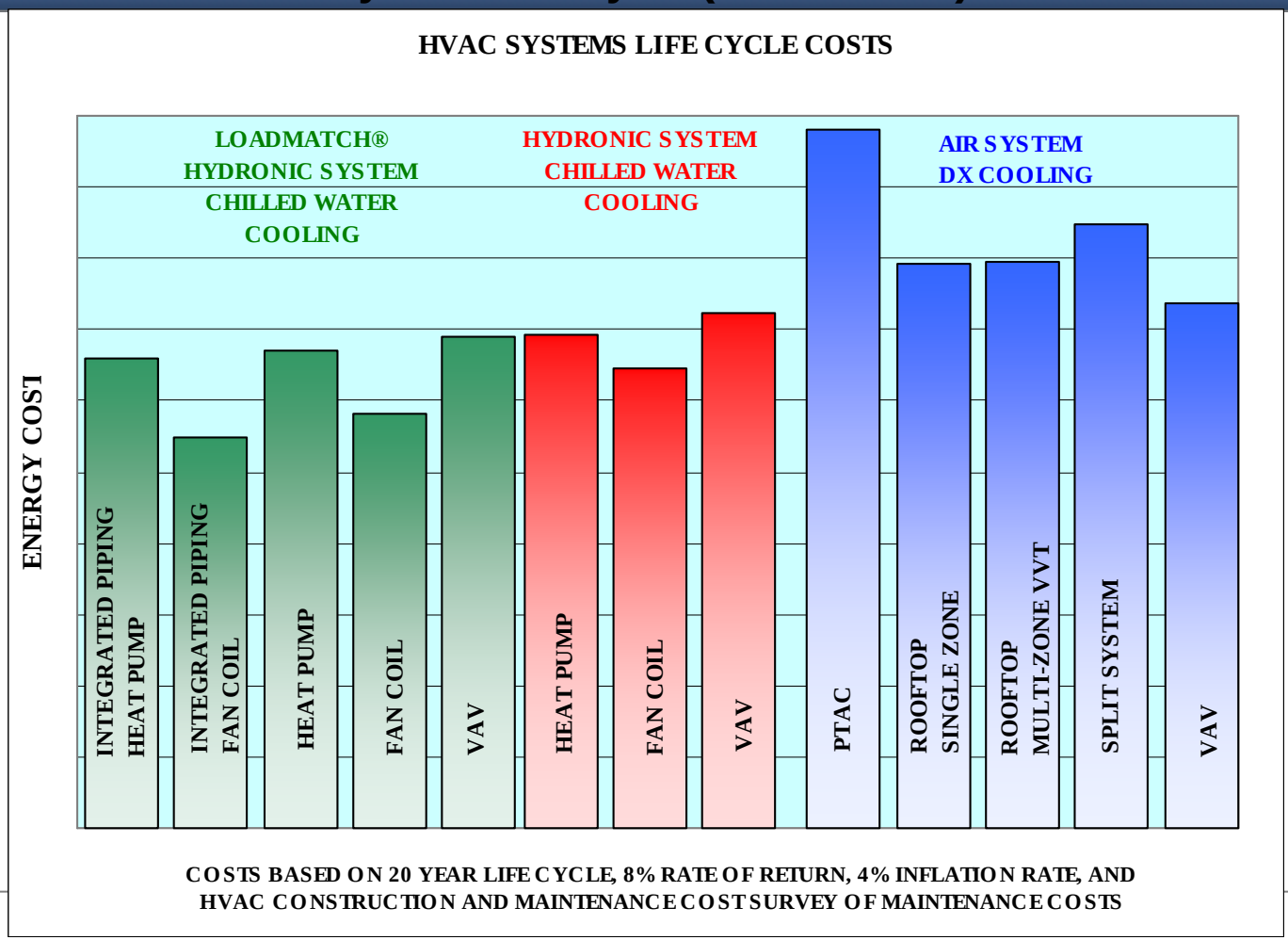
HVAC System Life Cycle (Sustainable) Costs



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System Installation Savings

- **More than just pipe is eliminated: up to 40 %**
  - **Sizing takes design time and coordination**
  - **Reducers, one size pipe, field coordination**
  - **Fittings**
  - **Hangers**
  - **Hydronic specialties**
  - **Valves**
  - **Insulation**

Avoid System Problems

Reduce field labor

Increased Flexibility of the System

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Thank you