Approaches for Achieving Better Comfort and Dehumidification

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CDE COMPANY

Presentation Scope

- Overview of Comfort Issues
- Design Process and Considerations to Improve Comfort and Dehumidification Capacity
- Case Studies

Overview of Comfort Issues

Thermal Comfort

- Condition of Mind that Expresses Satisfaction with Thermal Environment
- Behavioral Actions:
  - Altering Clothing, Activity
  - Change Posture, Location, Thermostat Setting
  - Opening Window, Complain, Leave the Space
- Thermal Comfort Scale

  + 3 Hot, 0 Neutral, -3 Cold
- ASHRAE Standard 55 – Comfort Zone (Summer, Winter)

Local Discomfort

- Problem: Asymmetric Thermal Radiation, Draft
  - Review: Air Distribution, Location/Quantity/Size of Diffusers
- Problem: Varying Thermal Comfort Scale Through a Building
  - Review: Zoning, Thermostat Location, RA Path Design, Diffuser Selection, Duct Sizing
- Problem: Poor Air Quality, High Humidity
  - Review: Outdoor Air Treatment, AC Sizing/Selection, Type of AC System, Controls, OA/EA Balance, Architectural Issues
- Problem: Noise
  - Review: Diffuser Selection, Duct sizes, Location of AC Units or Terminal Units

Common Problems Resulting in Poor Comfort

- Oversized AC Units (or not Enough Stages for Part-load Comfort Control)
- Poorly Zoned (Low-cost System)
- Improper Location of Thermostat (Behind Refrigerator, Exterior wall, Above Copier etc.,)
- No Outside Air Pre-treatment/Unit Selection with Inadequate Latent Capacity
- Outside Air Closed Due to Inadequate System Capacity
- Air Flow Analysis for Pressure Balances not Performed

Common Problems Resulting in Poor Comfort (Con't)

- Sensors not Routinely Calibrated (Temperature, Humidity, Pressure)
- Poor Selection of Diffusers (NC Levels, Throw, Type)
- Pressure Drop Calculations not Performed Including System Effect
- Renovation Project without Reviewing Air Distribution Issues
- No Reheat Options Provided During Design
- Certified Test and Balance not Performed
- Poor Architectural Design

Common Problems Resulting in Poor Comfort (Con't)

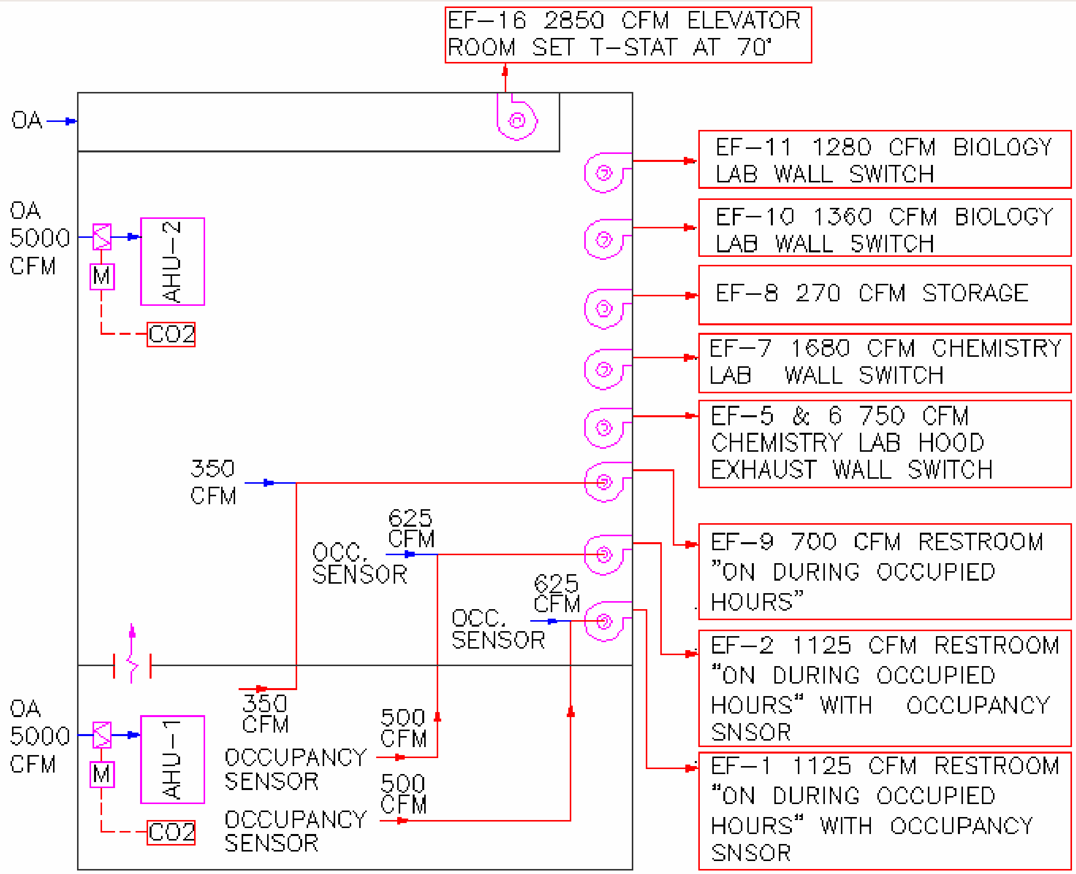
- Flows to AHUs not Balanced
- Sequence of Operations:
  - Never Verified Through Commissioning Process
  - Not Developed for all the Possible Scenarios
  - Poor Communication of Design Intent
- Inadequate/non-existing Preventive Maintenance Programs
- Long-term Reliability/Maintenance Issues

Design Process and Considerations to Improve Comfort and Dehumidification

Design Process

- Review and Confirm Requirements
- Perform Zoning Analysis
- Identify Ventilation Rates Per Code
- Air Balance Diagrams (Outside Air/Exhaust Air)
- Minimize Impacts with:
  - CO_2 Control
  - Motorized Dampers
  - Occupancy Sensors
- Review Sensible Heat Ratio
  - Select Appropriate System Based on SHR

Typical Air Balance Diagram



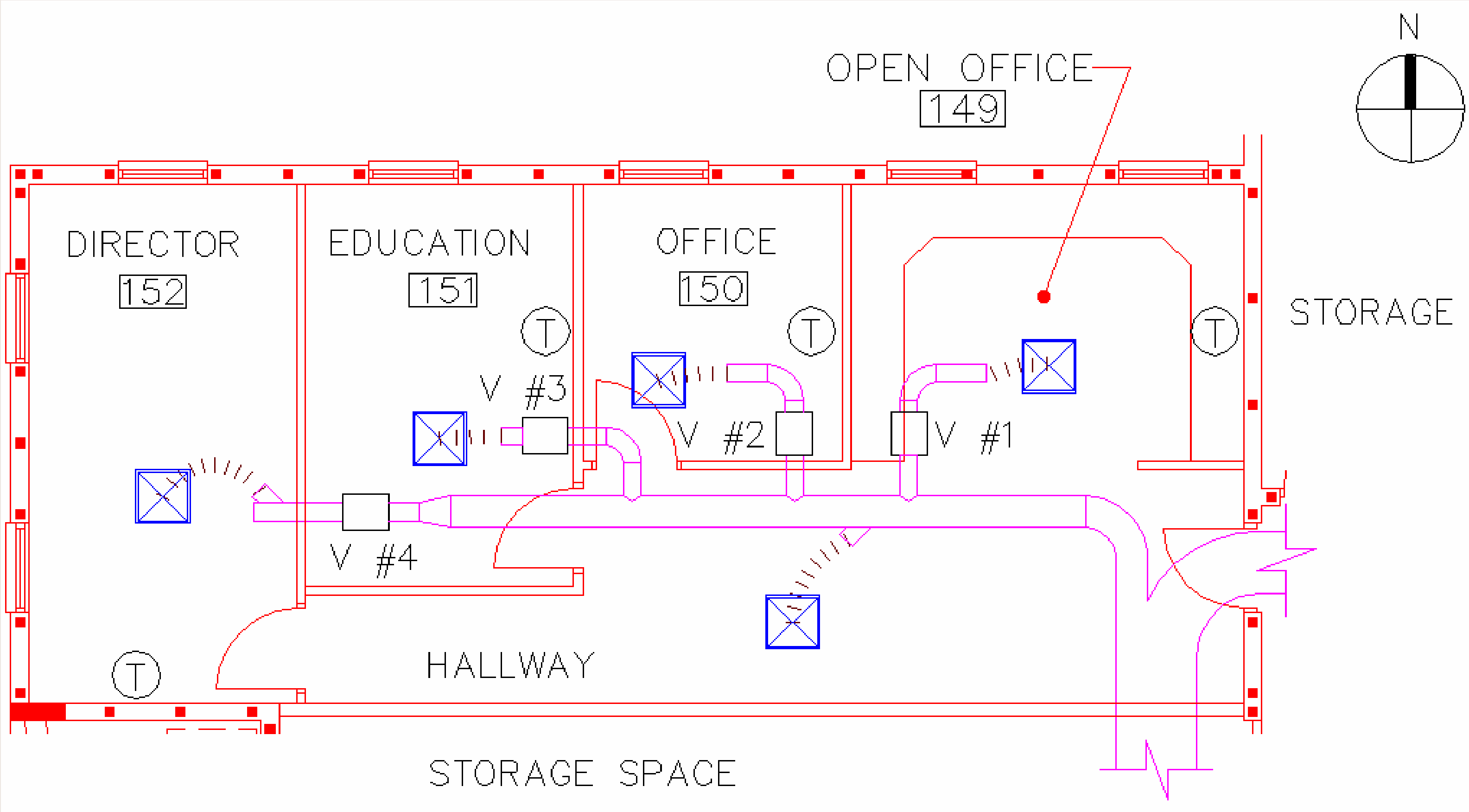
Design Process (Con't)

- Review Applicable System Options
  - Constant Volume/Variable Air Volume
  - Single Zone/Multi-zone
  - DX /Chilled Water
  - Additional Enhancements
- Select System Based on
  - Capital Cost (Budget)
  - Comfort/Process Requirements
  - Space Restrictions, Maintenance, Energy Use
- Air Distribution System and Controls Design

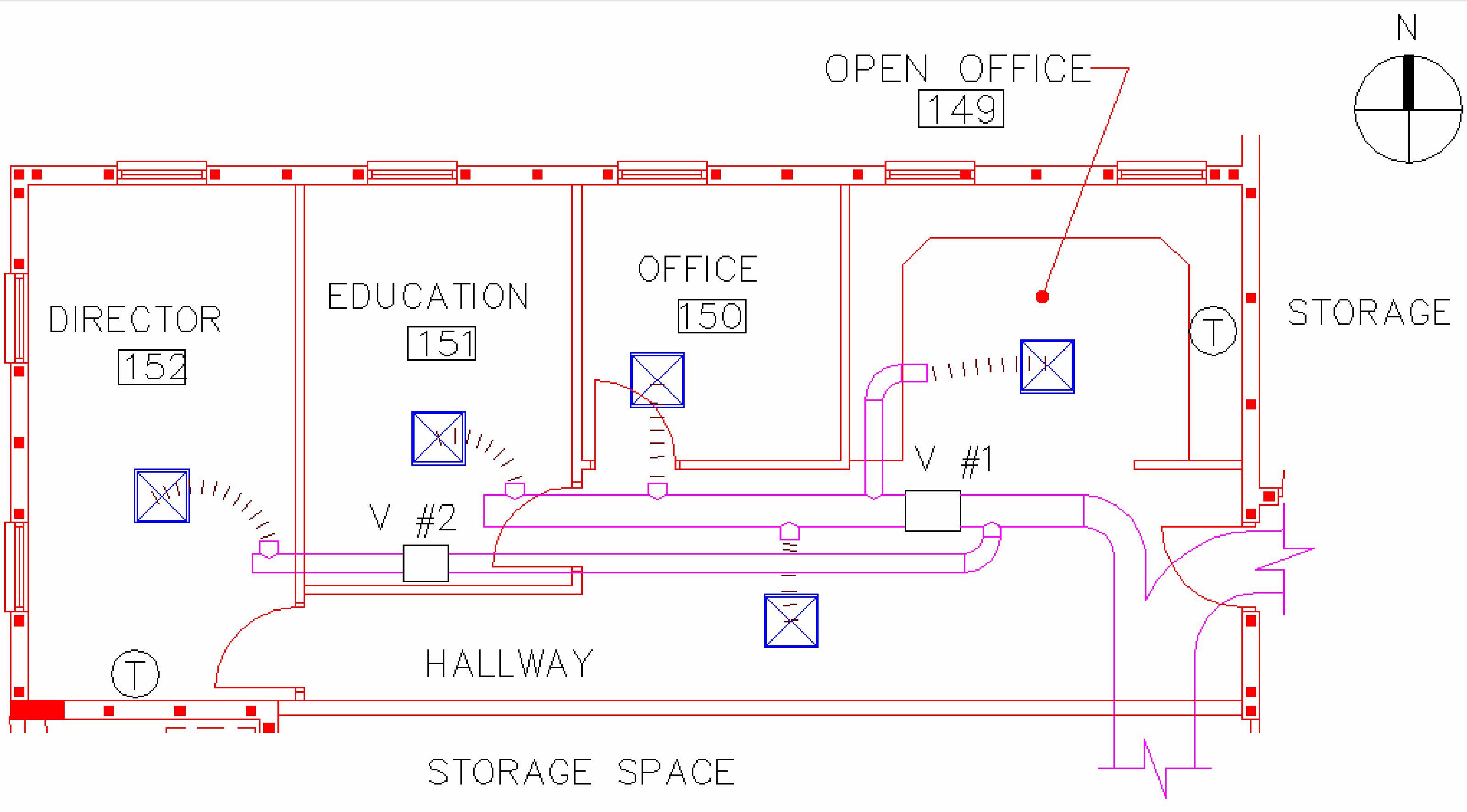
Zoning

- Perimeter and Core Zones
  - Fan Powered Boxes/VAV
- Occupancy (Meeting Rooms, Class Rooms)
- Process Requirements (Clean Area, Computer Rooms, Chemical Labs)
- Temperature/Humidity Control Requirements
- Sensors Location
  - Supply
  - Return
  - Space

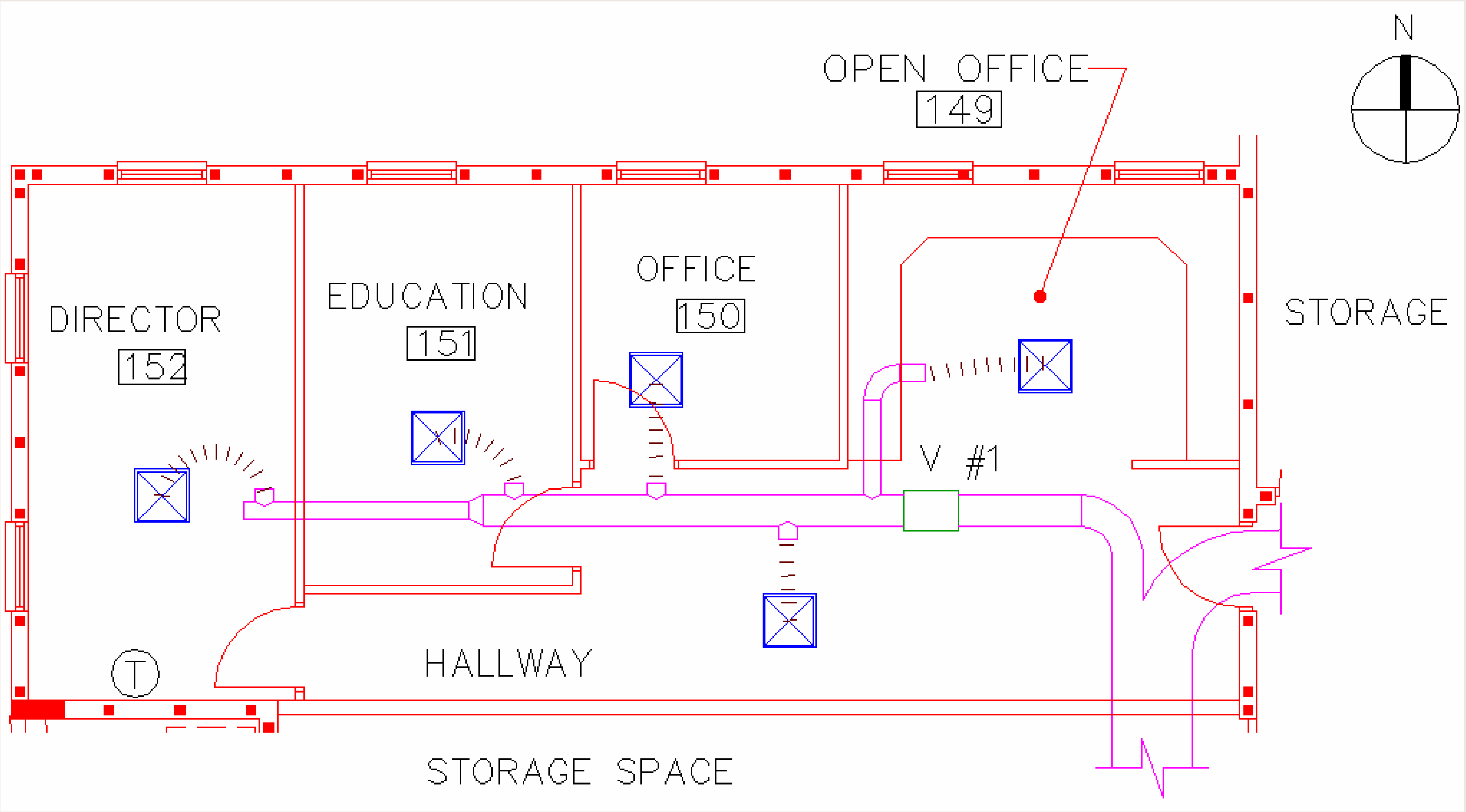
Thermostat Locations - VAVs



VAVs - Two Zones



VAV - One Zone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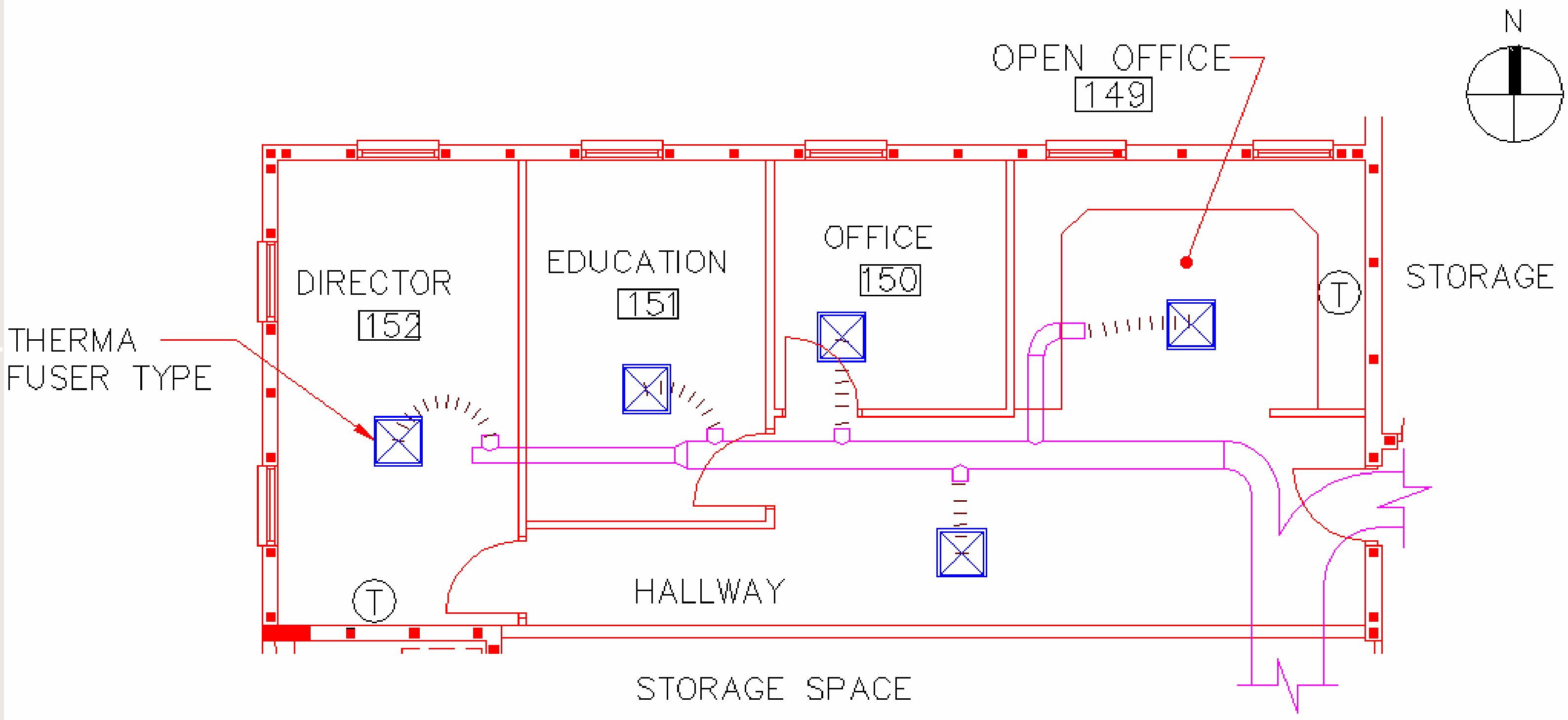
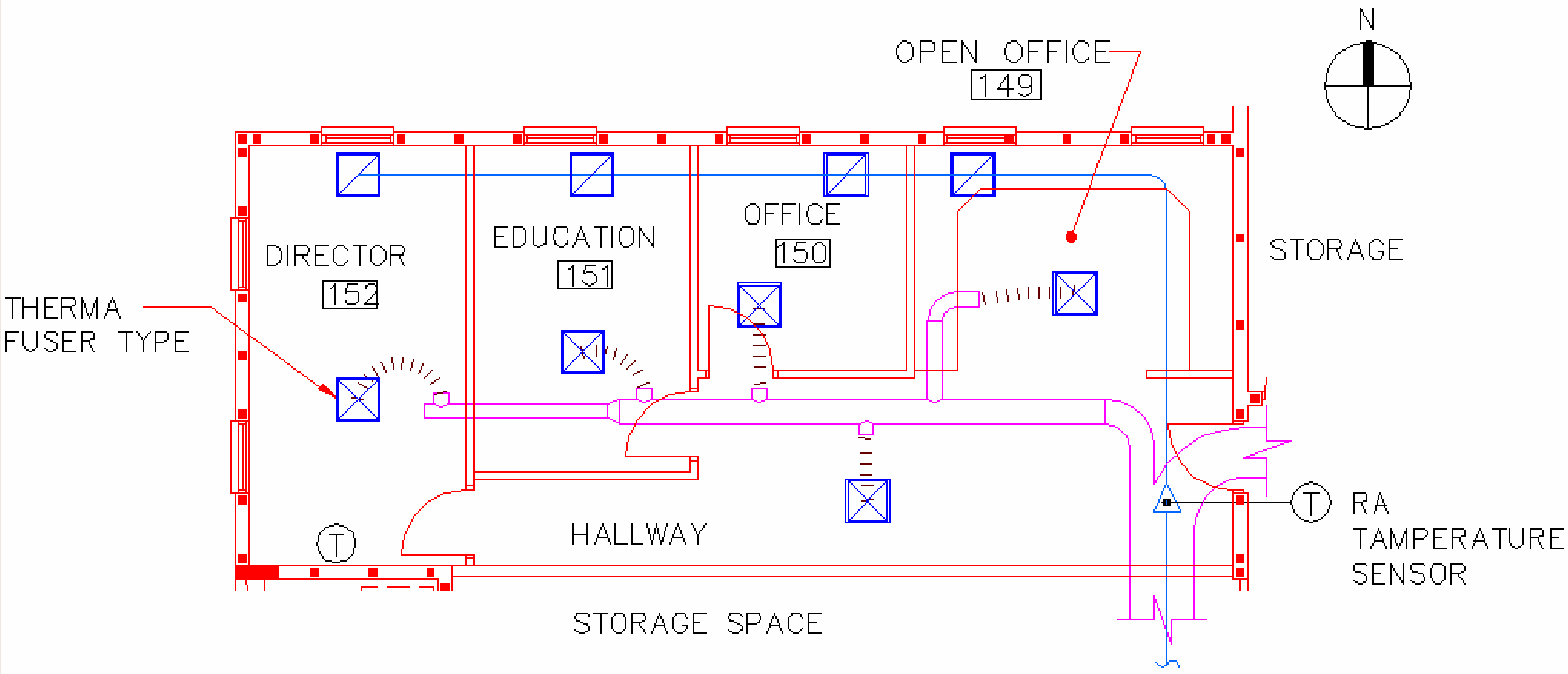
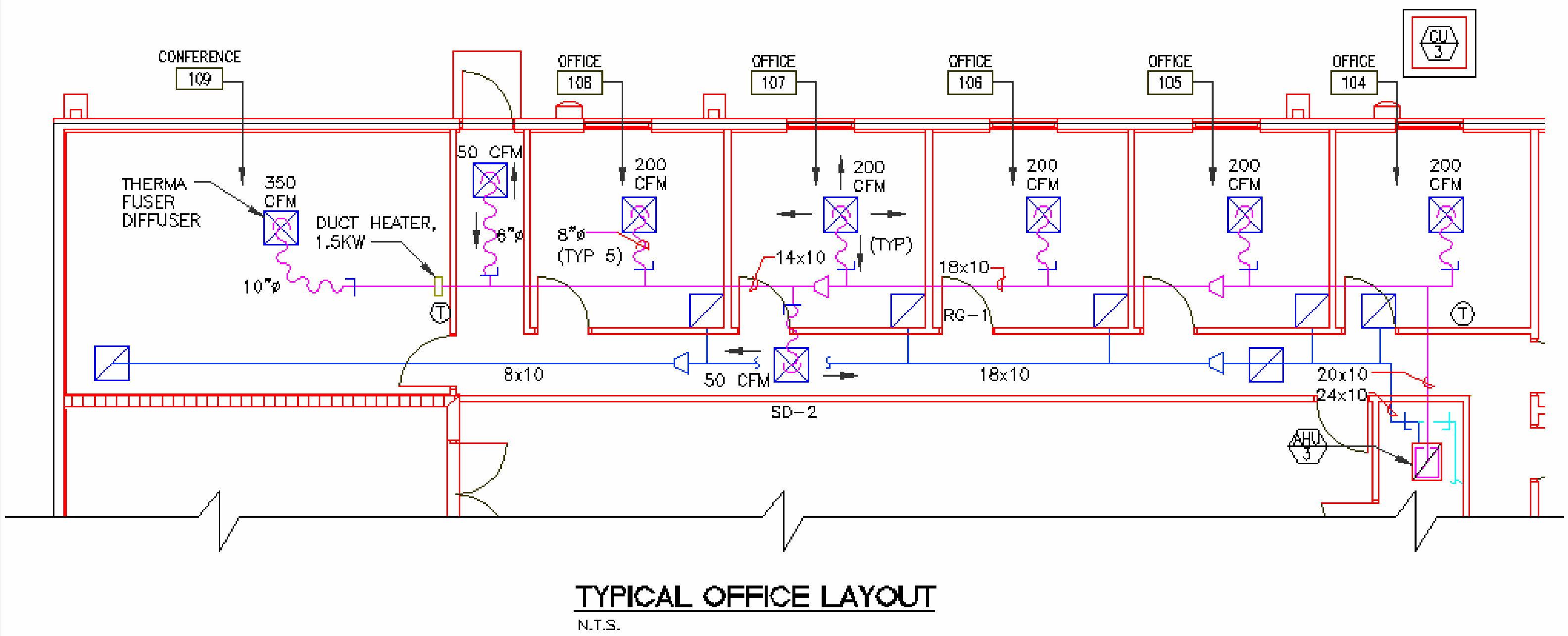
Thermostats – AHU



Thermostats – RA & Space



Typical Office – HVAC Control



Air Distribution

- Separate OA and SA Distribution
- Mix Conditioned OA and SA Upstream/Downstream
- VAV - Fan Powered Boxes to Improve Circulation
- Higher Air Flow for Perimeter Diffusers in a Single Space
- High Induction Diffuser for Low air Flow Spaces
- Spacing of Diffusers and ADPI Calculations
- Ensure Return Air Flow Path from Each Space
- Ducted Versus Plenum Return
- Constant-Fan Operation/Auto-Fan Operation

SA/OA Requirements Analysis

- OA Requirement per ASHRAE 62-2001 - 2000 CFM
- If Critical Fraction to Space 3 Reduced to 0.375, OA - 1030 CFM
- Increases Reheat, Minimizes Capital Cost
- Reduces Dehumidification Costs in Humid Climates

Description	**Space 1**	**Space 2**	**Space 3**
Supply Air CFM	800	800	400
Outside Air CFM	200	300	400
Fraction of OA	0.25	0.375	1.0

Dehumidification

- Active Versus Passive Humidity Control
- Provide Source Control/Treatment for Latent Loads
  - Demand Controlled Ventilation
  - Positive Pressure in Spaces (Reduce Infiltration)
  - Pre-treat Outside Air
    - Utilize Energy Recovery Wheels, Heat Pipes, Desiccant Systems
- Utilize the State-of-the Art Controls Capability
- Utilize Multiple Condensing Units or Multiple Compressors
- Face and Bypass Option, Face-split coils
- Avoid Utilizing Fan Coil Systems in Humid Climates
- Use Lower Supply CFM (275 to 350 CFM per Ton)
- Lower Supply Air Temperature (48 to 52 deg F) and Control SAT

Where/Why VAV More Suited?

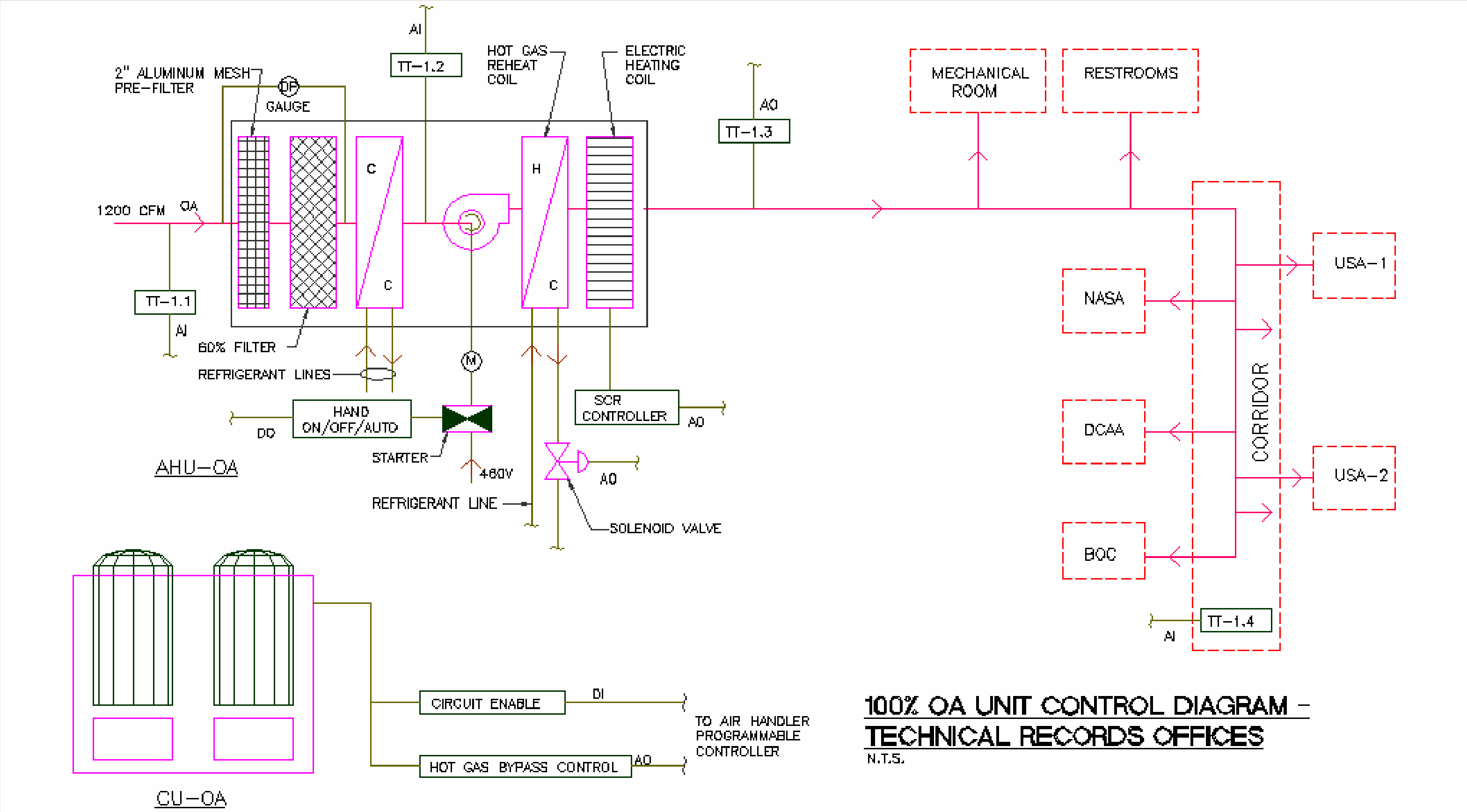
- Modulating loads
- Better Zoning Capabilities
- Better Humidity Control with Constant SAT
- Lower Operating Costs
- More Forgiving if Unit is Oversized
- DDC Controls Help to Control VAV & Meet Ventilation

Case Studies

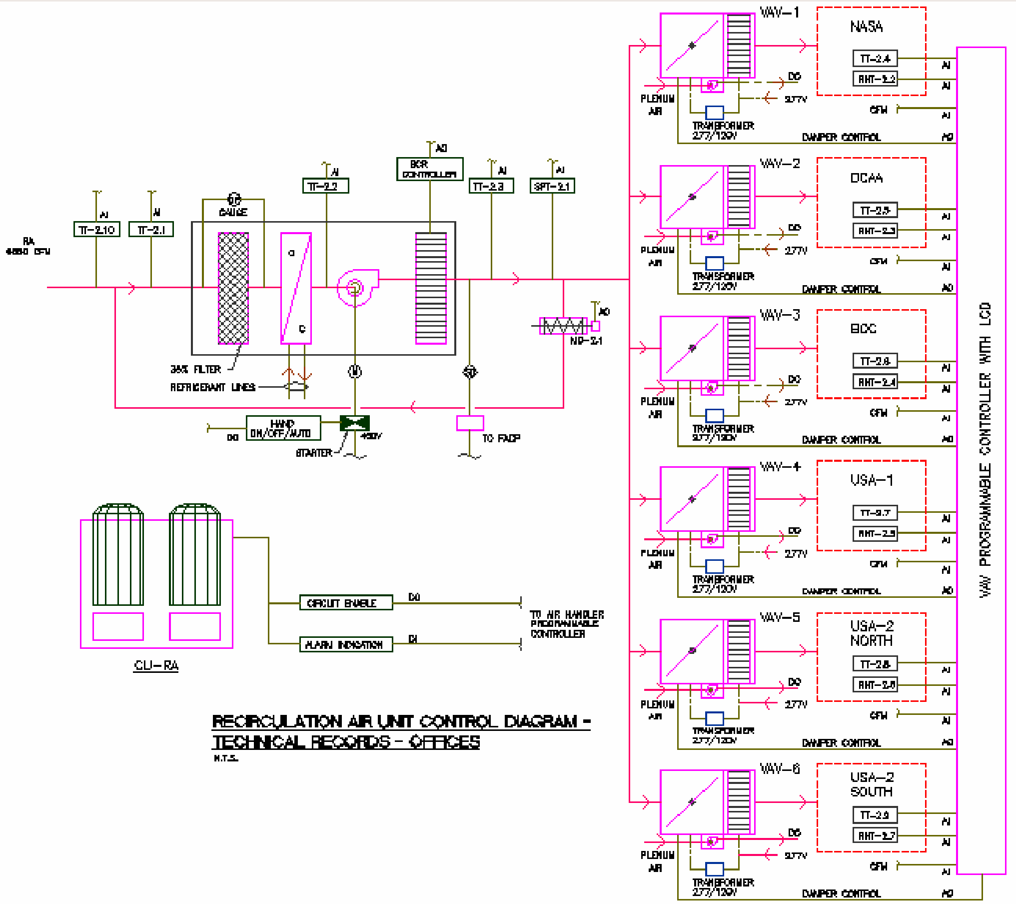
Case Study 1

- Technical Records Facility (14,000 Sq.ft.)
- Multiple Users
- Pre-Engineered Metal Building
- Dual-path System
  - CAV OA Unit (7.5 Tons)
  - VAV DX unit (20 Tons)
- Active Temperature and Humidity Control
- Positive Pressurization

Dedicated OA Unit



Recirculation Unit

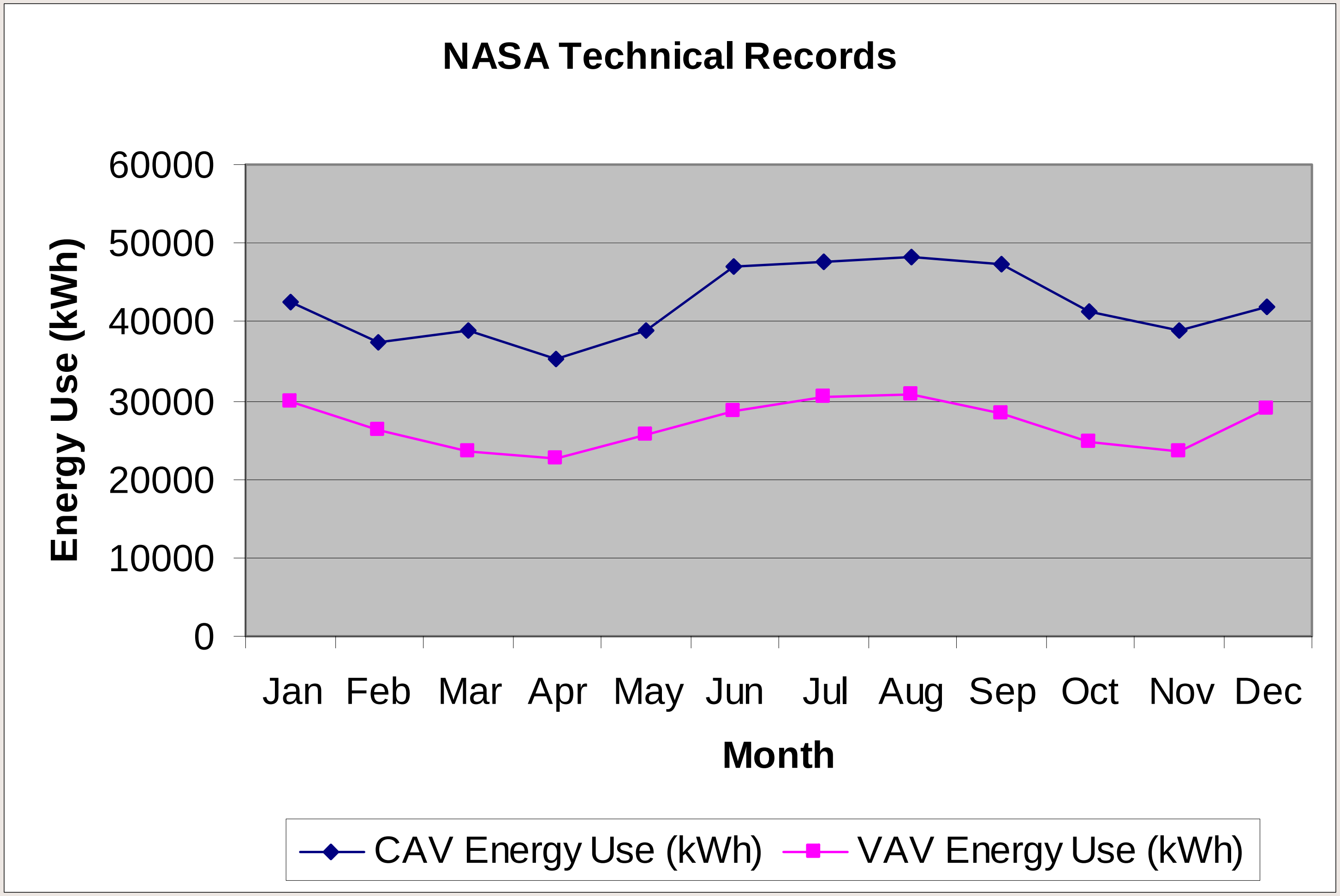


Design Highlights

- Supply Air Fan Cycling (Reduced Moisture Carryover)
- Fan Powered VAV - Humidity Control Capability
- Electric Heat/Hot Gas-Reheat
- Hot Gas Bypass – 53 +/- 3 deg F Control
- 35% Energy Savings Compared to a Constant Volume System
- Humidity Control – 50 +/- 5% RH for the Last Three Years
- Excellent Comfort Control (ASHRAE Regional Technology Award)

NASA Technical Records HVAC

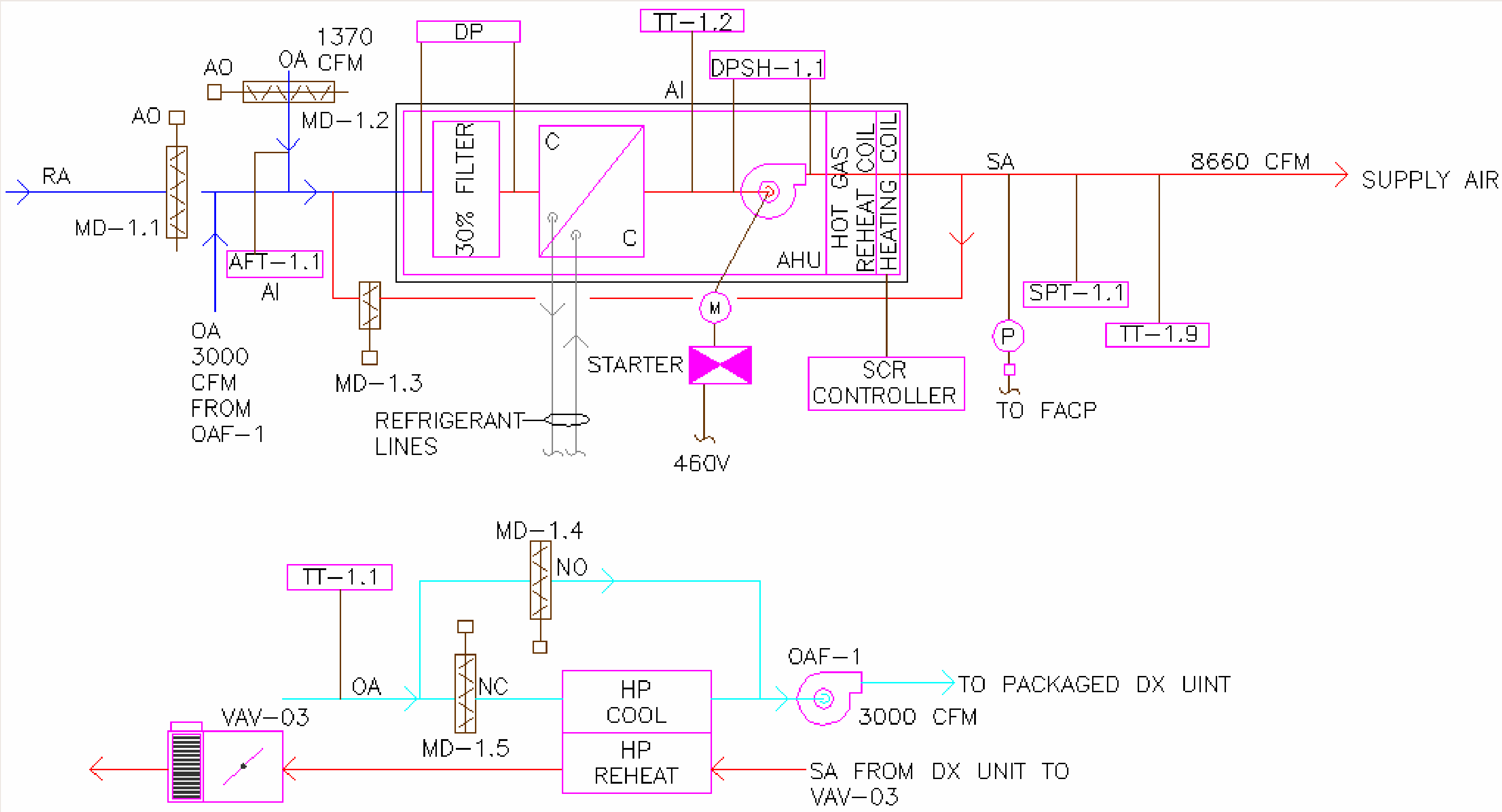
Energy Use Analysis



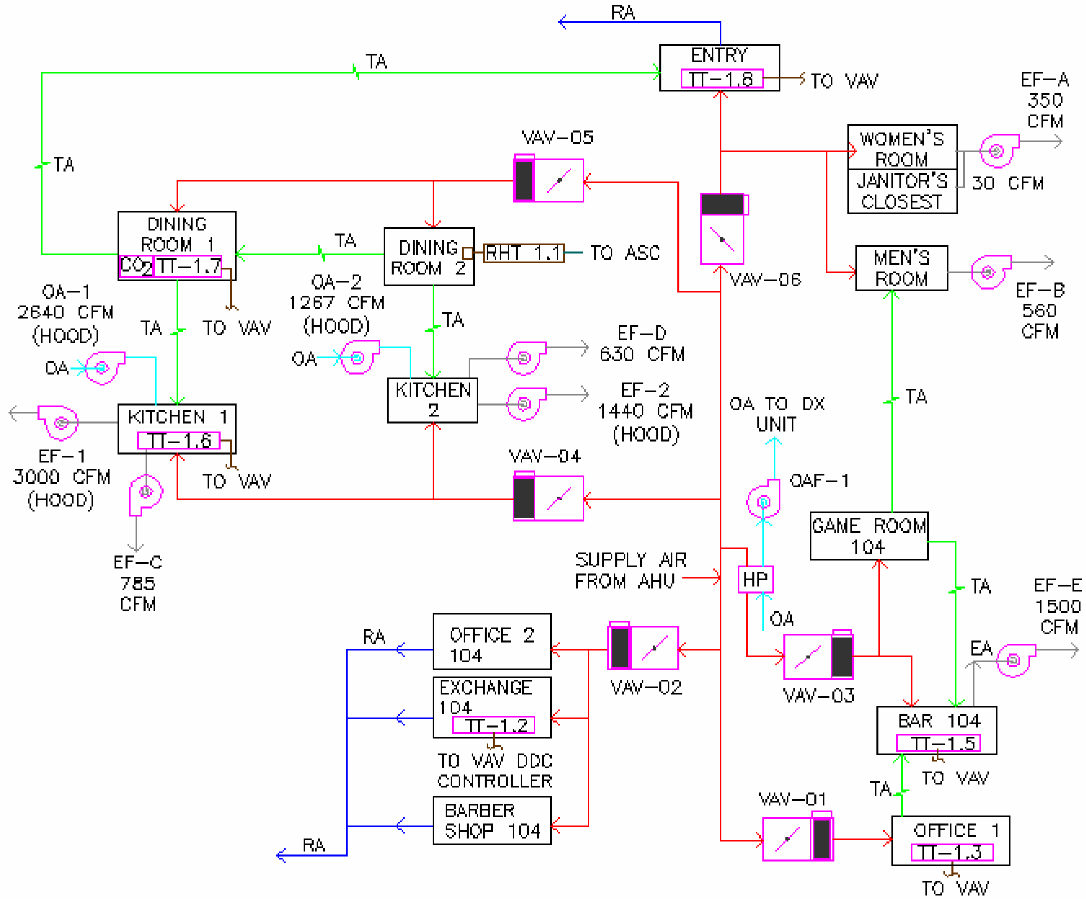
Case Study 2

- Multi-user Facility 3600 sq.ft
- Dining, Kitchen, Game Room, Retail Space, Office and Barber shop
- VAV System – Bypass Damper
- Pressure Balance, Outside Air control, Heat Recovery
- DDC – Temperature and Humidity Controls
- 25 Tons Split-AC Located Outside the Facility

Multi-user Facility HVAC



Multi-user Facility Comfort Control



Design Highlights

- Constant Supply air Temperature to Improve Dehumidification Capacity at all Times
- Heat Pipes to Reheat a Zone with High OA Requirement and Pre-cool Outside Air
- CO_2 Sensor to Modulate Ventilation in Dining Space
- Active Humidity Control through a Space RH Sensor in Dining Space
- OA/EA Flow Balance to Various Zones Under Various Operating Conditions

Design Highlights

- Minimize Energy Use through Hot gas Reheat Control When Required
- DDC Controls with Sequences Identified for Various Operating Scenarios
- Has Been in Operation for the Last Three years Providing Excellent Comfort Conditions

Old HVAC – Multi-user Facility

Main HVAC Unit

North Dining Room Condensing Unit

Pool Room Unit

2 ton Wall-Hung Unit

New HVAC Units

Summary

- Energy Efficiency and Improved Comfort Control can be Achieved Through an Integrated Design Process
- Current DDC Controls Provide Several Options to Better Control Individual Zones
- Cost-effective Technologies are Available to Improve Dehumidification Capacity of Units
- Identifying/Understanding Requirements is the Most Critical Step in Designing a Cost-effective HVAC System

Thank You!

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