BASIC

PNEUMATIC

CONTROL

COURSE

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CONTENTS

Every building and control system is different from all others, making it an impossibility to foresee each situation you will face in the field. The training is intended to allow one to understand the operational range relating to each type of component. The performance of each control set up depends on the quality of the design and commissioning. The responsibility of each system rests on the persons working directly with the system.

You must have a clear vision of the final performance level for your system considering safety, health, comfort, energy, etc. You must assure that the system has all information available that would allow good decisions with your performance goal in mind. You must also assure that the control system has proper control over all the functions required to achieve the performance level desired.

Under any set of conditions the control system should do exactly what you would do, if manually operating the mechanical system.

You and the control system must "think" logically alike.

There are many more types of systems and situations in the field than illustrated in this document.

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NORMALLY OPEN VALVE OR DAMPER

NORMAL POSITION (NO AIR PRESSURE) ALLOWS MEDIUM FLOW.

NORMALLY CLOSED VALVE OR DAMPER

NORMAL POSITION (NO AIR PRESSURE) DISALLOWS MEDIUM FLOW.

NORMALLY OPEN PRESSURE/ELECTRIC SWITCH (PE)

NORMAL POSITION (NO AIR PRESSURE) DISALLOWS ELECTRICITY FLOW.

NORMALLY CLOSED PRESSURE/ELECTRIC SWITCH (PE)

NORMAL POSITION (NO AIR PRESSURE) ALLOWS ELECTRICITY FLOW.

DIRECT ACTING (DA)

INCREASE IN SENSED MEDIUM = CONTROLLER OUTPUT INCREASE

REVERSE ACTING (RA)

INCREASE IN SENSED MEDIUM = CONTROLLER OUTPUT DECREASE

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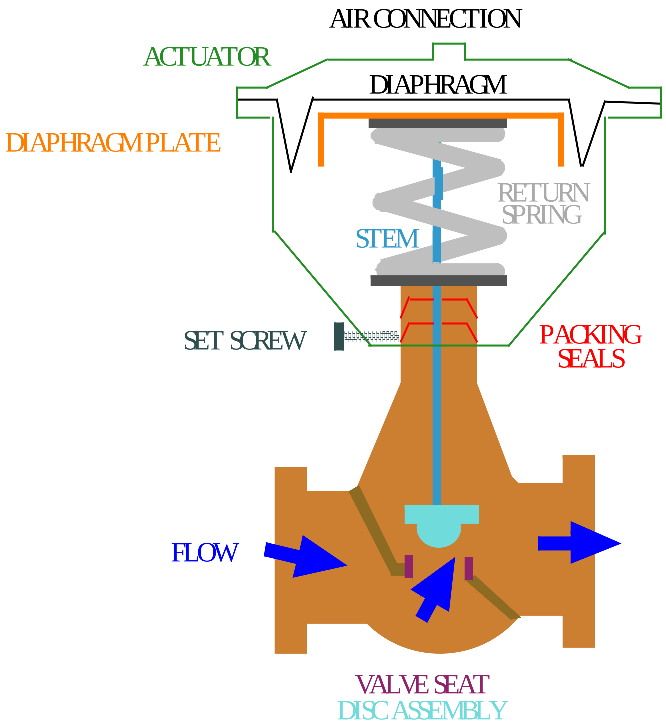
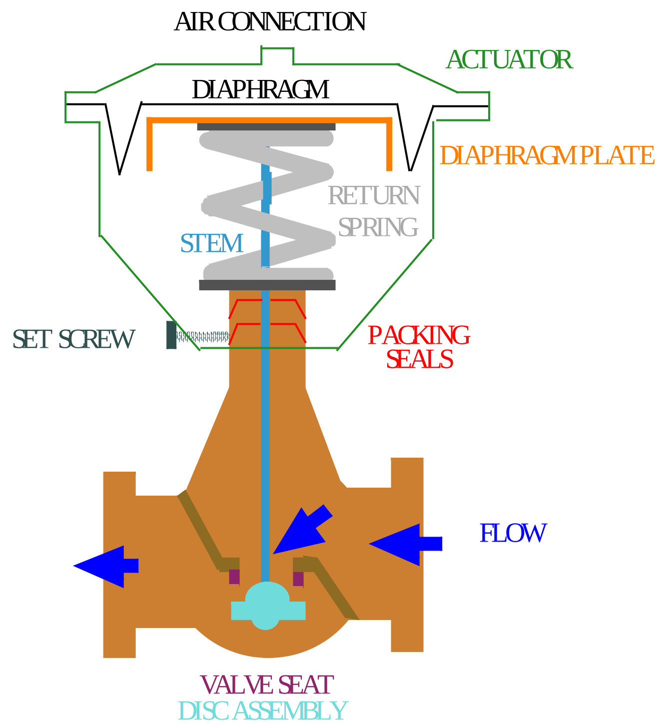
NORMALLY OPEN

THE COMPRESSED AIR CLOSES THE VALVE.
THE RETURN SPRING OPENS THE VALVE.



NORMALLY CLOSED

THE COMPRESSED AIR OPENS THE VALVE.
THE RETURN SPRING CLOSES THE VALVE.



NOTE:

SOME VALVES ARE EXTREMELY DANGEROUS IF THE DISC ASSEMBLY IS BROKEN FROM THE STEM, AS THE ONLY MEANS CONTAINING THE SPRING POWER IS THE SET SCREWS OF THE ACTUATOR.

A VALVE ACTUATOR WITH 200 SQUARE INCHES EFFECTIVE DIAPHRAGM AREA AND A 9# TO 13# SPRING RANGE WILL THROW THE ACTUATOR WITH 1800 POUNDS OF FORCE, WHEN THE SET SCREWS ARE LOOSENED, UNDER THIS CONDITION.

NOTE:

HONEYWELL USES A NORMALLY OPEN VALVE BODY WITH A REVERSE ACTING ACTUATOR TO ACHIEVE A NORMALLY CLOSED VALVE.
NEW LARGE JOHNSON CONTROL VALVES USE THIS SAME METHOD.

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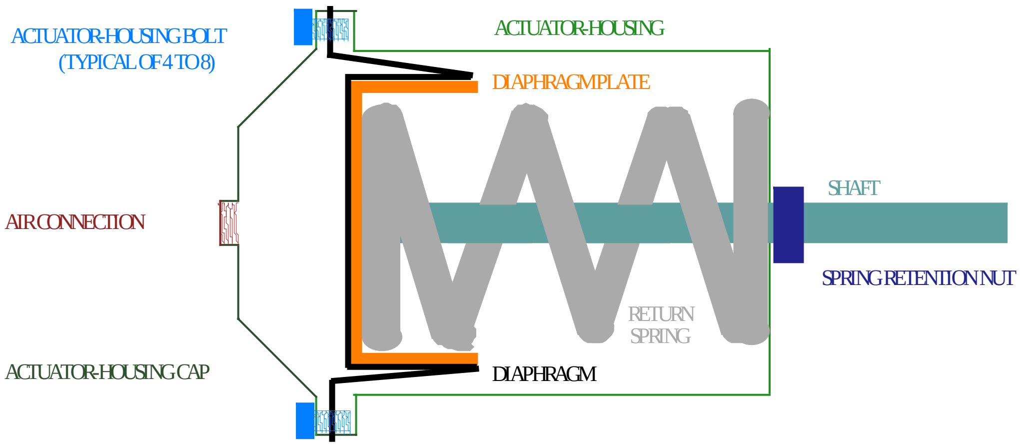
DAMPER ACTUATOR



NOTE:

While replacing a leaking diaphragm you are required to remove the actuator-housing cap. If the type of actuator does not have a spring retention nut you must find a means of containing the spring power when the actuator-housing bolts are removed.

THE POTENTIAL FOR PERSONAL INJURY IS VERY SIGNIFICANT AT THIS POINT IN CHANGING A DIAPHRAGM.

Respecting your safety, loosen the actuator-housing bolts only until you create a gap between the two parts of the actuator-housing. Manually push on the actuator-housing cap to close the gap. This should allow you a flavour of the spring force with which you are contending on the particular actuator. Take appropriate action to protect yourself and others before continuing with the diaphragm replacement.

DO NOT APPLY PRESSURE BEYOND THE DESIGN MAXIMUM STATED BY THE MANUFACTURER, AS YOU MAY INJURE OR KILL YOURSELF OR OTHERS.

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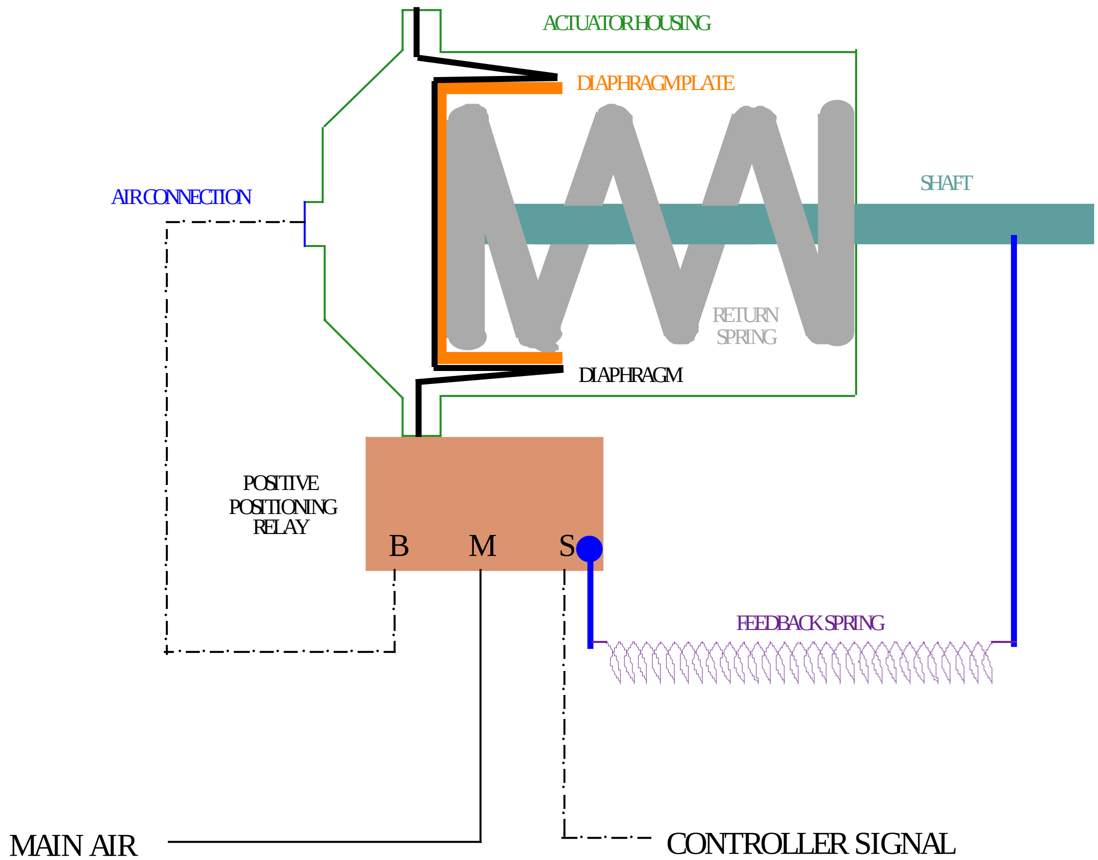
DAMPER ACTUATOR
WITH
POSITIVE POSITIONER



THE POSITIVE POSITIONER PRESENTS THREE BENEFITS:

(1) THE RANGE OF THE CONTROLLER SIGNAL IMPACT ON THE DAMPER ACTUATOR'S STROKING RANGE IS ALTERED VIA THE SPAN ADJUSTMENT ON THE PILOT POSITIONER.
THE SPAN IS ALTERED BY ADJUSTING SIX SCREW POSITIONS LOCATED UNDER THE COVER IN THE OLD HONEYWELL UNITS, CHANGING THE ACTUAL FEED BACK SPRINGS IN THE NEW HONEYWELL, ROBERTSHAW AND KREUTER UNITS. MOVING THE SPRING LOCATION OF THE FEED BACK SPRING ON THE PILOT ARM ON JOHNSON, BARBER COLMAN AND POWERS UNITS.

(2) THE POSITIVE POSITIONER USES FROM MAXIMUM MAIN AIR PRESSURE TO ZERO POUNDS PRESSURE TO ATTAIN THE PROPER PERCENTAGE OF STROKE DEMANDED BY THE CONTROLLER SIGNAL. (THE FEEDBACK SPRING ALLOWS THE POSITIVE POSITIONER TO DETERMINE THE PERCENTAGE STROKE AT ALL TIMES.)

(3) THE POSITIVE POSITIONER BOOSTS A LOW VOLUME SIGNAL TO A HIGH VOLUME SIGNAL.

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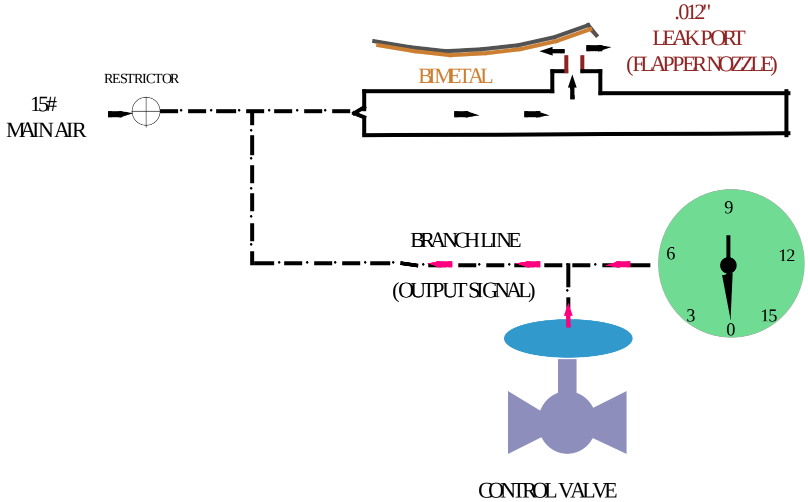

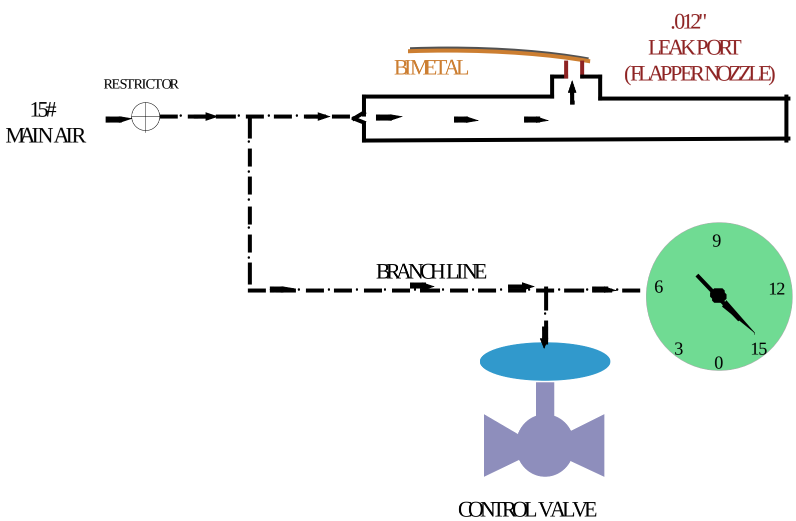

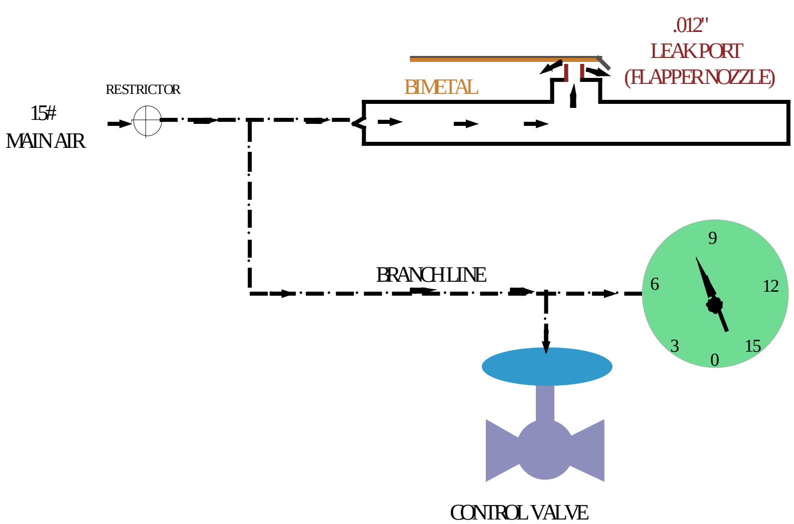

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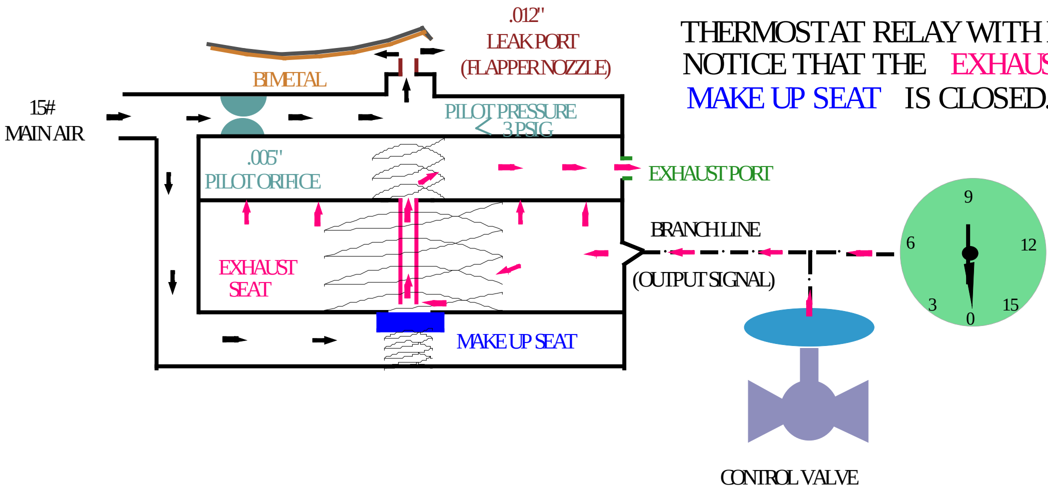
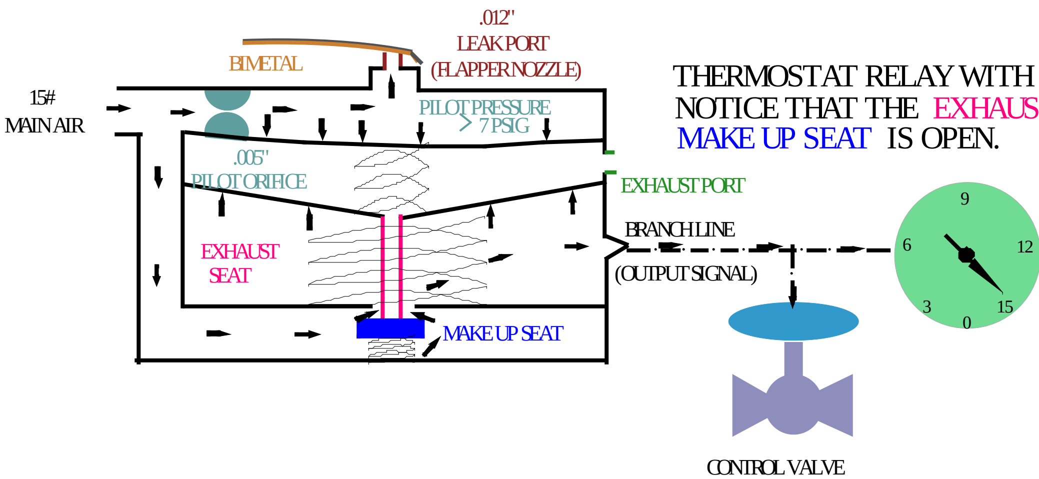
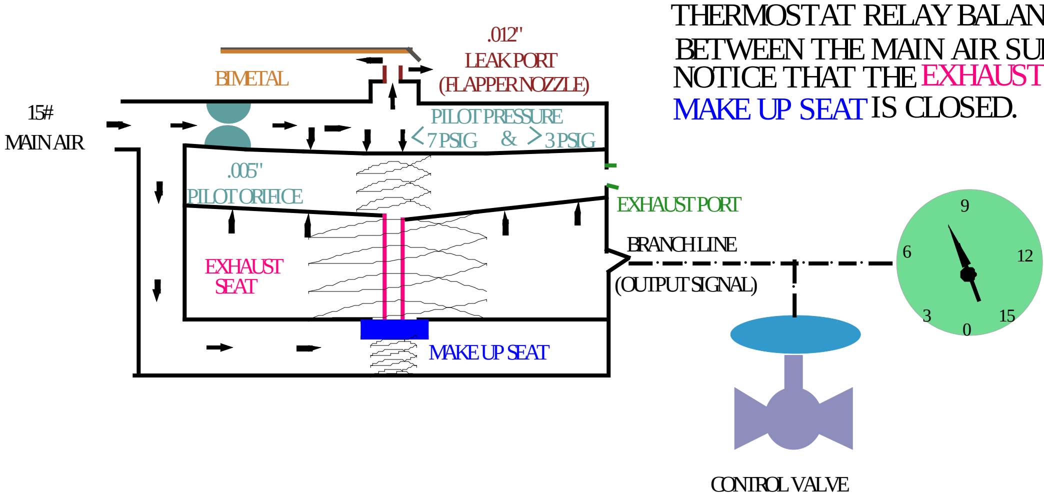


THERMOSTAT RELAY WITH NO OUTPUT SIGNAL.
NOTICE THAT THE EXHAUST SEAT IS OPEN AND THE MAKE UP SEAT IS CLOSED.



THERMOSTAT RELAY WITH MAXIMUM OUTPUT SIGNAL.
NOTICE THAT THE EXHAUST SEAT IS CLOSED AND THE MAKE UP SEAT IS OPEN.

THERMOSTAT RELAY BALANCED, WITH OUTPUT SIGNAL BETWEEN THE MAIN AIR SUPPLY PRESSURE AND ZERO POUNDS.
NOTICE THAT THE EXHAUST SEAT IS CLOSED AND THE MAKE UP SEAT IS CLOSED.



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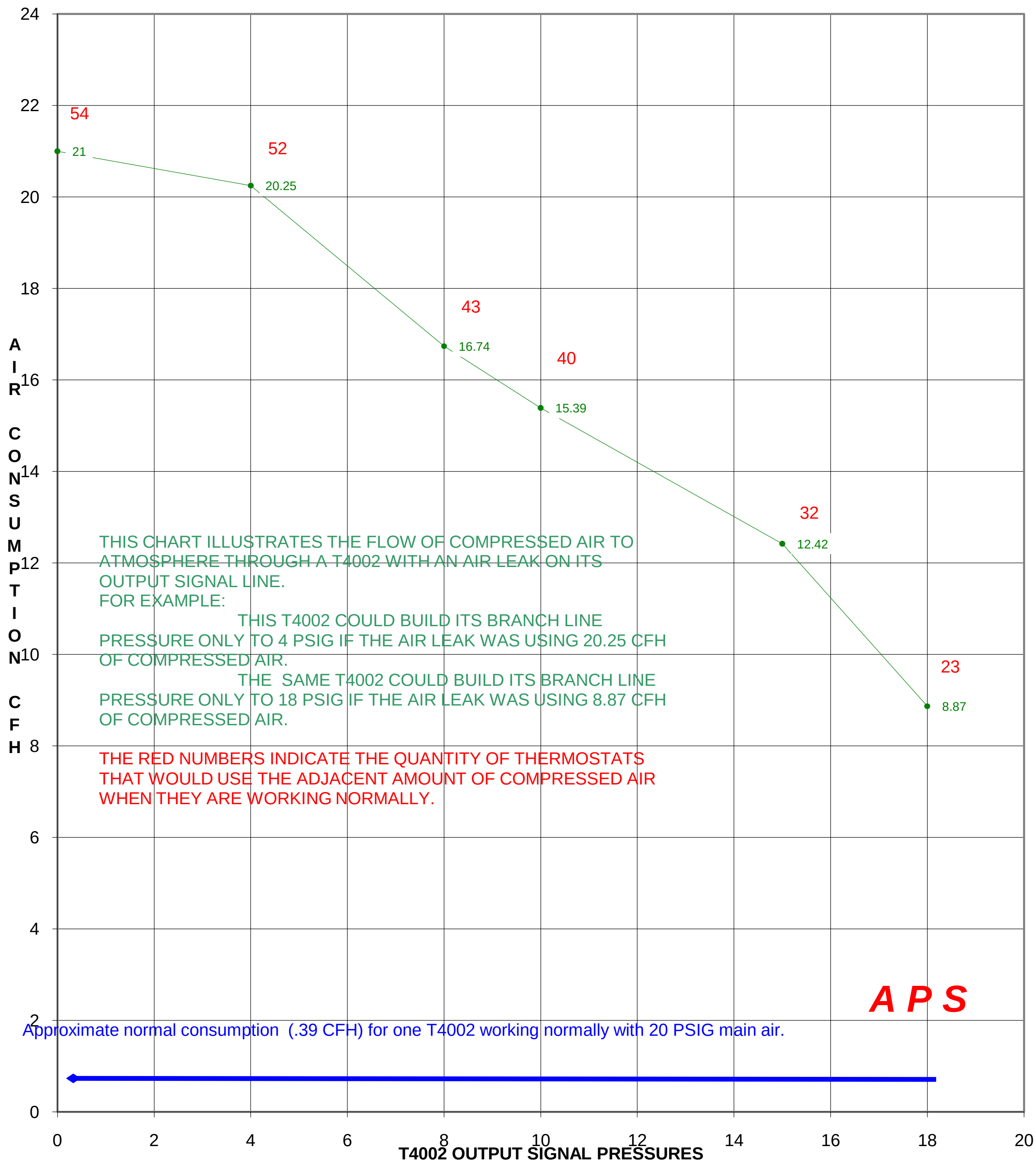
NOTE:
THE PROPORTIONAL BAND FUNCTION IS NOT ILLUSTRATED HERE.

JOHNSON T4002
TOTAL AIR CONSUMPTION (CFH)
WITH OUTPUT SIGNAL LEAKS AT VARIOUS STAGES



PNEUMATIC TRANSMITTERS

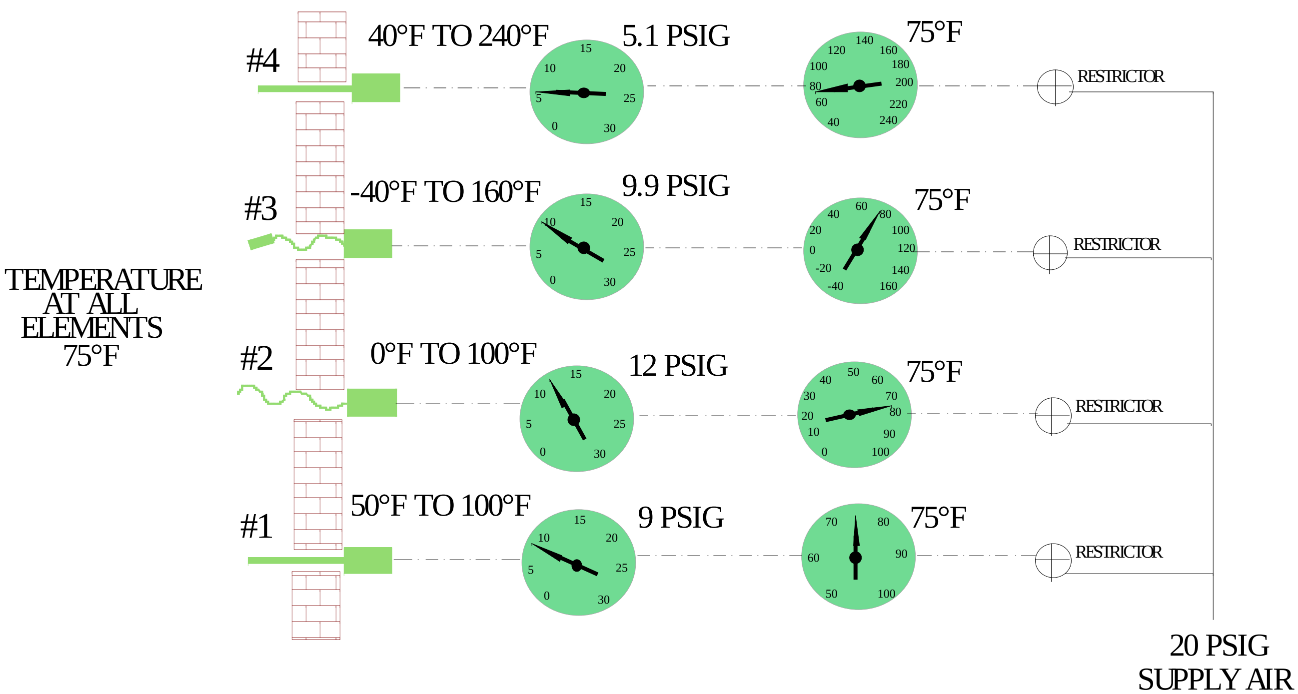
Most commercial pneumatic transmitters are one pipe, as illustrated; however, two pipe transmitters do exist. Note that they all have a 3 PSIG to 15 PSIG range regardless of their temperature, humidity, static pressure, etc. range.

They are all direct acting; therefore, when the element loses its gas, a low value is simulated on the transmission signal.

Most transmitters use restrictors in the range of .007”, but some use restrictors in the range of .005”. The graphs on pages ten and eleven illustrate the relative air consumption of most of the manufacturers’ restrictors.

Transmitters’ operational characteristics are very useful in energy conservation efforts.

For Example: If the outside temperature is 10°F, the –40°F to 160°F transmitter will be sending a 6 PSIG signal to the control system, resetting the main heat to the building. If the area requiring the most heat over-rides that 6 PSIG signal with a 9 PSIG signal, via a selector, the control system will believe that the outside air temperature is 60°F rather than the true 10°F. This is the means of matching the main heat source temperature to the actual requirement of the coolest area of the building.



	#1	#2	#3	#4
15 PSIG	100°F	100°F	160°F	240°F
12 PGIG	87.5°F	75°F	110°F	190°F
9 PSIG	75°F	50°F	60°F	140°F
6 PSIG	62.5°F	25°F	10°F	90°F
3 PSIG	50°F	0°F	-40°F	40°F

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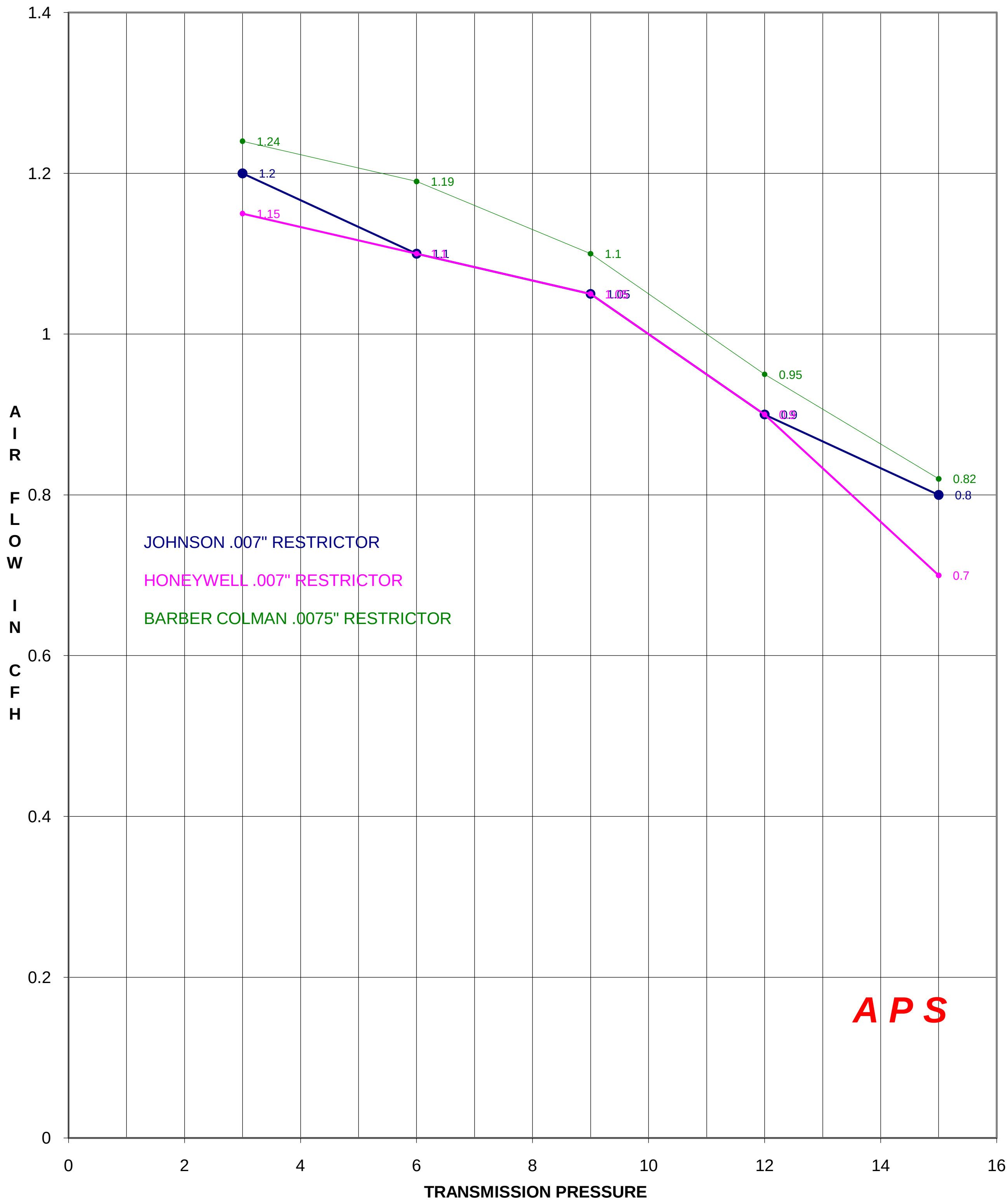
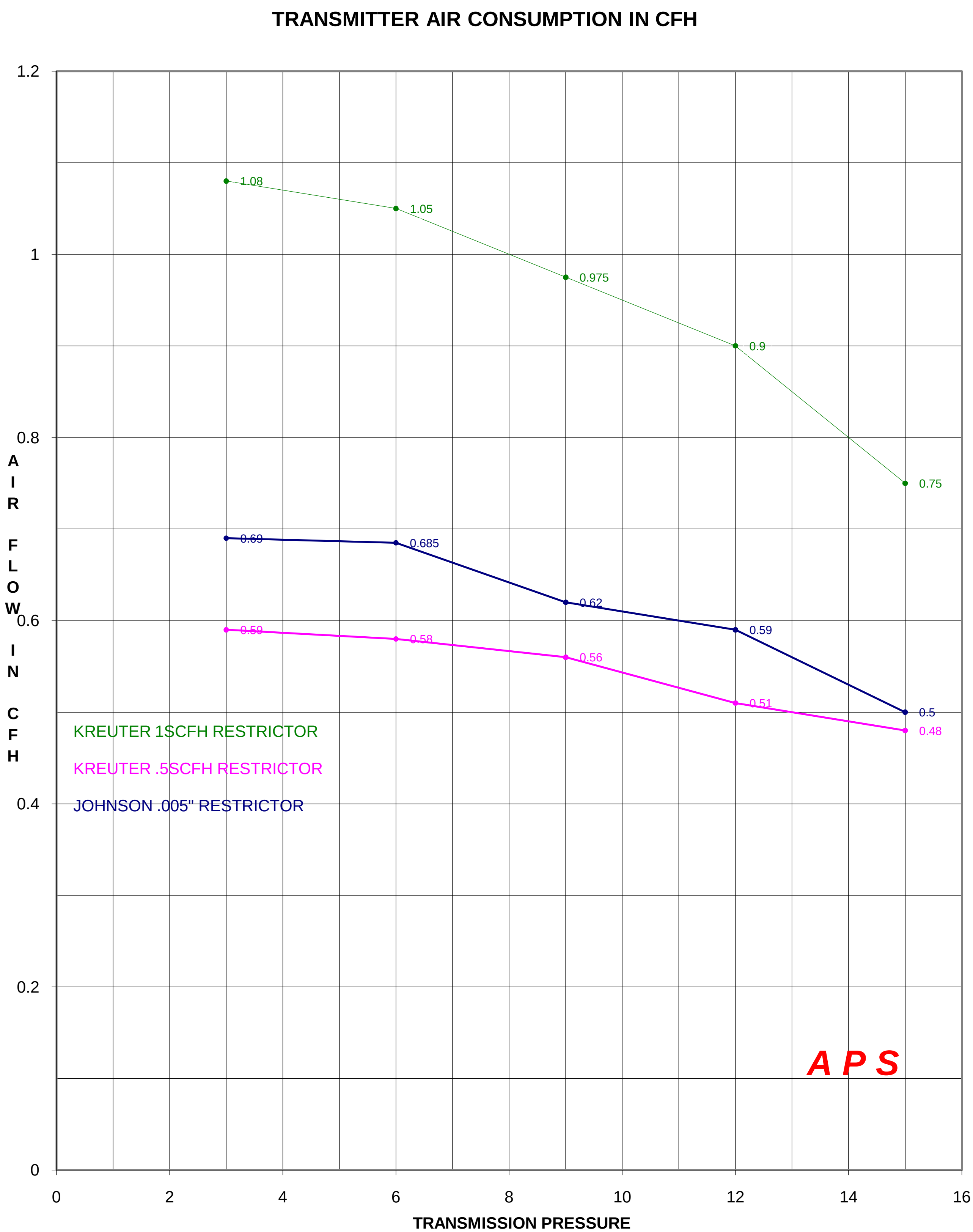
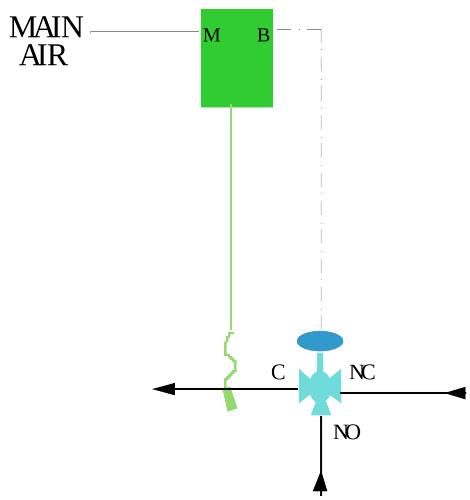
TRANSMITTER AIR CONSUMPTION IN CFH




TRANSMITTER AIR CONSUMPTION IN CFH
AIR FLOW IN CFH
TRANSMISSION PRESSURE
1.08
1.05
0.975
0.9
0.75
0.69
0.685
0.62
0.59
0.5
0.59
0.58
0.56
0.51
0.48
KREUTER 1SCFH RESTRICTOR
KREUTER .5SCFH RESTRICTOR
JOHNSON .005" RESTRICTOR
A P S

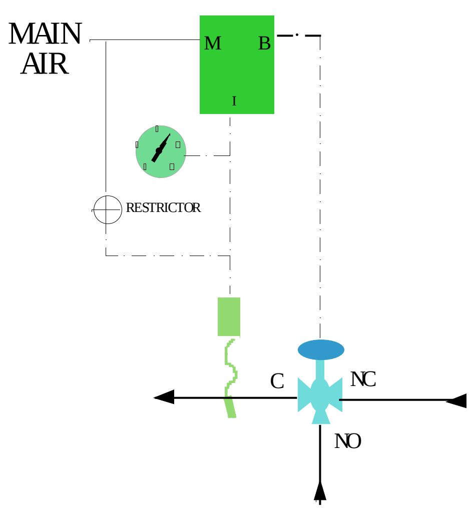
CONTROLLER

A CONTROLLER SENSES THE CONTROLLED MEDIUM DIRECTLY WITH ITS OWN ELEMENT.



RECEIVER CONTROLLER

A RECEIVER CONTROLLER RECEIVES A PNEUMATIC SIGNAL FROM A TRANSMITTER WHICH SENSES THE CONTROLLED MEDIUM AND PROVIDES A 3# TO 15# SIGNAL, REPRESENTING THE STATED RANGE OF THE TRANSMITTER.



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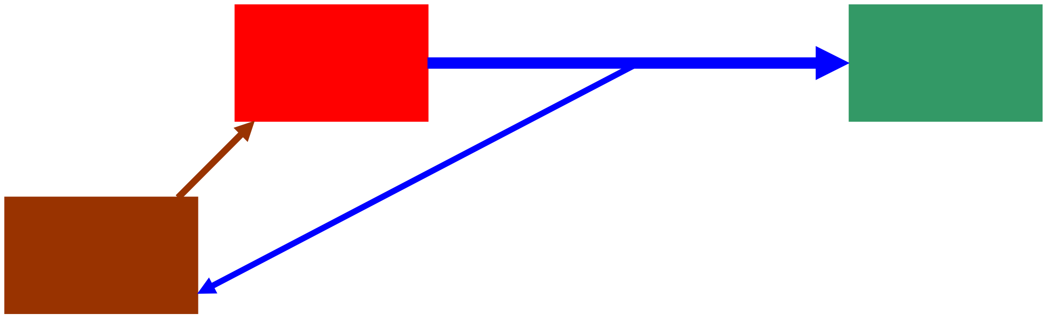
CONTROL LOOPS

OPEN LOOP

-The corrective medium is applied with no feed back indicating the actual condition of the addressed function.

-Example- Setting your furnace to run 50% of every hour with no thermostat sensing the temperature in your house.

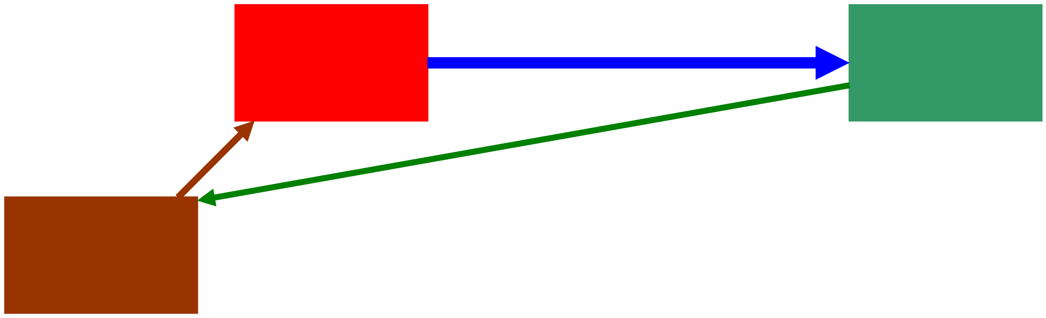
-The accompanying diagram illustrates the CONTROLLER receiving information regarding the amount of CORRECTIVE MEDIUM being applied, but does not sense the DESIRED RESULT.



CLOSED LOOP

-The corrective medium is applied based on the actual condition of the addressed function.

-The accompanying diagram illustrates the CONTROLLER controlling the CORRECTIVE MEDIUM based on receiving information regarding the DESIRED RESULT.



CONTROL LOOP COMPONENTS

DESIRED RESULT

-The target condition or set point for the addressed function.
-Temperature in a room, duct, pipe, etc.
-Humidity level in a room or duct.
-Level in a tank.
-Air quality level in occupied space.
-Open a door when some one approaches.
-Etc.

CORRECTIVE MEDIUM

-A replacement supply of what ever is required to maintain the desired condition of your addressed function.

-Hot or cold water, hot or cold air, pressurized air, steam, liquid, refrigerant, etc.

LOAD

-A varying condition that causes the desired result to be lost by consuming the corrective medium.
-Loss or gain of heat, loss or gain of humidity, loss or gain of liquid level in a tank, loss or gain of pressure in a duct, pipe, tank, etc.

CONTROLLER

-The decision-maker that determines when and how much corrective medium to apply.

CONTROLLED DEVICE

-The apparatus used by the controller applying the corrective medium to the addressed function. (Valve, damper, etc.)

CONTROLLER FUNCTIONS

The controller is the decision-maker in the control loop.
You are the controller when a manual hand valve requires adjustment.

INPUT SIGNALS

-The input signals are information telling the controller the existing conditions relating to the DESIRED RESULT.

-The controller may receive one input signal, two or more in determining the appropriate corrective action.

-The controller may sense the existing conditions directly with its own sensing element or receive information signals from transmitters.

-When you are manually adjusting a valve, you must obtain information allowing decision to be made regarding the desired position of the valve.

OUTPUT SIGNAL

-The output signal is the action taken by the controller after the controller compares the DESIRED RESULT (set point) to the actual condition of the controlled environment. The difference is the error from set point or sometimes called DROOP.

-Output signals can be either two position or proportional. Two position will have the controlled device (valve, damper, etc.) either fully open or fully closed. Proportional will gradually modulate the controlled device ranging from fully open to fully closed.

-Some controllers can be set up for several specific steps from fully open to fully closed.

-When you are required to manually adjust a valve, you must be able to physically change the degree of opening of the valve.

PROPORTIONAL BAND, SENSITIVITY, GAIN

-These terms relate to the same function, which is the amount of output signal change relating to a specific amount of input change on the controller.

-The more insensitive a controller, the more error from set point occurs at load extremes.

-If a controller is hunting or sometimes called cycling, the controller is over-shooting and the sensitivity has to be lessened to settle the system.

-When you are manually operating a valve you must gradually open the valve to the proper position or the system will over-shoot.

INTEGRAL RESET

-Reset is a controller function that corrects the error from set point or DROOP. Not all controllers have this function.

-When manually operating a hand valve on steam you would position the valve more open in cold weather than in warm weather to attain the same degree of heat in the air or water. This is similar to integral reset in controllers.

AUTHORITY, RESET

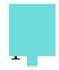
-This function allows the set point to vary based on another variable. An example is outdoor/indoor reset on heating hot water. As the outside air becomes colder, the set point for the heating hot water becomes hotter.

-When manually operating a water temperature for heating, you would likely target a hotter water temperature in cold weather than in warm weather conditions. This is similar to the authority function in controllers.

RESTRICTOR

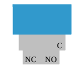
RESTRICTOR ORIFICES ARE USUALLY .007" OR .005".

RESTRICTORS ARE USED TO PROVIDE A PRECISE RATE OF FLOW AT A SPECIFIC PRESSURE DROP.



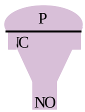
PRESSURE ELECTRIC SWITCH (PE)

A PNEUMATIC PRESSURE CHANGE SWITCHES THE ELECTRICAL CONTACTS IN THE PRESSURE SWITCH.
PRESSURE SWITCHES CAN HAVE SINGLE CONTACTS OR MULTIPLE CONTACTS.
THE DESIGN PRESSURE RANGE MUST MATCH THE APPLICATION.
SOME HAVE ADJUSTABLE DIFFERENTIAL WHILE OTHERS HAVE FIXED DIFFERENTIAL SETTINGS.



ELECTRIC/PNEUMATIC VALVE (SOLENOID AIR VALVE)

SOLENOID VALVES ARE USED TO ALLOW AN ELECTRICAL SIGNAL SWITCH A PNEUMATIC SIGNAL.
THE PRESSURE RATING OF THE VALVE MUST SUIT THE APPLICATION.
THE FLOW CAPABILITY MUST SUIT THE APPLICATION.
THE VOLATGE RATING MUST MATCH THE APPLICATION.

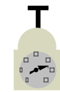


AIR VALVE

AIR VALVES ALLOW A PNEUMATIC SIGNAL TO REDIRECT, ALLOW OR DISALLOW ANOTHER PNEUMATIC CONTROL SIGNAL.
AIR VALVES CAN BE GRADUAL ACTING OR TWO POSITION.
EITHER THE AIR VALVE OR THE SWITCHING SIGNAL MUST BE TWO POSITION TO PREVENT BURDENING THE COMPRESSED AIR SOURCE WITH AIR BLEEDING TO ATMOSPHERE.

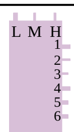
PRESSURE RELIEF VALVE

PRESSURE RELIEF VALVES PROTECT PNEUMATIC COMPONENTS FROM PRESSURES ABOVE THEIR NORMAL DESIGN.
COMPRESSORS HAVE RELIEF VALVES RATED AT HIGHER PRESSURES THAN THE MAIN AIR SUPPLY TO A CONTROL SYSTEM.
DO NOT REMOVE OR PREVENT A RELIEF VALVE FROM DOING ITS JOB.



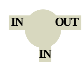
PRESSURE REDUCING VALVE (PRV)

PRESSURE REDUCING VALVES ARE USED TO REDUCE HIGH PRESSURE AIR TO THE PROPER WORKING PRESSURE FOR A SYSTEM.
THE MOST SUITABLE RANGED PRESSURE REDUCING VALVE SHOULD BE APPLIED IN EACH APPLICATION.



MULTI-HIGH-LOW SELECTOR

MULTI-HIGH-LOW SELECTORS ARE USED TO SELECT THE HIGHEST AND THE LOWEST OF A GROUP OF PNEUMATIC SIGNALS.
IF THE LOWEST SIGNAL IS TO BE USED BE SURE THAT NO PORT IS LEFT TO ATMOSPHERE AS THAT WILL PROVIDE A ZERO POUND LOW SIGNAL AT ALL TIMES. BARBER COLMAN MADE MULTI-HIGH AND MULTI-LOW, TEN INPUT UNITS, INDIVIDUALLY.



TWO SIGNAL SELECTORS

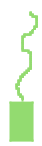
TWO SIGNAL SELECTORS COME AS EITHER HIGHER OF TWO OR LOWER OF TWO.
THE HIGHER OF TWO PRODUCES THE HIGHER PRESSURE ON THE RELAY'S OUTPUT.
THE LOWER OF TWO PRODUCES THE LOWER PRESSURE ON THE RELAY'S OUTPUT.
OLD BARBER COLMAN AND HONEYWELL UNITS REQUIRED A MAIN AIR CONNECTION AS WELL.

HIGH LIMIT HEAD (SPRINKLER HEAD)

SPRINKLER HEADS ARE USED AS HIGH LIMIT SENSING DEVICES ON FAN SAFETY LOOPS.
EACH SPRINKLER HEAD SHOULD BE RATED AT THE PROPER TEMPERATURE FOR ITS LOCATION.

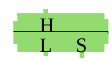
LOW LIMIT

LOW LIMITS ARE SOMETIMES CALLED FREEZE STATS.
THEY CAN BE ELECTRIC OR PNEUMATIC.
THEY CAN HAVE MANUAL RESET OR AUTOMATIC.
THE ELEMENT CAUSES THE LIMIT TO TRIP IF ANY ONE FOOT OF THE ELEMENT SENSES A TEMPER-ATURE BELOW ITS SET POINT.
IT IS NOT AN AVERAGING ELEMENT.



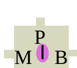
PNEUMATIC TRANSMITTERS

PNEUMATIC TRANSMITTERS SENSE A MEDIUM WITH THEIR SENSING ELEMENT AND PROVIDE A 3# TO 15# SIGNAL REPRESENTING THE RANGE DESIGN OF THE TRANSMITTER.
TRANSMITTERS CAN BE TWO PIPE, BUT ARE USUALLY ONE PIPE DEVICES.
MOST ARE DESIGNED FOR A .007" RESTRICTOR, BUT SOME REQUIRE A .005" RESTRICTOR.



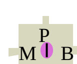
PRESSURE TRANSMITTERS

PRESSURE TRANSMITTERS ARE USED TO SENSE EITHER DIRECT PRESSURE OR DIFFERENTIAL PRESSURE IN A SYSTEM.
THEY ARE USUALLY ONE PIPE AND PRODUCE A 3# TO 15# SIGNAL OVER THE DESIGN RANGE.



BIASING RELAY

BIASING RELAYS (RATIO RELAYS) ARE USED TO INCREASE A PNEUMATIC SIGNAL BY THE RATIO DESIGN OF THE RELAY.
THEY ARE USUALLY A VOLUME BOOSTER RELAY.
SOME DESIGNS ALLOW SELECTION OF A RATIO SELECTION CAUSING A SIGNAL REDUCTION IN RANGE.
THEY ARE VERY USEFUL ALLOWING SIGNAL OFFSET, VIA THE BIASING ADJUSTMENT SCREW.



REVERSING RELAY

REVERSING RELAYS ARE USED TO REVERSE THE DIRECTION OF A PNEUMATIC SIGNAL.
REVERSING RELAYS USUALLY HAVE A BIASING SCREW ADJUSTMENT ALLOWING SIGNAL OFFSET FOR SEQUENCING PURPOSES.
JOHNSON CONTROLS MAKES A UNIT THAT APPLIFIES THE INPUT CHANGE AT A 1:2 RATIO.

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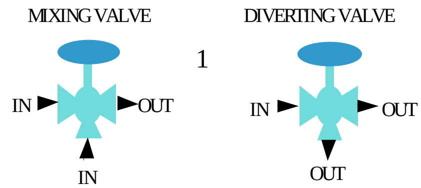
JOB	APS BASIC CONTROLS
SYSTEM	PNEUMATIC COMPONENTS
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	

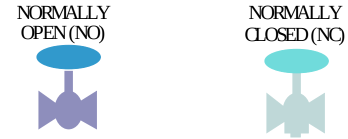
CONTROL DAMPERS

CONTROL DAMPERS ARE POWERED BY ACTUATORS TO DIRECT AIR FLOW AS REQUIRED BY THE BUILDING VENTILATION AND FREE COOLING REQUIREMENTS.
THE "NORMAL" POSITION IS ATTAINED WHEN THE AIR PRESSURE TO THE ACTUATOR IS BELOW THE SPRING RANGE OF THE ACTUATOR.



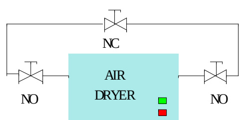
THREE-WAY VALVES

BOTH DIVERTING AND MIXING VALVES ARE USED TO CONTROL THE HEATING OR COOLING FLOW TO PART OF THE MECHANICAL SYSTEM.
CAUTION MUST BE EXERCISED TO NOT DEAD-HEAD A PUMP WHEN SELECTING A VALVE FOR A PARTICULAR APPLICATION.
PROPER DIRECTION OF WATER FLOW IS IMPORTANT.



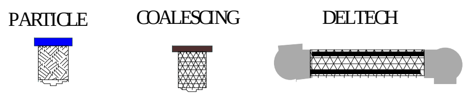
TWO-WAY VALVES

BOTH NORMALLY CLOSED AND NORMALLY OPEN VALVES ARE USED TO REGULATE THE FLOW OF HEATING OR COOLING INTO A SYSTEM.
IF INSTALLED BACKWARD, THE VALVE WILL HAMMER AT TIMES AND SHOULD BE REVERSED.



REFRIGERATED AIR DRIER

REFRIGERATED AIR DRYERS COOL COMPRESSED AIR TO THE POINT WHERE MOISTURE CONDENSES FROM THE AIR.
THE MOISTURE IS DISCHARGED FROM THE DRYER AUTOMATICALLY.
DRY AIR IS EQUALLY IMPORTANT TO PROPERLY FILTERED AIR IN YOUR PNEUMATIC SYSTEM.

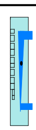


AIR FILTERS

THE PARTICLE FILTER IS A PRE-FILTER FOLLOWED BY A COALECING (OIL) FILTER AND/OR A DELTECH (OIL WITH PROPER INDICATION) FILTER.
FILTRATION IS ONE OF THE MOST IMPORTANT REQUIREMENTS OF YOUR PNEUMATIC SYSTEM.

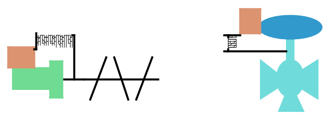
AIR COMPRESSORS

COMPRESSORS ARE USUALLY SELECTED TO RUN NO MORE THAN 33% OF THE TIME.
ALWAYS SELECT AN INSTRUMENTATION GRADE COMPRESSOR.
CLOSELY FOLLOW THE MAINTENANCE GUIDE SET BY THE MANUFACTURER.



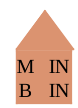
AIR FLOW METER

AIR FLOW METERS ARE AN INDICATING DEVICE THAT ALERT THE OPERATOR TO THE FACT THAT A LEAK EXISTS IN THE PNEUMATIC SYSTEM.
THESE METERS ARE ALSO EXTREMELY VALUABLE DURING THE SEARCH FOR THE LEAK (S) IN THE SYSTEM.



PILOT POSITIONER (POSITIVE POSITIONER)

PILOT POSITIONERS SENSE THE STROKE OF THE DAMPER OR VALVE VIA A SPRING.
THE SPAN AND THE START POINT OF THE STROKE CAN BE ALTERED VIA THE PILOT POSITIONER.
THE PILOT POSITIONER WILL USE FROM ZERO PSIG TO FULL MAIN PSIG TO POSITION THE DEVICE.

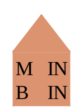


AVERAGING RELAY

AVERAGING RELAYS GENERATE AN OUTPUT THAT IS AN AVERAGE OF THE INPUTS.
BE CAREFUL WITH THIS INSTRUMENT. IF ONE ROOM IS 60°F AND THE OTHER IS 80°F, THE AVERAGE IS 70°F. PROBLEMS EXIST IN BOTH ROOMS, BUT THE AVERAGE INDICATES PERFECT CONTROL.

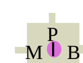
ADDITION RELAY

ADDITION RELAYS ADD THE PRESSURE CHANGE ON ONE INPUT TO THE VALUE OF THE OTHER INPUT WITH THE RELAY BRANCH PRESSURE BEING THE SUM.
THESE RELAYS ARE VERY USEFUL IN CONSERVATION STRATEGIES. AS AN EXAMPLE, YOU MAY WISH THAT THE CONTROL SYSTEM "BELIEVE" THAT THE OUTSIDE AIR TEMPERATURE IS WARMER THAN ACTUAL.
THE OUTPUT CAN BE BIASED TO FIT SEQUENCING REQUIREMENTS.



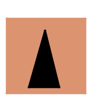
SUBTRACTION RELAY

SUBTRACTION RELAYS SUBTRACT THE PSIG CHANGE OF ONE INPUT FROM THE VALUE OF THE OTHER INPUT. THE RELAY OUTPUT REFLECTS THE END VALUE.
THESE RELAYS ARE ALSO USEFUL IN WHEN ALTERING SYSTEMS FOR CONSERVATION.



MINIMUM POSITIONING RELAY

MINIMUM POSITIONING RELAYS ARE USUALLY ASSOCIATED WITH LIMITING THE FRESH AIR DAMPER CLOSURE TO THE MINIMUM VENTILATION REQUIREMENTS OF THE SYSTEM.



SELECTOR SWITCH

SELECTOR SWITCHES ALLOW SELECTION OF TWO OR MORE INPUTS TO BE THE SELECTORS OUTPUT.

GRADUAL SWITCH

GRADUAL SWITCHES ALLOW A VARIABLE OUTPUT SIGNAL TO BE MANUALLY SELECTED VIA THE DIAL.

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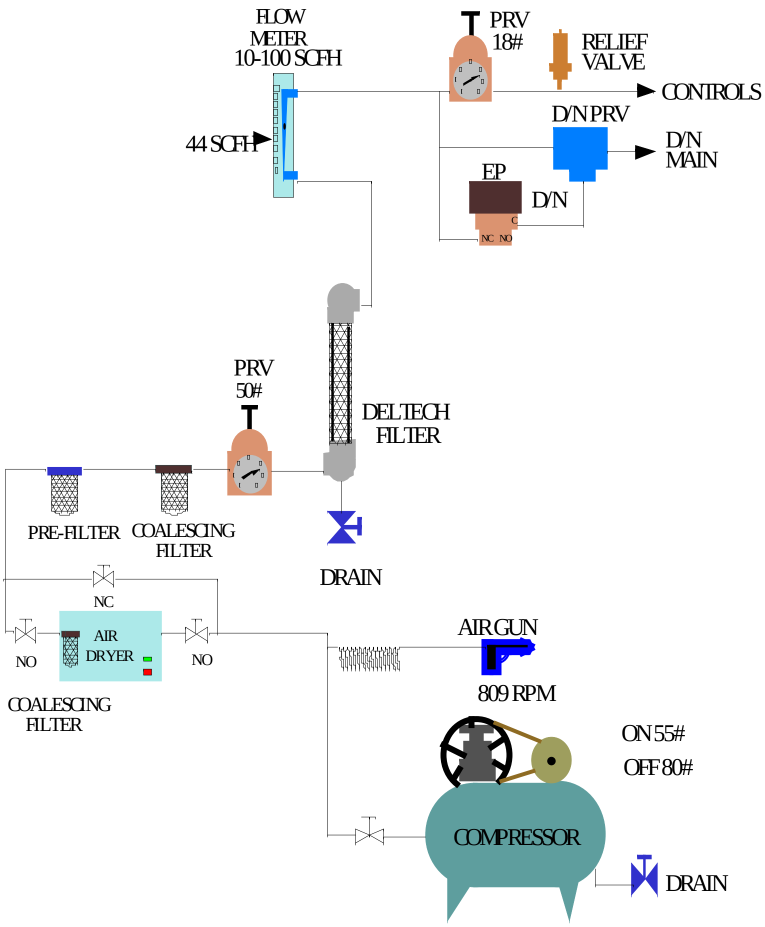
JOB	APS BASIC CONTROLS
SYSTEM	PNEUMATIC COMPONENTS
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	



NOTE:
ALWAYS TURN OFF THE COMPRESSOR WHILE SERVICING!

-When the red area on the Deltech filter advances by 1/2" from the last time you had the coalescing element changed, this indicates that oil is passing by the coalescing filter. At this time submit a work order to have the coalescing element changed and mark the top of the red advancing area on the Deltech filter element with a felt pen to guide you for the next 1/2" change to indicate the next required element change.

-When the Deltech filter turns red over about 2/3 of its lower area, submit a work order to have both elements changed.

-Time the compressor's run time once a month. Record this run time as well as the flow meter reading. Send recorded figures to the energy department at end of each year. (Run time/run time + rest time X 100 = % run time)

-Change oil in compressor every six months. FILL TO PROPER LEVEL. EXAMPLES: To check Devilbiss, with dipstick, screw dipstick in all the way. If no dipstick, on Devilbiss, fill to first thread below oil fill port opening. (The correct oil is none detergent 20 that is available from the stock room.)

-Report any unusual sounds, air leaks, large increases in compressor run time or large increases in flow rate at the time of discovery.

-Check compressor belt, with the compressor turned off, for cracking and tension when the oil is being changed. Replace belt at first sign of cracking. The belt should flex by your finger tension about 3/4" at the middle of the belt.

-Use the air gun to clean the air dryer coil. Wear eye safety glasses. Do not use the air gun to clean yourself or your clothing.

NOTE:

NEW PUMP DATA SHEETS INDICATE THAT
A 123 PUMP PASSES 3.6 CFM AT 80 PSIG
WITH .71 HP AT 800 RPM

MANUFACTURER	DEVILBISS
MODEL	123
HORSE POWER	1
TIME TO FILL TANK (0-80#)	5 MIN AND 30 SEC
TANK SIZE	60 GAL
PERCENTAGE RUN TIME	40%
UNIT CFM AT 80#	3.1 CFM
BELT	4L580
INTAKE ELEMENT	M2003 (3" PAPER)

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JOB	APS BASIC CONTROLS
SYSTEM	COMPRESSOR STATION
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	

MIXED AIR

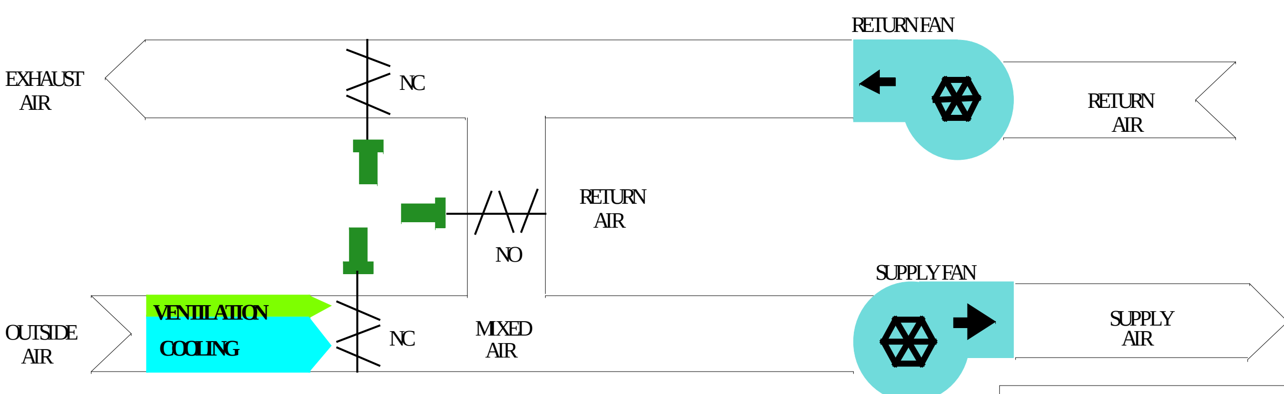
Mixed air in a fan system is the body of air that is a mixture of outside air and return air from the building. Most conventional fan systems attempt to control the mixed air temperature in the range of 55°F. A certain percentage of the fresh air is required for ventilation purposes and exhaust air replacement, while fresh air beyond that percentage is required for cooling purposes only.

Often the mixed air is referred to as “FREE COOLING”, but is it always? Most buildings require varying degrees of cooling, even during the winter. The mixed air in the range of 55°F is the design temperature for times when the building requires maximum cooling. What happens when that amount of cooling is forced into the building and the maximum amount of cooling is not required?

The building will either become uncomfortably cold or the building system will have to add heat to compensate for the unwanted cooling.

This is similar to going home and putting a manual switch on your central air conditioner to have refrigeration active all the time. When the load for cooling is great enough to match the capability of the refrigeration unit the building will be comfortable. When the cooling load drops, you will either have to find a way to have the cooling delivered match the actual requirement or turn on your furnace to remain comfortable.

“FREE COOLING” is not “free” if the amount of cooling delivered is not required by any part of the receiving areas. This “FREE COOLING” cost is equal to the heating energy cost to correct for the over-cooling.



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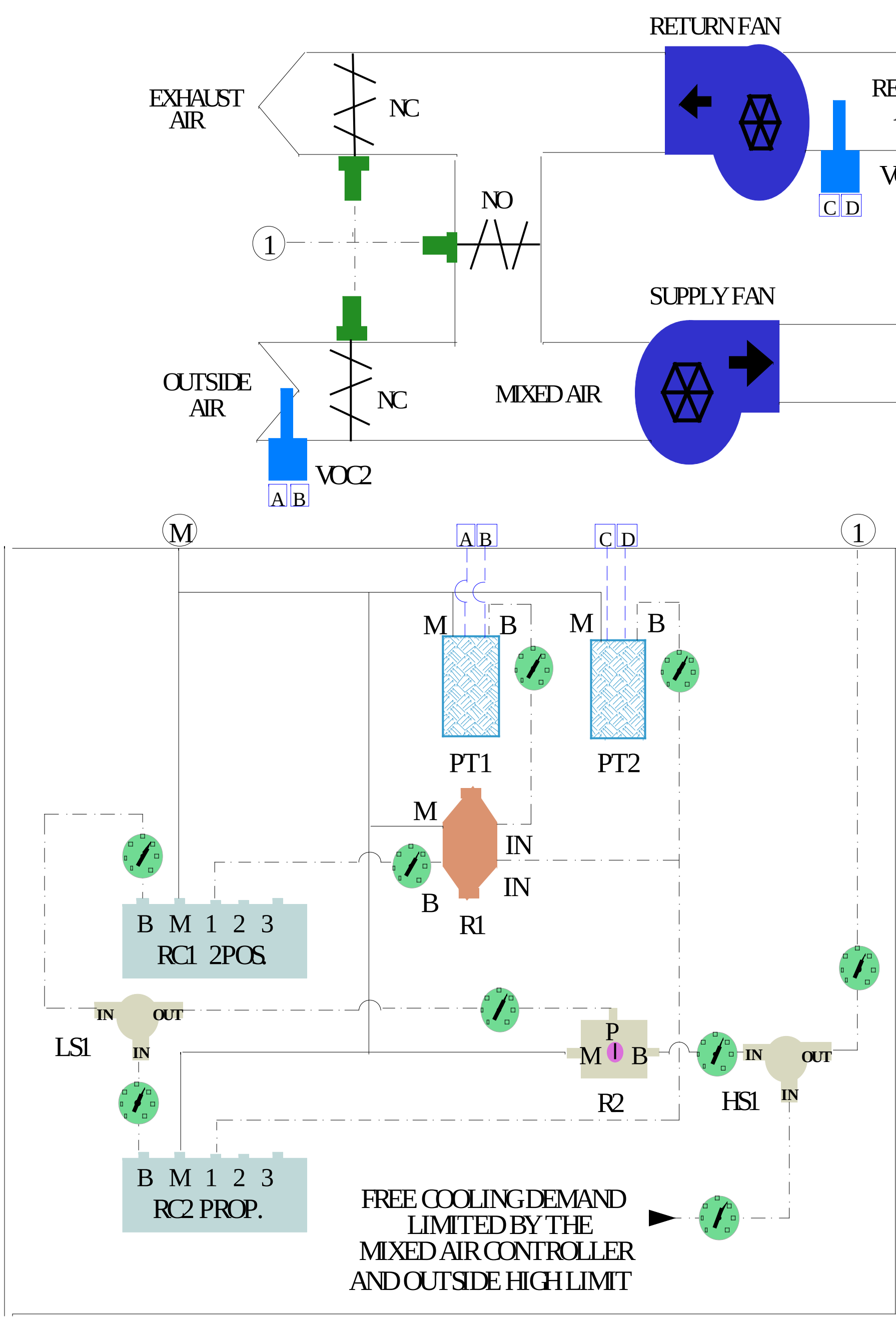
JOB	APS BASIC CONTROLS
SYSTEM	MIXED AIR
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	

VOC FRESH AIR QUALITY TO RETURN AIR QUALITY COMPARATOR

PURPOSE

-Electronically/pneumatically determine if the outside air or the return air is cleaner based on VOC levels.
-Use fresh air for ventilation only if it is cleaner than the return air.
-Use only enough ventilation fresh air to maintain the return air VOC level at the target value (eg. – 16500).
-Limit the maximum CFM of ventilation based on the mechanical system capability.
-Limit the minimum of the minimum allowing for exhaust air replacement.
-Allow free cooling demand to exceed the minimum ventilation demand as required for comfort.



VOC1,VOC2	VOC SENSORS
RC1	2 POSITION RECEIVER CONTROLLER
RC2	PROPORTIONAL RECEIVER CONTROLLER
R1	SUBTRACTION RELAY
R2	MINIMUM/MAXIMUM LIMITING RELAY
PT1, PT2	TRANSDUCERS
LS1	LOW SELECTOR
HS1	HIGH SELECTOR

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JOB	VOC LOGIC LOOP
SYSTEM	
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	ONE OF ONE

HEATING INPUT

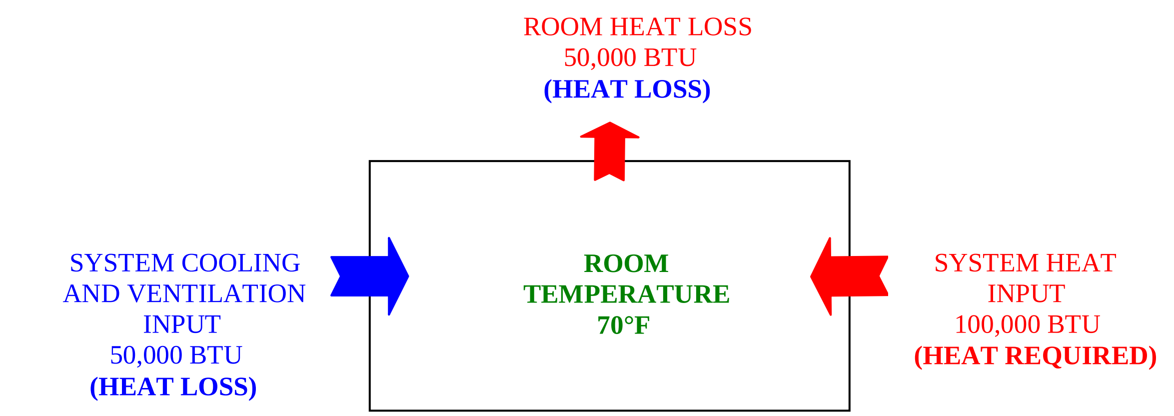
Many control systems determine the main building supply heating temperature based only on the outside air temperature. This similar to allowing your furnace to run for varying number of minutes per hour based on the outside air temperature. This might sound logical, but consider these scenarios.

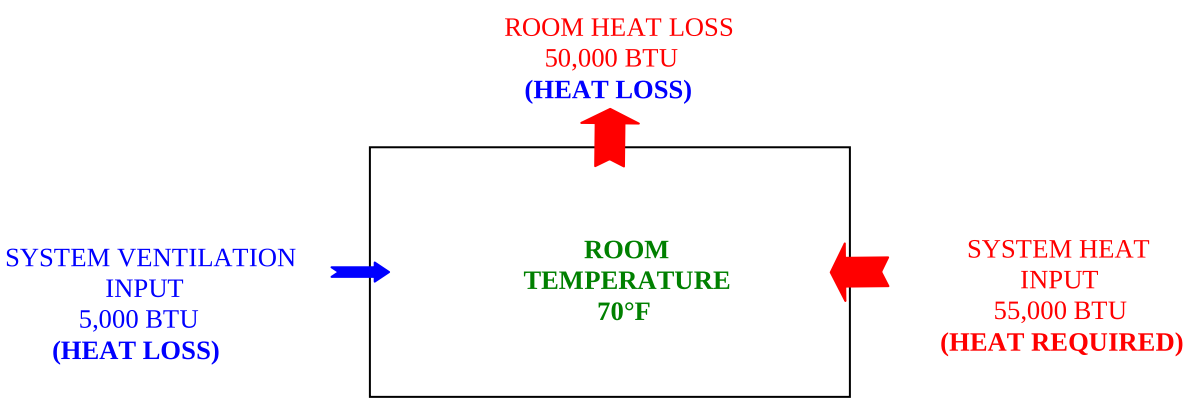
SCENARIO	OSA TEMP.	FURNACE RUN	WIND	OCCUPANCY	SUN CONDITION	ROOM TEMP.
ONE	30°F	15 MIN./HR	STILL	25 (GATHERING)	BRIGHT NOON SUN	?
TWO	30°F	15 MIN./HR	BLIZZARD	YOU ALONE	NIGHT	?

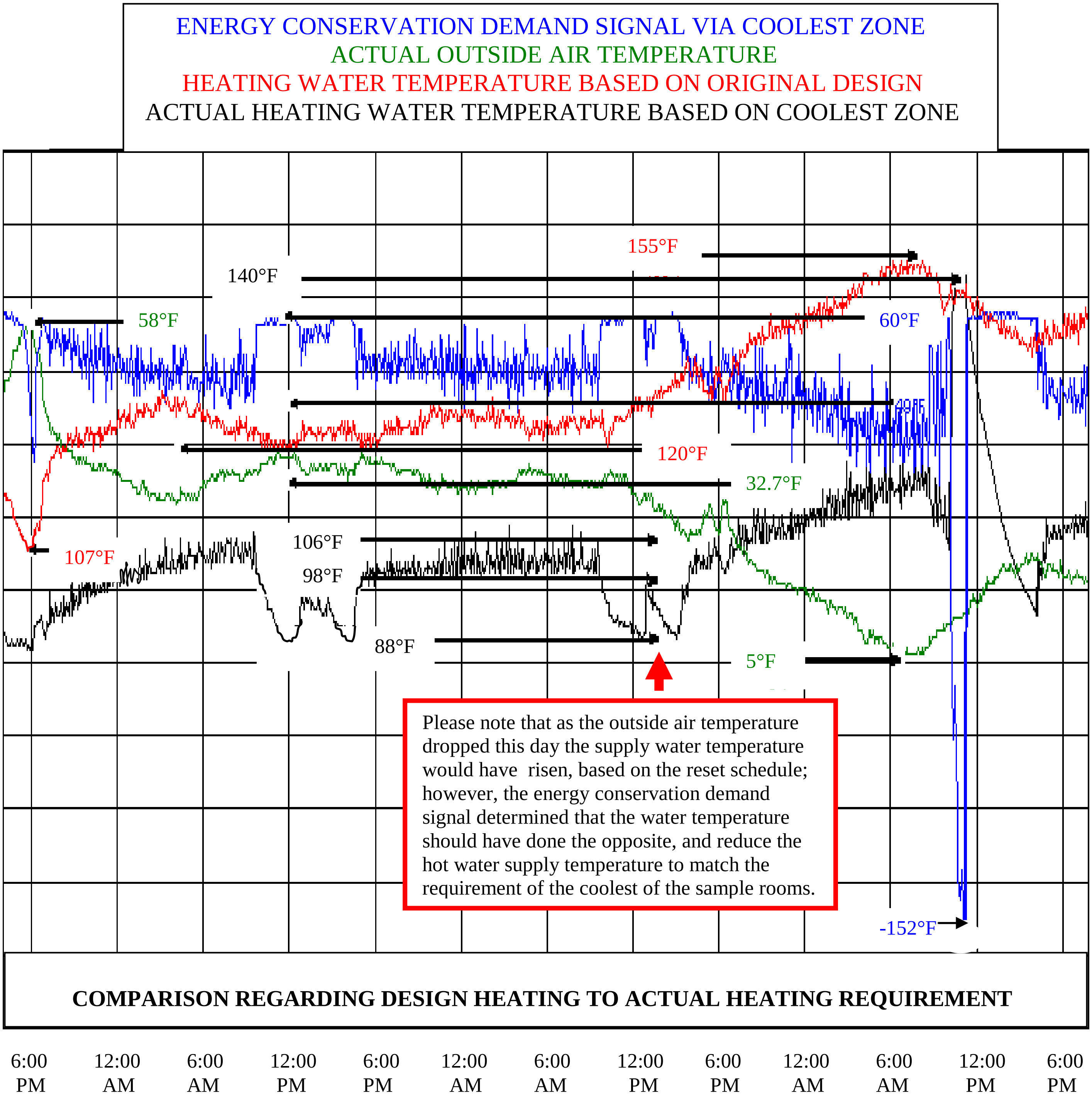
If the fifteen minute run time per hour, based on the 30°F outside air temperature is enough to keep you warm in scenario two's conditions, the gathering will over-heat under the conditions of scenario one with the same run time based only on the outside air temperature.

The graph on page twenty-two illustrates a comparison of actual heating water requirements of the coolest area of the building to heating water determined by only outside air temperature.

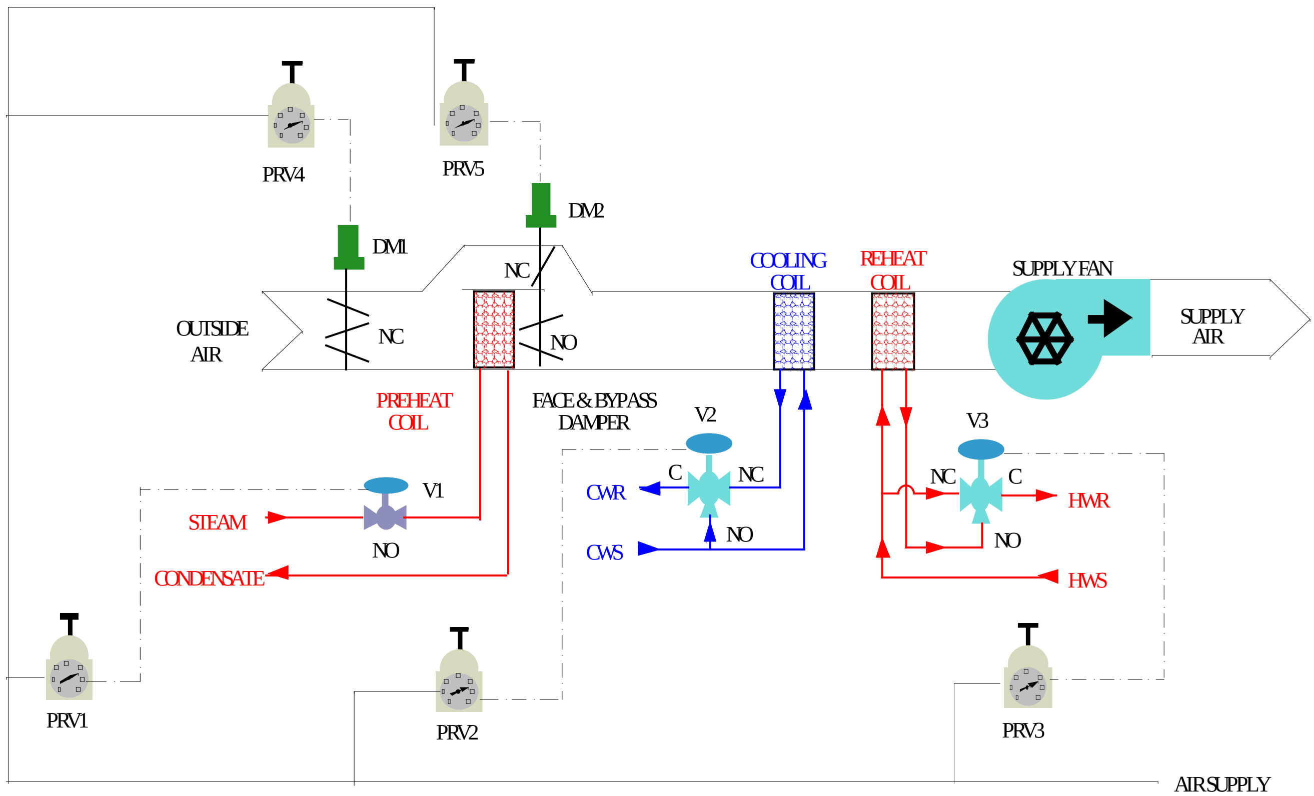
CO-ORDINATING THE HEATING AND COOLING WHICH ARRANGEMENT SEEMS BETTER?







COMPARISON REGARDING DESIGN HEATING TO ACTUAL HEATING REQUIREMENT



What are the considerations for the illustrated system regarding safety of the mechanical components?

What are the considerations for the illustrated system regarding energy use?

What is a typical application of the type of system illustrated?

How would you manually operate this fan system to address ventilation, comfort and energy use requirements under these different conditions?

(1) At unoccupied times when the outside air (OSA) temperature is below 35°F?
(2) At occupied times when the OSA temperature is below 35°F?
(3) At unoccupied times when the OSA temperature is above 35°F?
(4) At occupied times when the OSA temperature is above 35°F?

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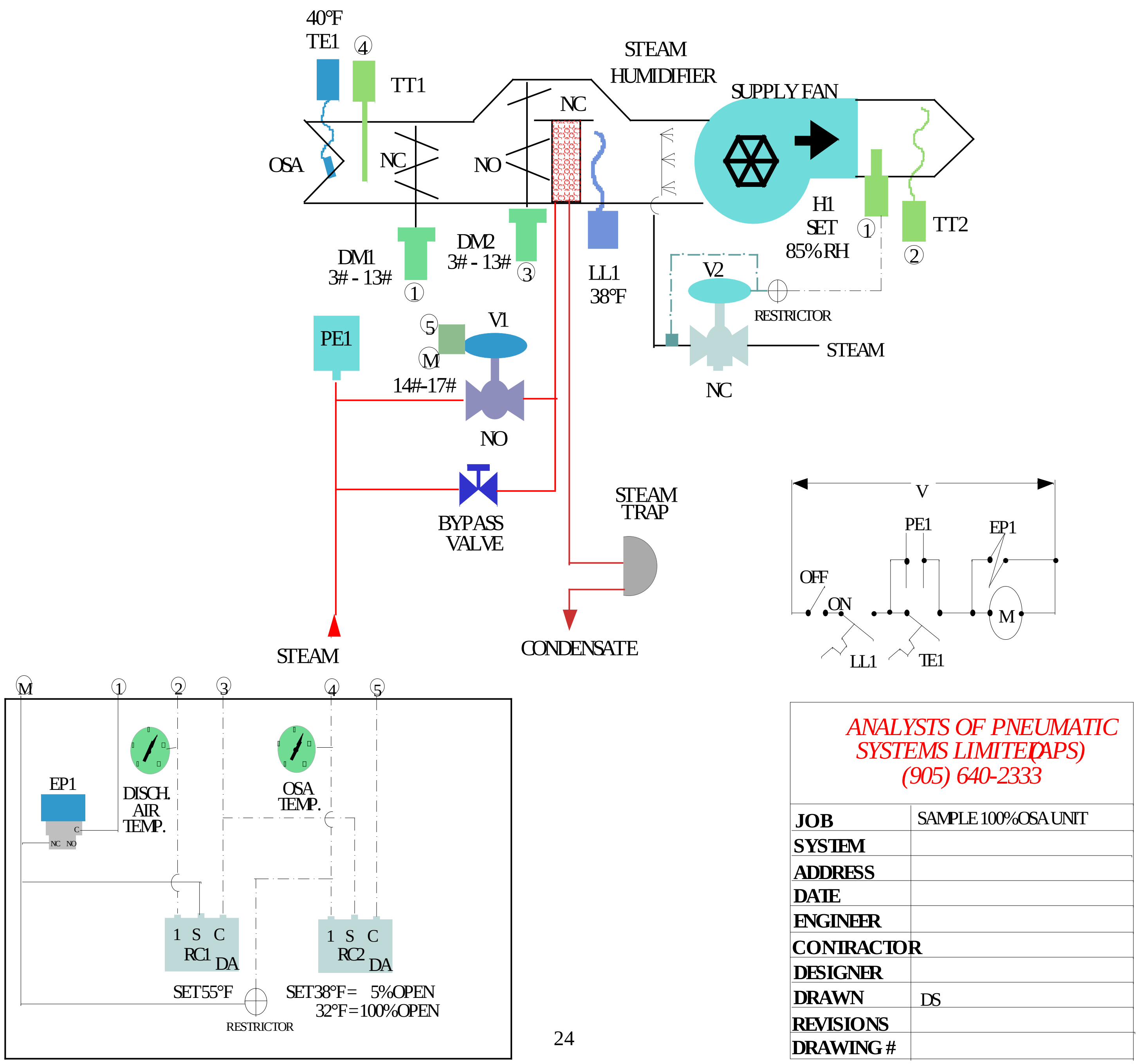
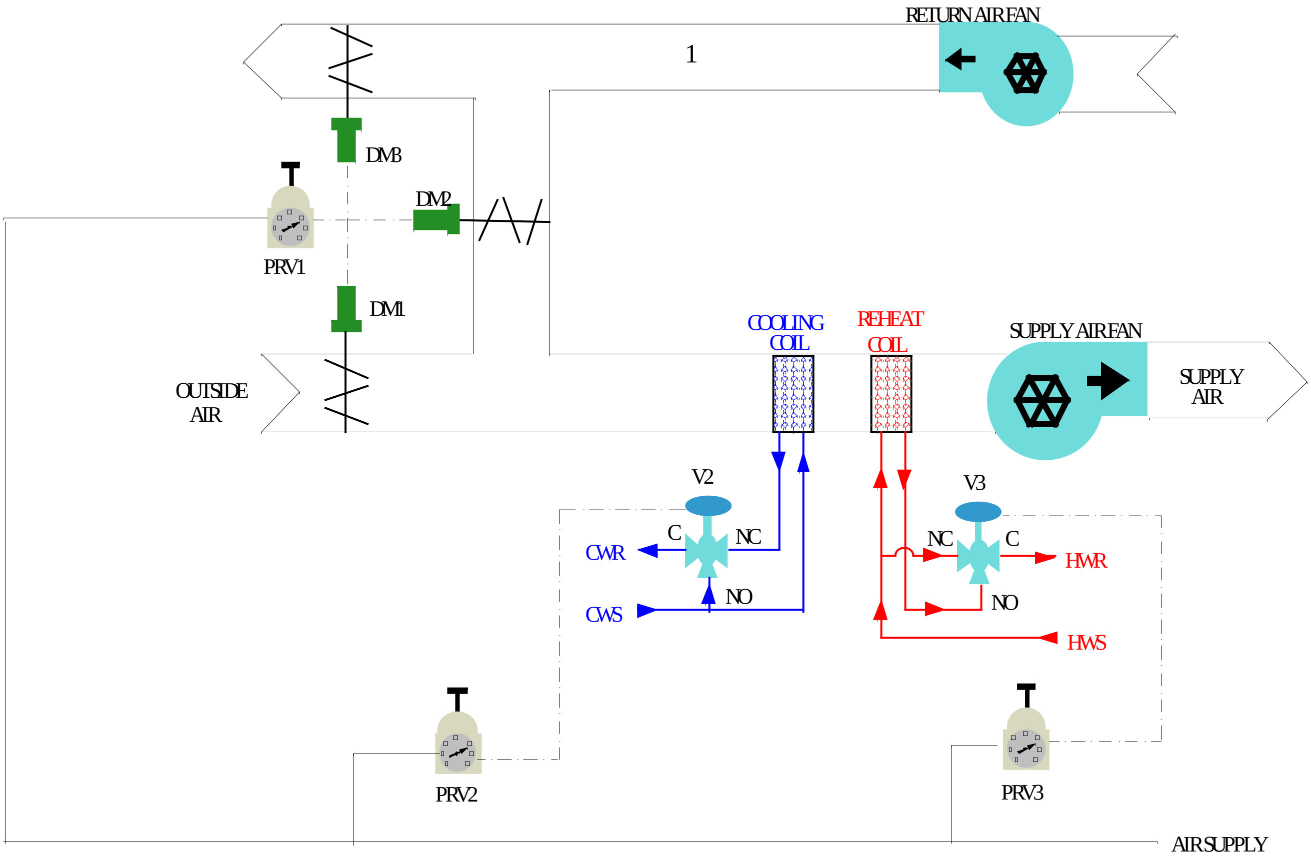
JOB	APS BASIC CONTROLS
SYSTEM	100% OSA FAN
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	

SEQUENCE OF OPERATION

When the fan starts solenoid air valve (EP1) energizes and passes control air to drive damper motor (DM1) fully. EP1 also passes control air to humidity controller (H1). Receiver controller (RC1) senses the discharge air temperature via transmitter (TT2). RC1 sends its signal to modulate face & bypass damper motor (DM2). RC1 also sends its signal to feed receiver controller (RC2). RC2 senses the outside air temperature via transmitter (TT1). RC2 passes its signal to modulate control valve (V1).
H1 sends its signal to modulate humidifier valve (V2).
If low limit (LL1) senses a temperature below its set point on anyone foot of its element the fan will shut down. If pressure switch (PE1) senses a loss of steam pressure in cold weather as determined by controller (TE1) the fan will shut down.
The humidifier must be valved off for summer operation.





What are the considerations for the illustrated system regarding safety of the mechanical components?

What are the considerations for the illustrated system regarding energy use?

What is a typical application of the type of system illustrated?

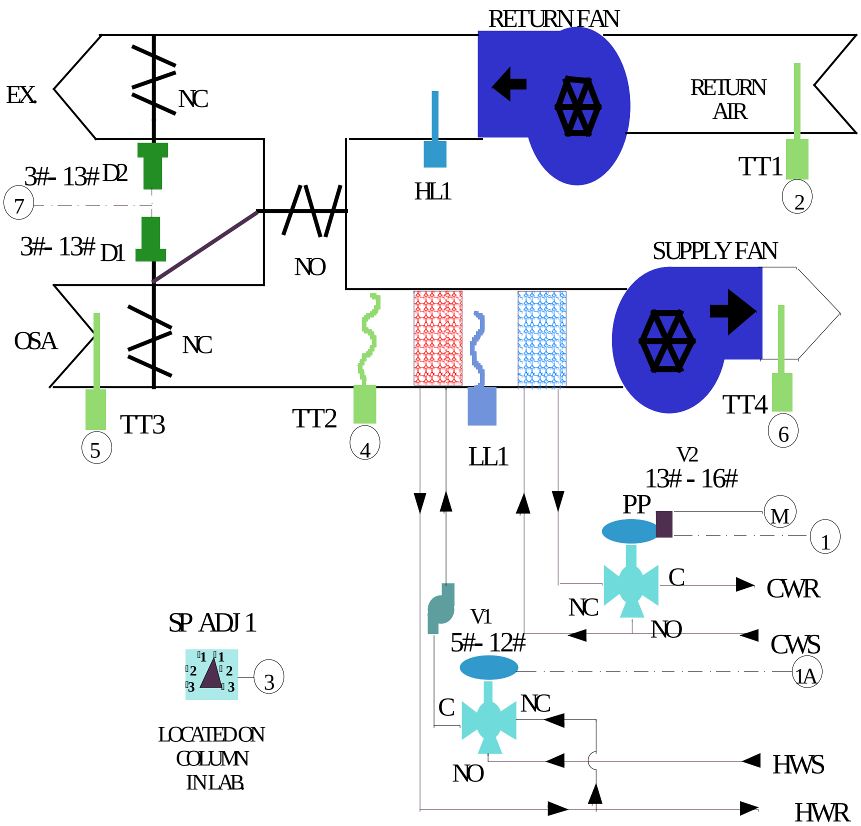
Where and what safeties should be installed?

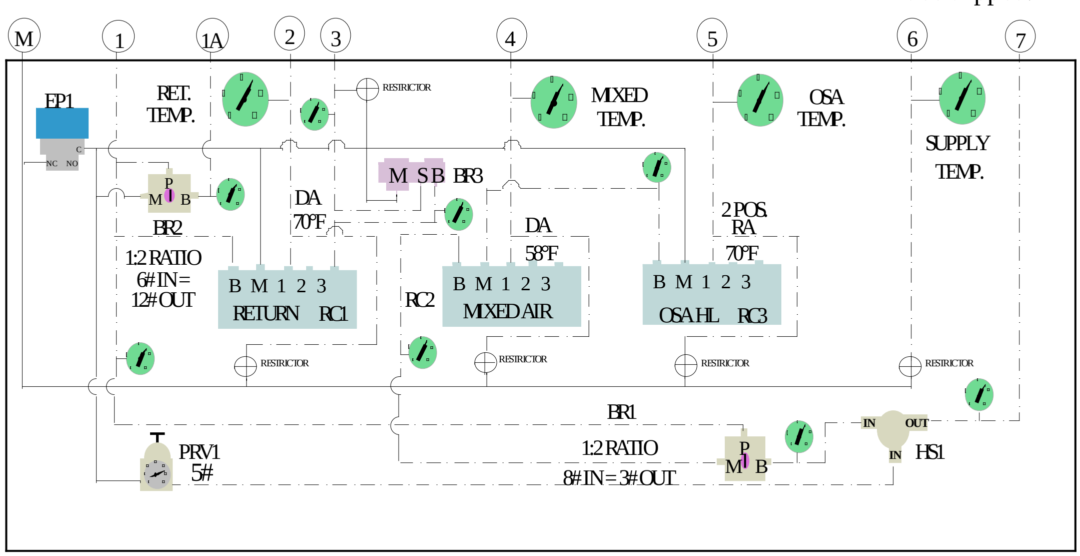
Where is the mixed air plenum and what are the mixed air's two purposes?

How would you manually operate this fan system to address ventilation, comfort and energy use requirements under these different conditions?

(1) At unoccupied times when the outside air (OSA) temperature is below 35°F? (If the fan is the only source of heating? If adequate perimeter heating also exists?)
(2) At occupied times when the OSA temperature is below 35°F?
(3) At unoccupied times when the OSA temperature is above 35°F?
(4) At occupied times when the OSA temperature is above 35°F?

ANALYSTS OF PNEUMATIC SYSTEMS LIMITED (905) 640-2333 (APS)	
JOB	APS BASIC CONTROLS
SYSTEM	MIXED AIR FAN
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	





SEQUENCE OF OPERATION

-The fan runs continuously to suit laboratory operation.

-Solenoid air valve (EP1) passes control air to the fan controls when the fan runs.

-Receiver controller (RC1) senses the return air temperature via transmitter (TT1) and receives a set point demand from (SP ADJ 1). RC1 sends its signal to biasing relays (BR1), (BR2), (HS4 on drawing three), as well as to cooling valve (V2). The instrument arrangement causes the heating valve (V1) to close first, then the free cooling dampers (D1) and (D2) to be maximized and then the mechanical cooling valve (V2) to be used on a demand for cooling.

-BR1 sends its signal to high selector (HS1) which also receives a signal from regulator (PRV1) to assure the system of at least minimum ventilation.

-Receiver controller (RC3) senses the outside air temperature via transmitter (TT3). RC3 passes main air to receiver controller (RC2) only when free cooling is available based on the outside air temperature to economize on mechanical cooling. RC2 senses the mixed air temperature via transmitter (TT2). RC2 limits the mixed air temperature to a minimum of 58°F by limiting the main air to BR1.

-Turndown ratio relay (BR3) is set to limit the degree of set point demand from the laboratory.

-Static pressure controller (SPC1) senses the differential pressure between the outside air and the lab. SPC! Sends its signal to limiting relay (LM1) which limits the vanes to not close beyond LM1's set point. LM1 sends its signal to modulate vane motor (D3).

-If low limit (LL1) senses a temperature below its set point on any one foot of its element the fan will shut down. If high limit (HL1) senses a temperature above its set point, the fan will shut down. Both HL1 and LL1 require resetting after they have tripped.

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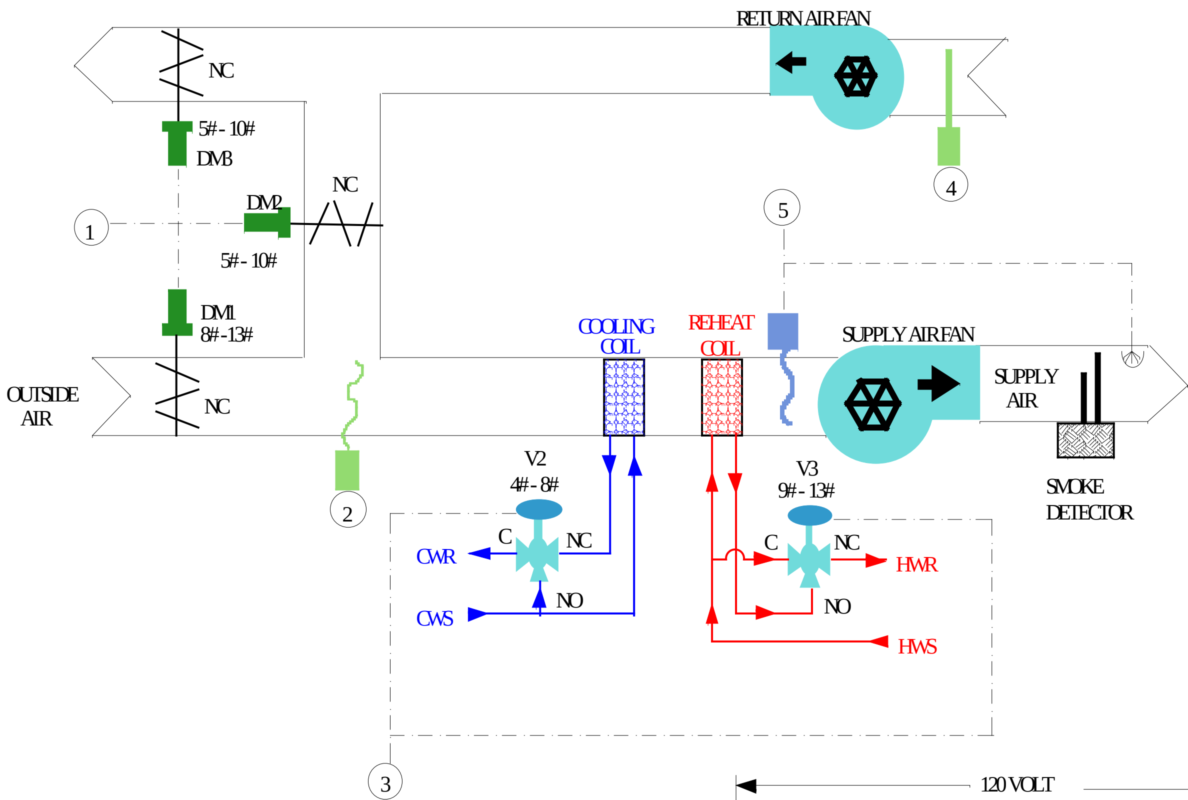
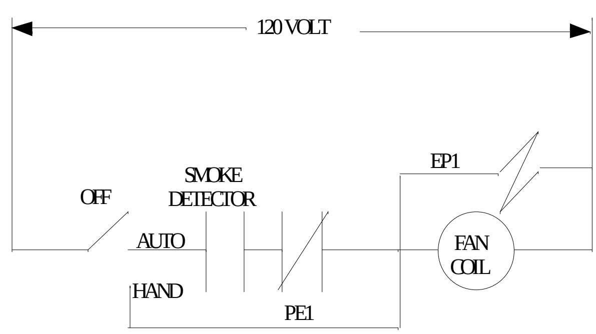
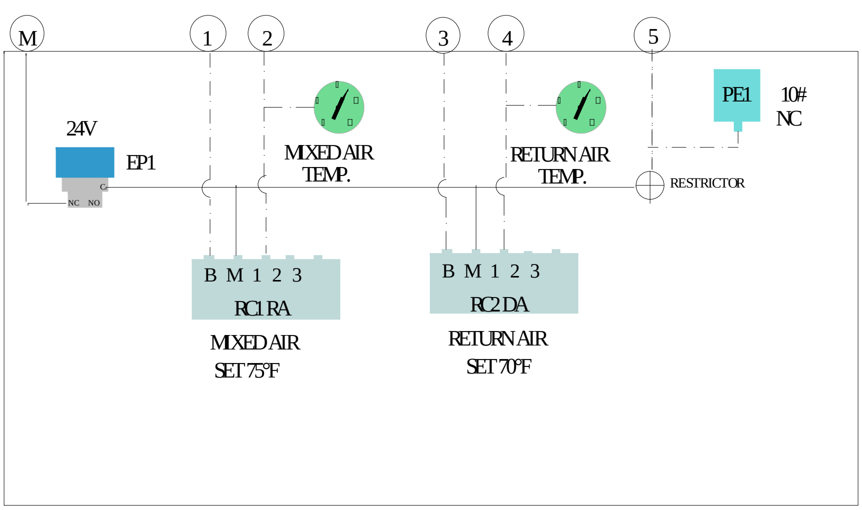
JOB	MIXED AIR EXAMPLE
SYSTEM	
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING#	

FAN SYSTEM WITH MANY ERRORS

WHAT IS WRONG WITH THE MECHANICAL ARRANGEMENT?
WHAT IS WRONG WITH THE PNEUMATIC ARRANGEMENT?
WHAT IS WRONG WITH THE WIRING?
WHAT IS WRONG WITH THE STARTER WIRING?
SEE PAGE 40 FOR SOME HINTS.







ANALYSTS OF PNEUMATIC SYSTEMS LIMITED (APS) (905) 640-2333	
JOB	APS BASIC CONTROLS
SYSTEM	SYSTEM OF MANY ERRORS
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	

FACE & BYPASS UNITVENTILATOR

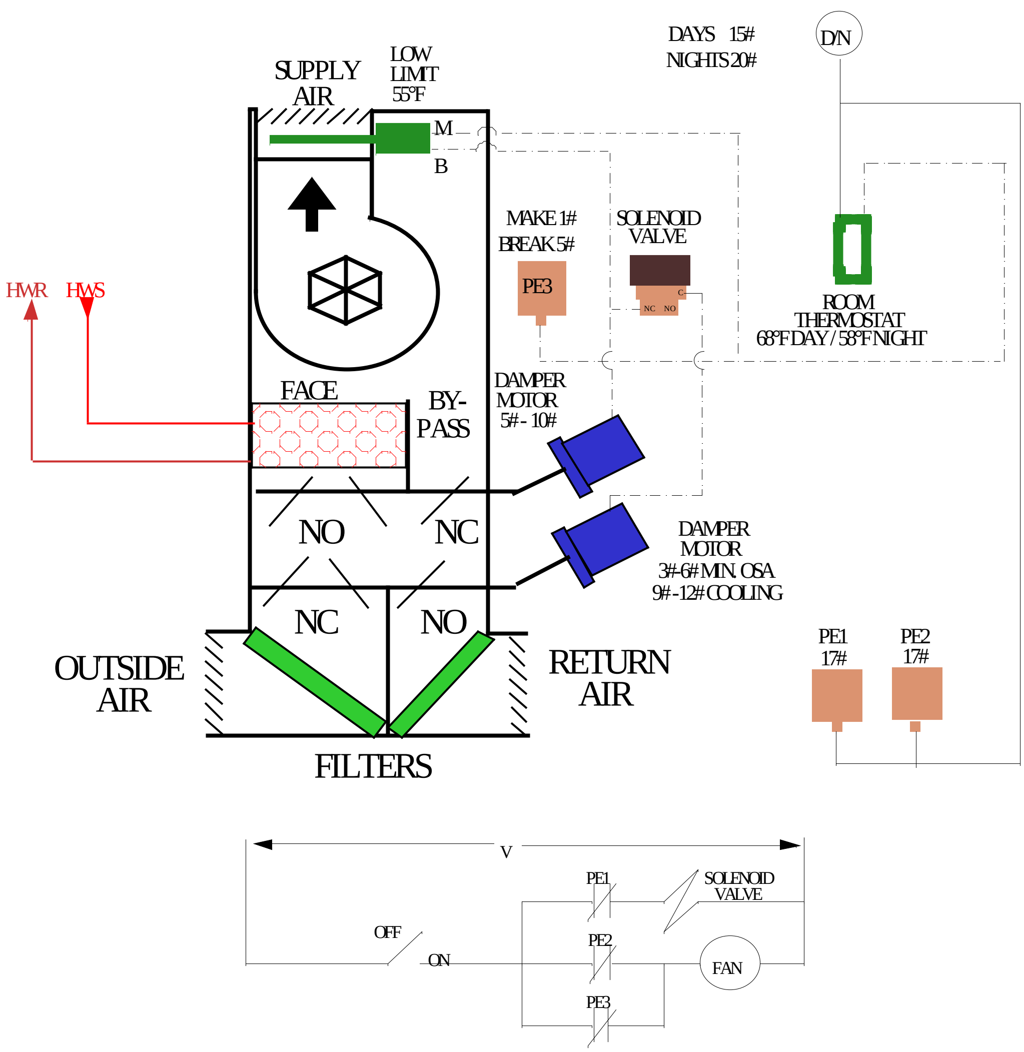
A unitventilator is a fan system dedicated to one area. They normally run continuously during occupied mode providing ventilation, heating and cooling.

On day mode PE1 and PE2 close their contacts causing the fan to run, allowing a signal through the solenoid valve to open the fresh air damper. The signal from the thermostat goes through the low limit to both the fresh air and face & bypass damper motors. As the thermostat signal starts to rise, first the split-range, fresh air motor drives from 3# to 6#, opening to the minimum ventilation requirement; then the face & bypass motor drives from full heating with the face open to no heating on full bypass. If the thermostat requires cooling the fresh air motor will restart to drive from 9# to 12# attaining 100% outside air. The low limit will over-ride the thermostat's demand for cooling if the supply air temperature decreases to the 55°F setting of the low limit.

On night mode PE1 and PE2 open their contacts and the unit shuts down. The thermostat changes to the night set point. When the room cools to the night setting the unit is duty cycled via PE3. The fresh air damper is completely closed on night mode.

A case study on these units' energy performance demonstrates that if the supply water temperature were 171°F rather than the required 93°F by the coldest zone in the experiment, there would be 546% more heat wasted on full cooling, day mode.

There are many control arrangements used on unitventilators; however, each should address safety, comfort and energy requirements.



FACE & BYPASS UNITVENTILATOR WITH THERMOSTAT INDEXING SWITCH

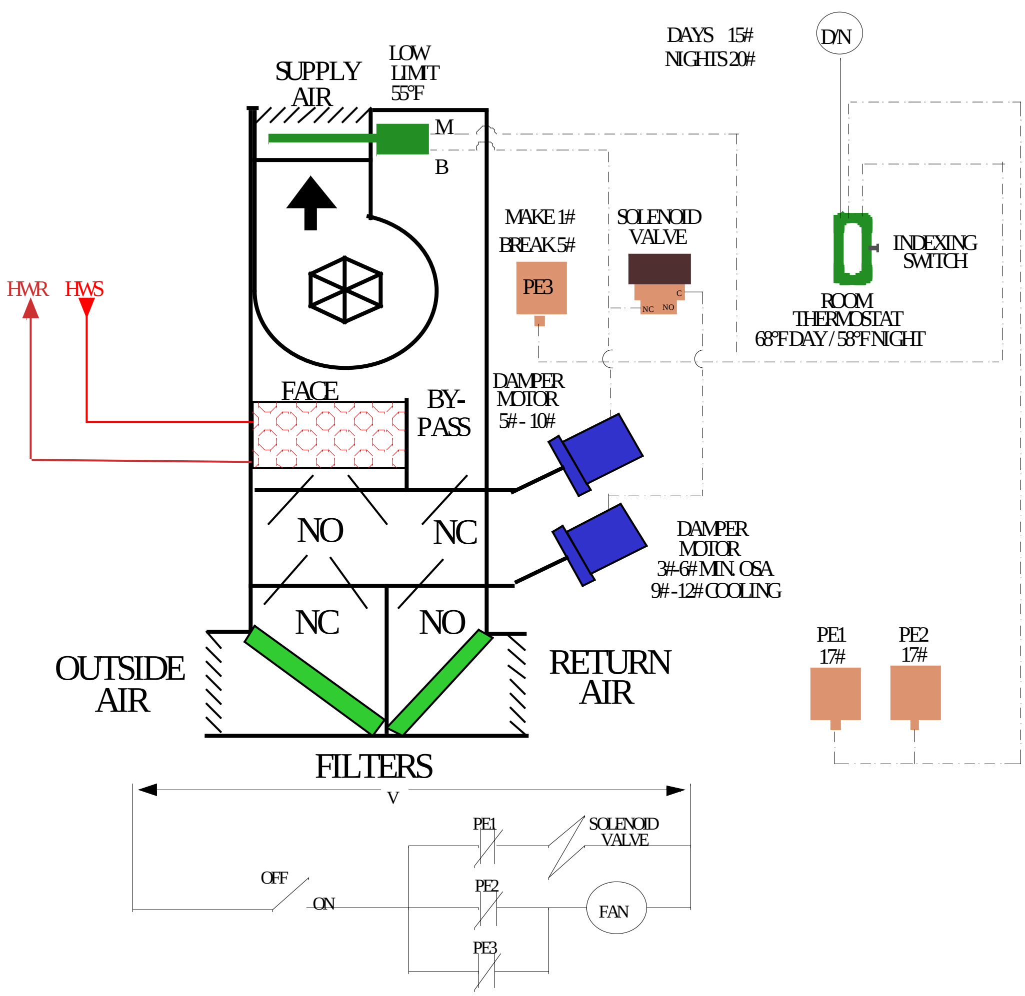
The drawing and sequence of operation is the same for this page as page twenty-four, with the exception of the thermostat type.

The one on page twenty-four is a two-pipe thermostat. The only means of achieving day mode, at normally unoccupied times, is to alter the main air to the fifteen-pound day value. The whole building will return to day values in this case.

The thermostat on this page is a three-pipe thermostat with an indexing switch. When the main system changes to twenty pound main air, altering the unitventilators to night mode, any of the rooms can be locally restored to day mode by pushing the indexing switch to manual. This action takes air off PE1 and PE2 causing the thermostat set point to return to day setting, causes the fan to run continuously and energizing the solenoid valve, allowing full ventilation and cooling.

The next morning, the main system switches back to fifteen pound supply air causing the whole building to be on days. The indexing switches that were manually forced to manual the night before will alter back to automatic.

There are two-pipe thermostats with indexing switches. Unitventilator arrangements using these thermostats allow manual restoration of the day set point in the thermostat. They do not cause the fan to run continuously when the indexing switch is manually set to manual at night, nor does this arrangement allow restoration of a continuously running fan with ventilation and cooling.



MULTIZONE FAN SYSTEM

The physical arrangement of most multizones is illustrated below.

Original design caused a constant mixed air temperature of 55°F. When the outside air exceeded 70°F the mixing dampers returned to their minimum ventilation setting.

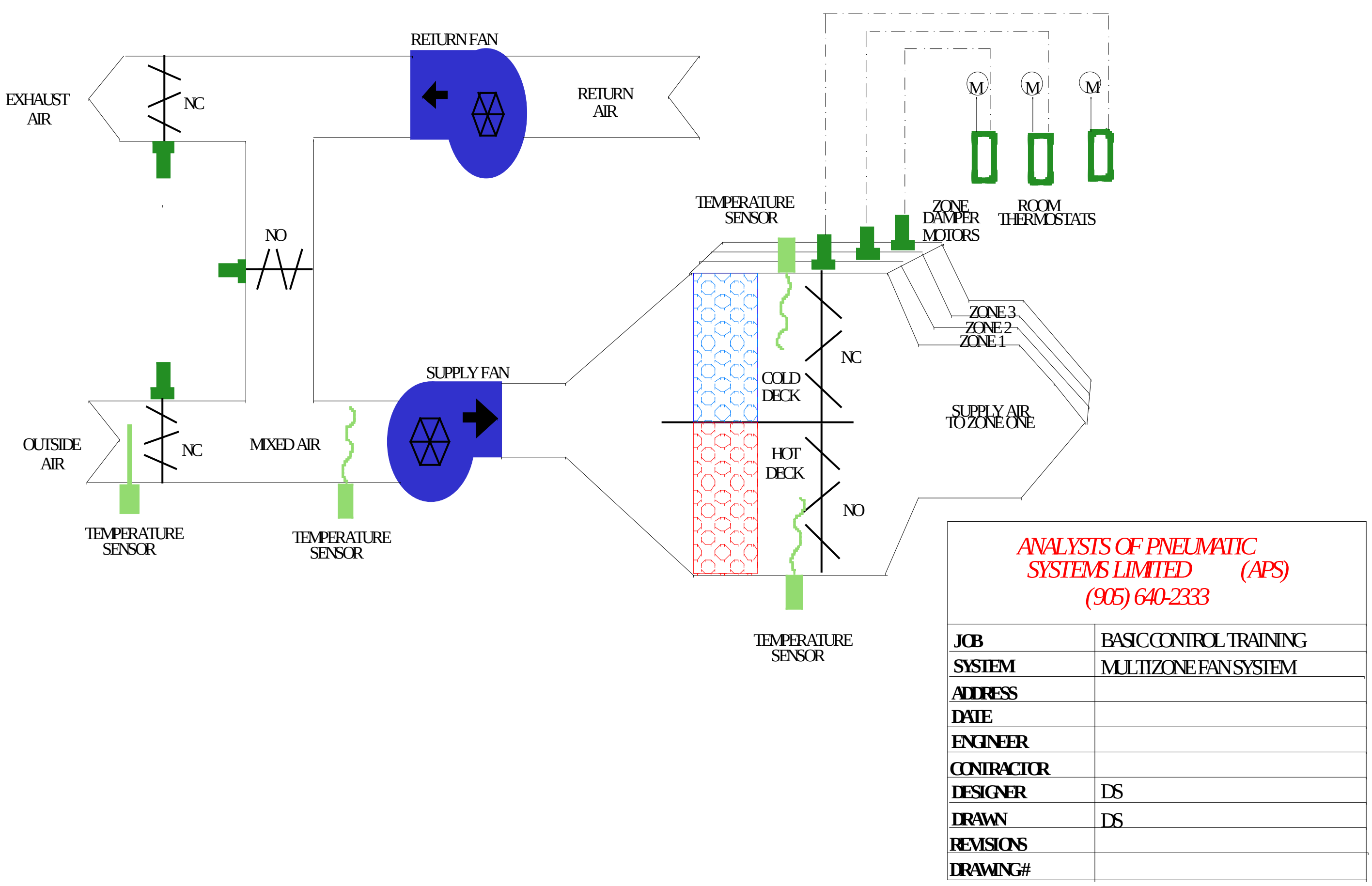
The cold deck was controlled to 55°F constantly via the cooling coil for summer operation.

The hot deck temperature was scheduled based on outside air temperature variation. The colder the outside air temperature, the hotter the hot deck.

The thermostats blended air from the cold deck with air from the hot deck to achieve a supply air temperature satisfying the individual zone.

Modern logic knows the maximum demand for cooling and heating from all the zones. If all zone signals are within the range of the zone damper motors, the heating and cooling are kept at a minimum value. If any zone opens its cold deck 100% and closes its hot deck 100%, that zone can gradually cause the cold deck temperature to be lowered. Conversely, if any zone opens its hot deck 100% and closes its cold deck 100%, that zone can gradually raise the hot deck temperature. The demand for cold deck is limited to a minimum of 55°F and the demand for hot deck is limited by an outside air reset schedule similar to original design. The system receives at least minimum ventilation during occupied mode.

The gas sections of Wendell Statton PS and West Hill C.I. in Scarborough and the Administration Office and Henry Street HS in Durham are all multizones. The saving achieved with modern logic are illustrated later in this book.



DUAL DUCT FAN SYSTEM

The physical arrangement of most dual duct systems is illustrated below.

Original design caused a constant mixed air temperature of 55°F. When the outside air exceeded 70°F the mixing dampers returned to their minimum ventilation setting.

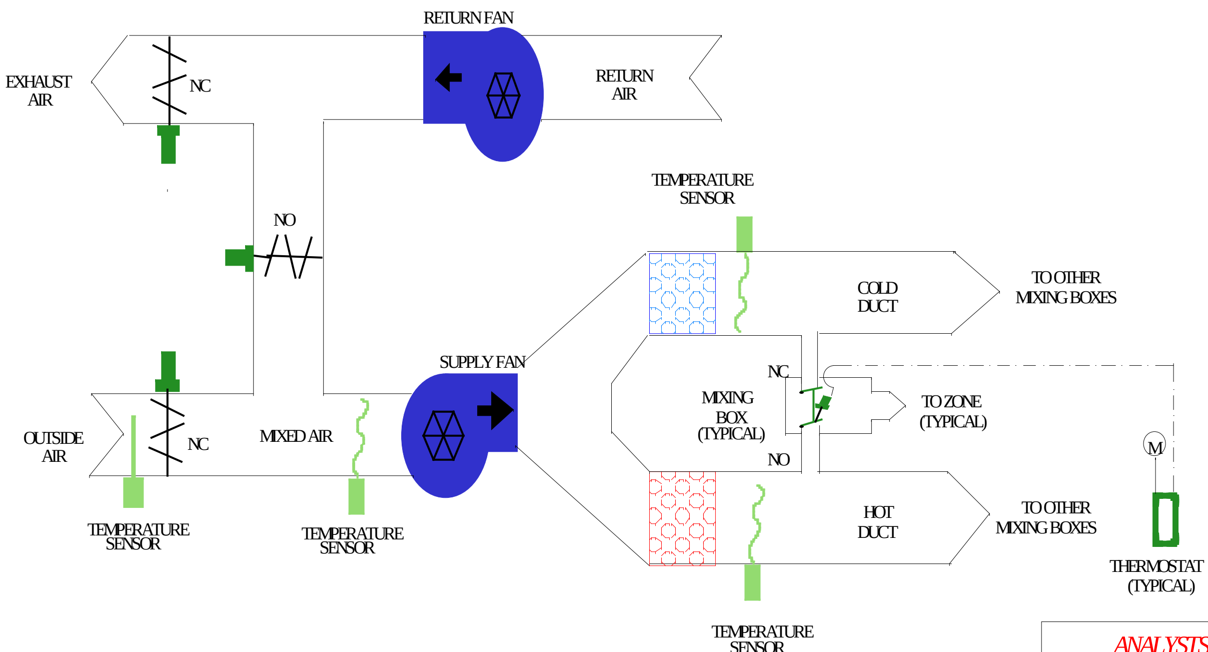
The cold duct was controlled to 55°F constantly via the cooling coil for summer operation.

The hot duct temperature was scheduled based on outside air temperature variation. The colder the outside air temperature, the hotter the hot duct.

The thermostats blended air from the cold duct with air from the hot duct in a mixing box, usually in the ceiling of the room with the thermostat, to achieve a supply air temperature satisfying the individual zone.

Modern logic knows the maximum demand for cooling and heating from all the zones. If all zone signals are within the range of the mixing boxes' damper motors, the heating and cooling are kept at a minimum value. If any zone opens its cold duct 100% and closes its hot duct 100%, that zone can gradually cause the cold duct temperature to be lowered. Conversely, if any zone opens its hot duct 100% and closes its cold duct 100%, that zone can gradually raise the hot duct temperature. The demand for cold duct is limited to a minimum of 55°F and the demand for hot duct is limited by an outside air reset schedule similar to original design. The system receives at least minimum ventilation during occupied mode.

The set up and logic for a dual duct system is similar to that for a multizone.



ANALYSTS OF PNEUMATIC SYSTEMS LIMITED (APS)
(905) 640-2333

JOB	BASIC CONTROL TRAINING
SYSTEM	DUAL DUCT FAN SYSTEM
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING#	

VAV (VARIABLE AIR VOLUME) SYSTEM

This type of system allows each area's thermostat to vary the amount of cold air entering the occupied space, addressing the varying cooling loads.

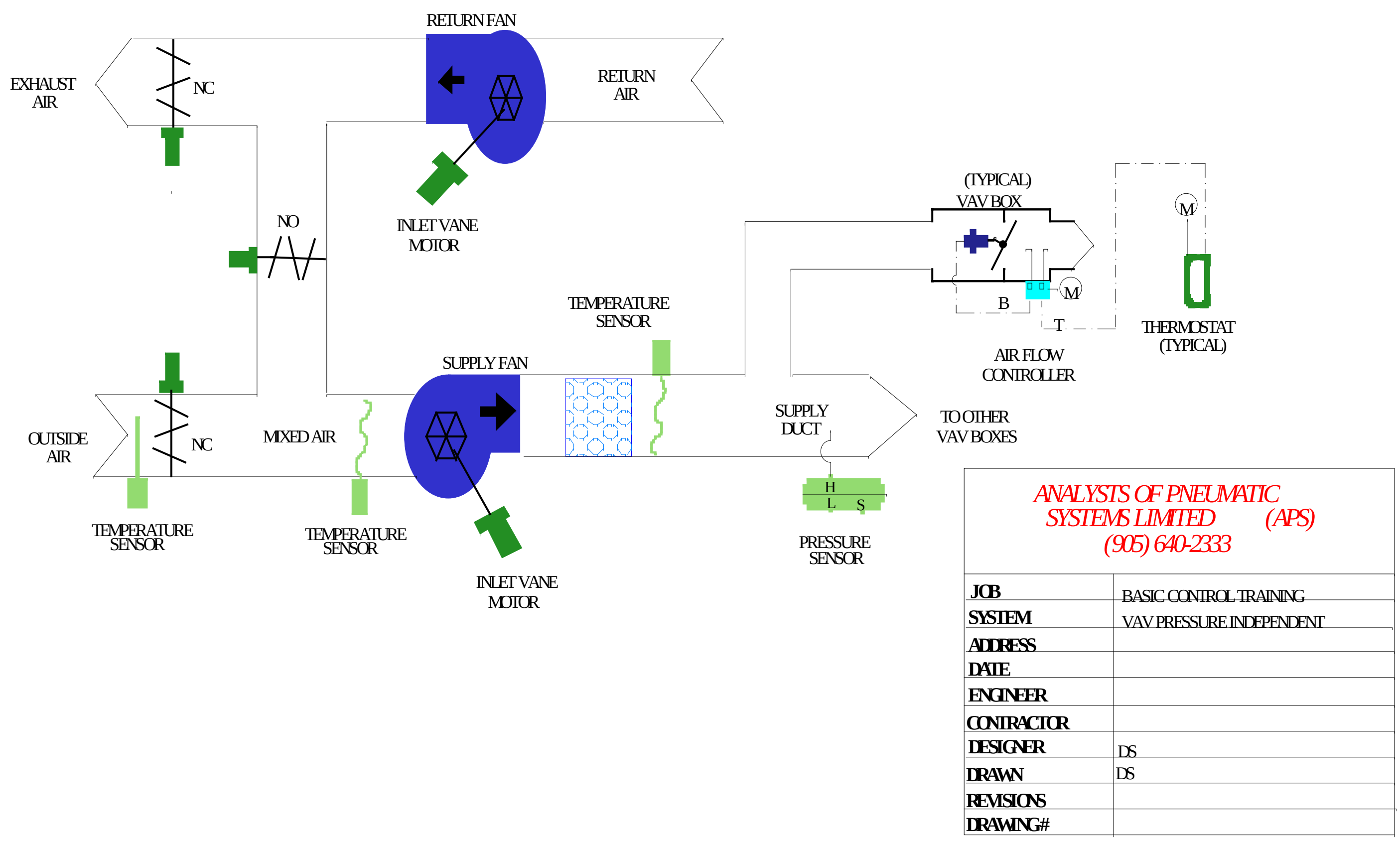
The VAV box illustrated has an air flow controller that senses the velocity pressure exerted by the airflow. The airflow controller sets the maximum and minimum amount of air allowed through the VAV box. The thermostat is allowed to vary the airflow between these two limits. This arrangement is referred to as pressure independent, as the airflow controller tends to correct for varying upstream static pressure values.

The airflow controllers are proportional with no integral reset; therefore, significant shift in control point is experienced if the static pressure variation is excessive.

The main duct pressure is controlled based on input from a pressure sensor located normally two-thirds of the way down the duct, based on air volume. The controller varies the position of the inlet vanes on the supply and return fans or controls variable frequency drives for these fans, maintaining constant duct static pressure.

Most systems have a diversity factor. This factor is the percentage difference between the total maximum volume of the VAV boxes and the maximum CFM of the supply fan. This is based on the fact that the sun can not shine on all sides of the building at one time; therefore, full cooling will not be required every where, at any one time.

The minimum ventilation requirement of a building is usually a fixed CFM value and the setting is normally a percentage of the supply fan's volume. The fact that the supply fan volume varies, requires that the relative percentage of air for minimum ventilation must vary also. This fact is rarely considered in setting the minimum ventilation logic.



VAV (VARIABLE AIR VOLUME) SYSTEM

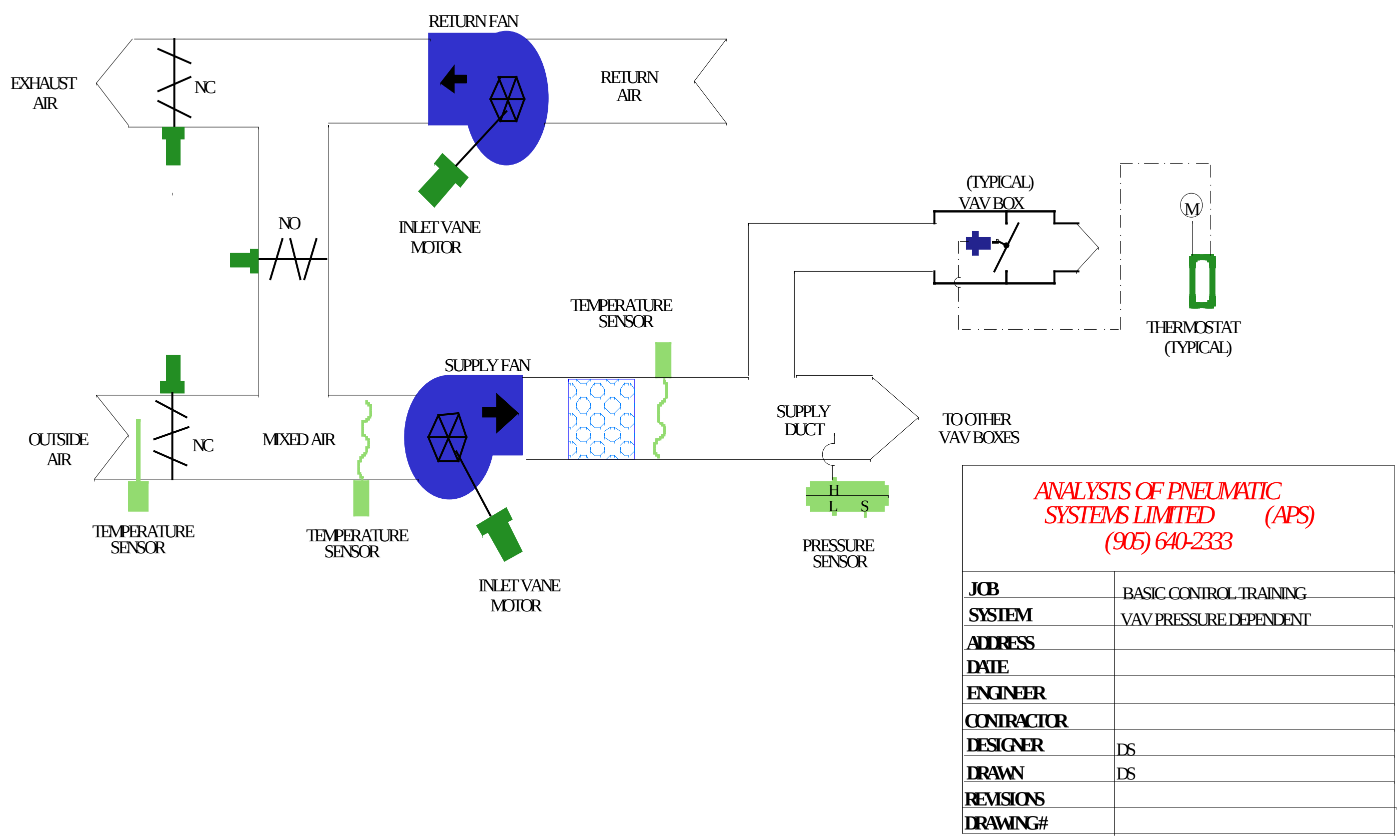
This type of system allows each area's thermostat to vary the amount of cold air entering the occupied space, addressing the varying cooling loads.

The VAV box illustrated does not have an air flow controller. This arrangement is referred to as pressure dependent. If the static pressure in the main duct varies, the amount of air entering the occupied space will vary even with the VAV box damper fixed at one degree of opening. Precise control of the main duct pressure is critical in these systems.

The main duct pressure is controlled based on input from a pressure sensor located normally two-thirds of the way down the duct, based on air volume. The controller varies the position of the inlet vanes on the supply and return fans or controls variable frequency drives for these fans, maintaining constant duct static pressure.

Most systems have a diversity factor. This factor is the percentage difference between the total maximum volume of the VAV boxes and the maximum CFM of the supply fan. This is based on the fact that the sun can not shine on all sides of the building at one time; therefore, full cooling will not be required every where, at any one time.

The minimum ventilation requirement of a building is usually a fixed CFM value and the setting is normally a percentage of the supply fan's volume. The fact that the supply fan volume varies, requires that the relative percentage of air for minimum ventilation must vary also. This fact is rarely considered in setting the minimum ventilation logic.



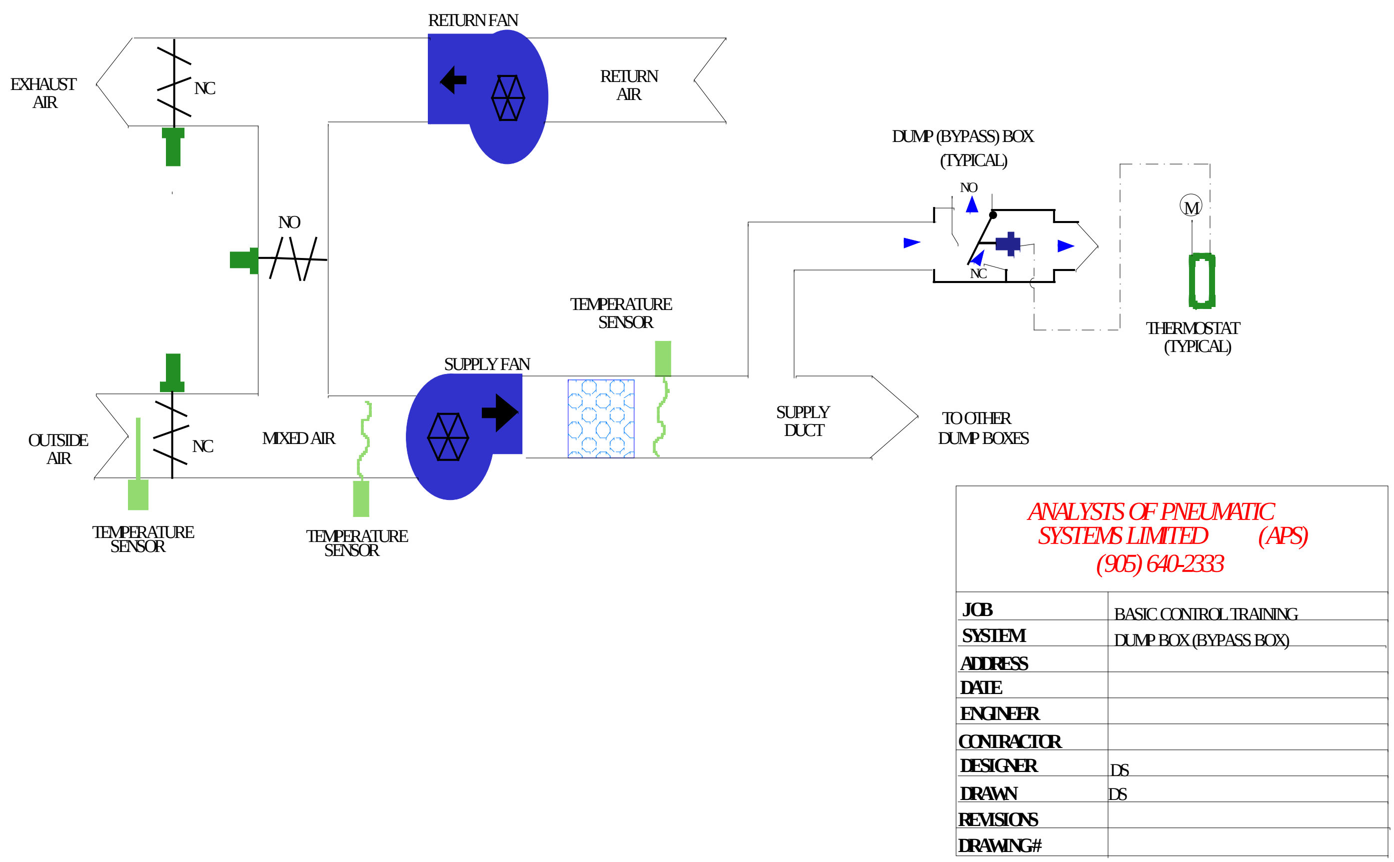
DUMP BOX (VARIABLE AIR VOLUME) SYSTEM

This type of system allows each area's thermostat to vary the amount of cold air entering the occupied space, addressing the varying cooling loads.

The dump box (bypass box) illustrated, always (in theory), consumes the same CFM from the main supply duct. The air is bypassed to the return air duct, forced into the occupied space or split between the two destinations. At a practical level the total CFM is different when the box is positioned to full bypass or full air flow to the occupied space relative to mixing positions between these two points.

The main fans do not require a means of varying their CFM as the system requirement in the main supply and return ducts does not vary.

As with all the fan systems, the air balancing should be performed by a qualified and experienced Air Balancing Technician.



INDUCTION UNIT SYSTEM

Induction unit systems are designed to heat and cool the perimeter area of a building up to about fifteen feet from the windows.

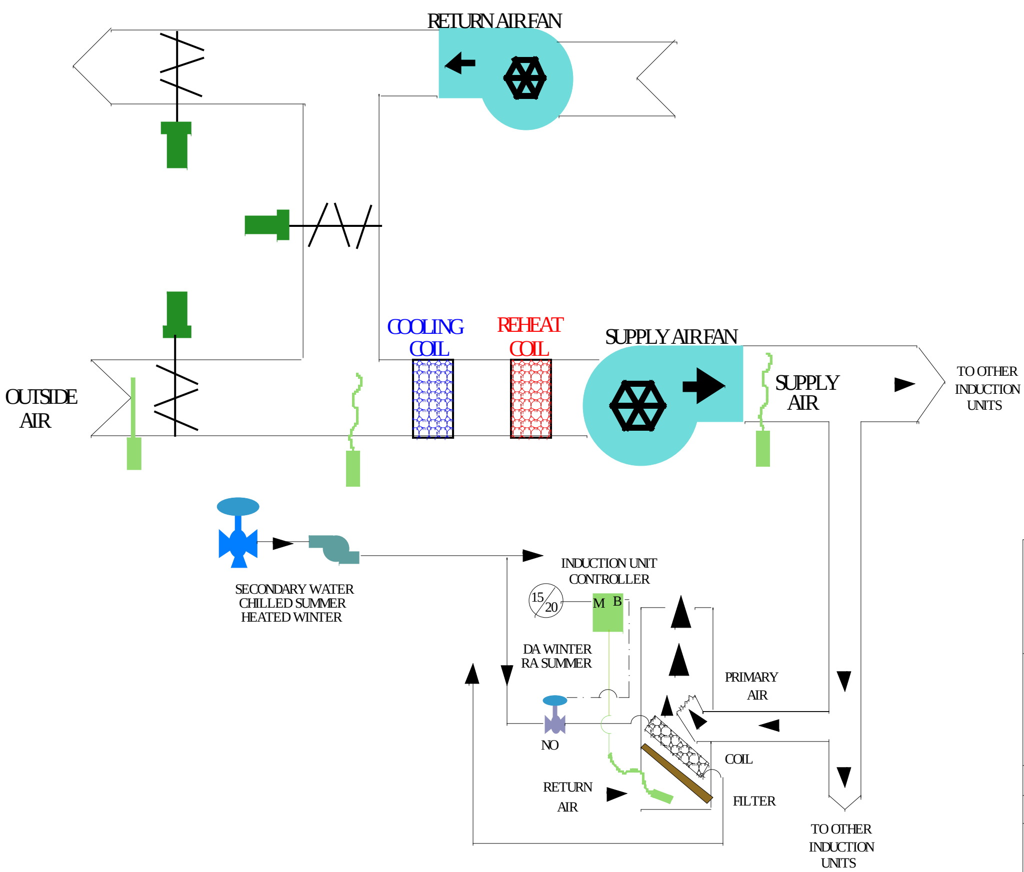
The primary air fan forces air out of the jets in the induction unit, causing an induced flow of return air from the room, through the filter and coil. The room controller senses the return air at this point. The total volume discharging from the grills of the induction unit is the sum of the primary airflow to the unit and the induced airflow.

The primary air is cold during winter mode and heated water is provided via the secondary loop to the control valve associated with each induction unit. The controller has the option of heating the return air or allowing it to pass unheated through the coil to be mixed with the cold primary air.

The primary air is heated during summer mode, based on reset from the outside air temperature. The induction unit receives chilled water via the secondary water loop. Usually the water temperature is controlled to minimize condensation at the room level.

Some systems work with chilled secondary water or heated secondary water all year with the heating or cooling source respectively being the primary air. These units do not require reversal of the control action regarding the induction unit controllers.

These systems have the potential for great inefficiency.



ANALYSTS OF PNEUMATIC SYSTEMS LIMITED (APS)
(905) 640-2333

JOB	APS BASIC CONTROLS
SYSTEM	INDUCTION UNIT CONTROL
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	

Wycliffe Property Management Limited

January 8th, 2003

To Whom It May Concern:

Re: Analysts of Pneumatic Services- Energy Saving Iniatives

Since it's inception over 40 years ago Wycliffe Property Management Limited has grown to the point where we manage over two million square feet of commercial and industrial property in the Greater Toronto Area for various owners. As part of our portofolio, for the last eight (8) years we have acted as property manager of The Shops on Steeles and 404, a 280,000 square foot Shopping Centre located in Thornhill, Onatrio.

Approximately 6 years ago upon a recommendation received from Carrier Canada we met with Dave Strain, owner of Analysts of Pneumatic Services (A.P.S.) to evaluate the Shopping Centre's H.V.A.C system with the goal of completely automating the control pneumatics to bring in "free" outside air when temperatures fell below 10C.

After upgrading the pneumatic system and installing safety features to prevent freezing of coils etc., we were able to annually shut down our 347 ton centrifugal chiller for 5 ½ months, relying solely on the "free" air provided, this resulted in a direct energy saving of over 30%.

In another matter, A.P.S. found the perimeter electric baseboard heaters were being used indiscriminately by the Tenants while the cooling system was functioning. In light of this, A.P.S. developed a morning "warm up" process which was initiated by using excess heat from our boilers to supply warm air through V.A.V boxes in each Tenant space. The electric baseboard heaters were then put under mall control, only activating if temperatures dropped below a set point. This additional energy saving iniative helped to bring our consumption cost savings down another 10% from previous usage.

The quality of air has actually improved with these innovations. Dave Strain's professional expertise has benefited The Shops on Steeles and 404 tremendously over the years and we have found him completely dedicated in his ongoing quest for helping the environment through saving energy.

Yours truly,
WYCLIFFE PROPERTY MANAGEMENT LIMITED

Grant Brunne
Operations Manager

Mark Murphy
Property Manager

Head Office
1485 Whitehorse Road
Downsview, Ontario M3J 2Z2
Telephone (416) 635-2910
Fax (416) 635-7869

Branch Office
2900 Steeles Ave. East Ste 204
Thornhill, Ontario L3T 4X1
Telephone (905) 881-7422
Fax (905) 881-1224

THE BOARD OF EDUCATION FOR THE BOROUGH OF SCARBOROUGH

CONTROL MODIFICATIONS BY
A P S

SCHOOL	UTILITY	ANNUAL REDUCTION	1979 UTILITY COST	UTILITY SAVINGS **	$	IMPROVEMENT COST	PAYBACK YR.
MILITARY TRAIL JR. PS	GAS ELECTRIC	31.1% 20.9%	9,863 11,217	2315 1758	4,073	4,072	1
JACK MINER PS	GAS ELECTRIC	20.4% 17.8%	14,338 15,059	2194 2010	4204	3,287	0.8
ALEXMUIR JR. PS	GAS ELECTRIC	29.5% 24.6%	7,308 10,285	1617 1898	3515	2,699	0.8
SILVER SPRINGS PS	GAS ELECTRIC	37.8% 36.6%	6,425 7,835	1822 2151	3,973	1943	0.5
WENDELL STATTON SR. PS	GAS OIL ELECTRIC	57.6% 19.5% 22.6%	10,221 16,463 14,684	4415 3210 2489	10,114	5300	0.5
TIMBERBANK PS	GAS ELECRIC	17.1% 22.1%	8,142 10,499	1044 1740	2,784	2110	0.8
WEST HILL C.I.	OIL ELECTRIC GAS	8.1%* 10.9%* 51.8%*	46,552 51,974 42,211	3771 4249 16,399	24,419	36,370	1.5
				TOTALS	53,082	55,781	1.05

- * - PART YEAR ONLY
- ** - GAS AND ELECTRIC @ 75% OIL @ 100%
JRM/sc June 18, 1981

LETTER FROM SCARBOROUGH BOARD ACCOMPANYING CHART ABOVE

Gentlemen:

During early 1979 control improvements were carried out by your firm on a number of our schools. These schools are listed on the attached schedule which indicates the savings that have been achieved.

For clarification purposes, it should be noted that:

a) no allowance has been made for the fact it was 4.7% colder in 1980 than in 1979.
b) The utility costs are 1979 actuals and no allowance has been made for escalation.
c) The majority of the savings are undoubtedly higher as the modifications were not in effect for the entire year.
d) We have assumed only 75% of the actual gas and electricity savings because of the sliding scale rate structures.
e) Approximately $17,000. Is included in the cost of improvements at West Hill Collegiate for other work that was performed at the time aimed primarily at improving poor environmental conditions.

It is almost needless to say that we are very pleased with the results and the manner in which they were carried out.

Yours very truly
J.R. Mazanik

NOTE: Actual Board information copied into Word.

THE DURHAM BOARD OF EDUCATION
CONTROL MODIFICATIONS BY
A P S

	ENERGY USE YEAR PRIOR TO CHANGE		ENERGY USE YEAR FOLLOWING CHANGE		ENERGY SAVINGS		ECONOMIC BENEFIT
SCHOOL	ELECTRIC	FUEL	ELECTRIC	FUEL	ELECTRIC	FUEL	SAVINGS
ADMIN.	575,040	767,690	469,120	597,192	105,920	170,498	$4,641.00
GENERAL VANIER	1,847,200	4,584,768	1,520,720	4,127,945	326,480	456,823	$13,480.00
HENRY ST. HS *	1,049,9162	2,772,563	961,263	2,671,423	88,653	101,138	$3,385.00
O'NEILL CVI	949,025	2,294,845	886,925	2,236,678	62,100	58,167	$2,219.00
DUNBARTON HS	1,686,500	3,376,841	1,586,086	3,001,606	100,414	375,235	$6,962.00
G.L. ROBERTS HS	1,129,996	2,433,187	1,001,192	1,338,622	128,804	896,565	$13,914.00
SOUTHWOOD PARK PS	820,080	NO FUEL	554,640	NO FUEL	265,440	NO FUEL	$6,503.00

TOTAL SAVINGS	$51,104.00
TOTAL COST	$42,340.00
PAYBACK 8 MONTHS, 1 WEEK	

- * - CHANGES WERE IN EFFECT FOR 3 MONTHS.
- ALL CONSUMPTION VALUES ARE IN KILOWATT-HOURS.
- DOLLAR VALUES ARE 1981 FUEL COSTS

DM: mm
1982 01 14

Notes:

- Actual chart of School Board's data copied into Word.
- Administration and Henry St. are multizone systems.
- Southwood Park PS is electric baseboard and electric reheat.
- General Vanier SS, O'Neill CVI and Dunbarton have a variety of HVAC fan systems, but no multizones.
- G.L. Roberts HS was VAV with perimeter heating only controlled via indoor/outdoor reset from one main valve.

ACTUAL GAS CONSUMPTION AMOUNTS FOR THE ETOBICOKE EDUCATION CENTRE ILLUSTRATING THE IMPACT OF EVAPORATIVE COOLING AND LOAD ANALYZING TECHNIQUES

READING DATE	GAS CONSUMPTION (X 100)
AUG. 29/75	1,324.8
SEPT. 30/75	2,069.8
OCT. 30/75	1,965.1
DEC. 01/75	1,776.8
DEC. 30/75	1,930.1
JAN. 30/76	2,806.9
FEB. 27/76	2,308.1
MAR. 30/76	2,624.8
APRIL 29/76	1,749.6
MAY 28/76	1,676.1
JUNE 29/76	1,053.2
JULY 28/76	924.6
JAN. 26/77	9,168.4
FEB. 21/77	1,276.8
MAR. 22/77	1,192.7
APRIL 21/77	613.6
MAY 20/77	522.5
JUNE 21/77	609.2
JULY 21/77	683.7
AUG. 22/77	1,066.6
SEPT. 22/77	1,156.2
OCT. 21/77	1,328.5
NOV. 22/77	1,224.2
DEC. 21/77	815.1
JAN. 20/78	927.5
FEB. 20/78	1,078.8
MAR. 22/78	920.5
APRIL 21/78	771.2
MAY 19/78	526.8

WHEN COMPARING THE GAS CONSUMPTION FOR THESE TWO SETS OF MONTHS, ONE FINDS JUNE AND JULY REQUIRED 13.5% MORE GAS Before THE CHANGES, THAN DECEMBER AND JANUARY REQUIRED AFTER THE CHANGES.

INITIAL CONSERVATION DESIGN EMPLOYING EVAPORATIVE COOLING EFFECT OF THE HUMIDITY WATER SPRAYS. OTHER TECHNIQUES WERE IMPLEMENTED SIMULTANEOUSLY.

THE WATER SPRAYS WERE REPLACED WITH STEAM HUMIDIFIERS CAUSING THE COOLING EFFECT TO BE LOST.

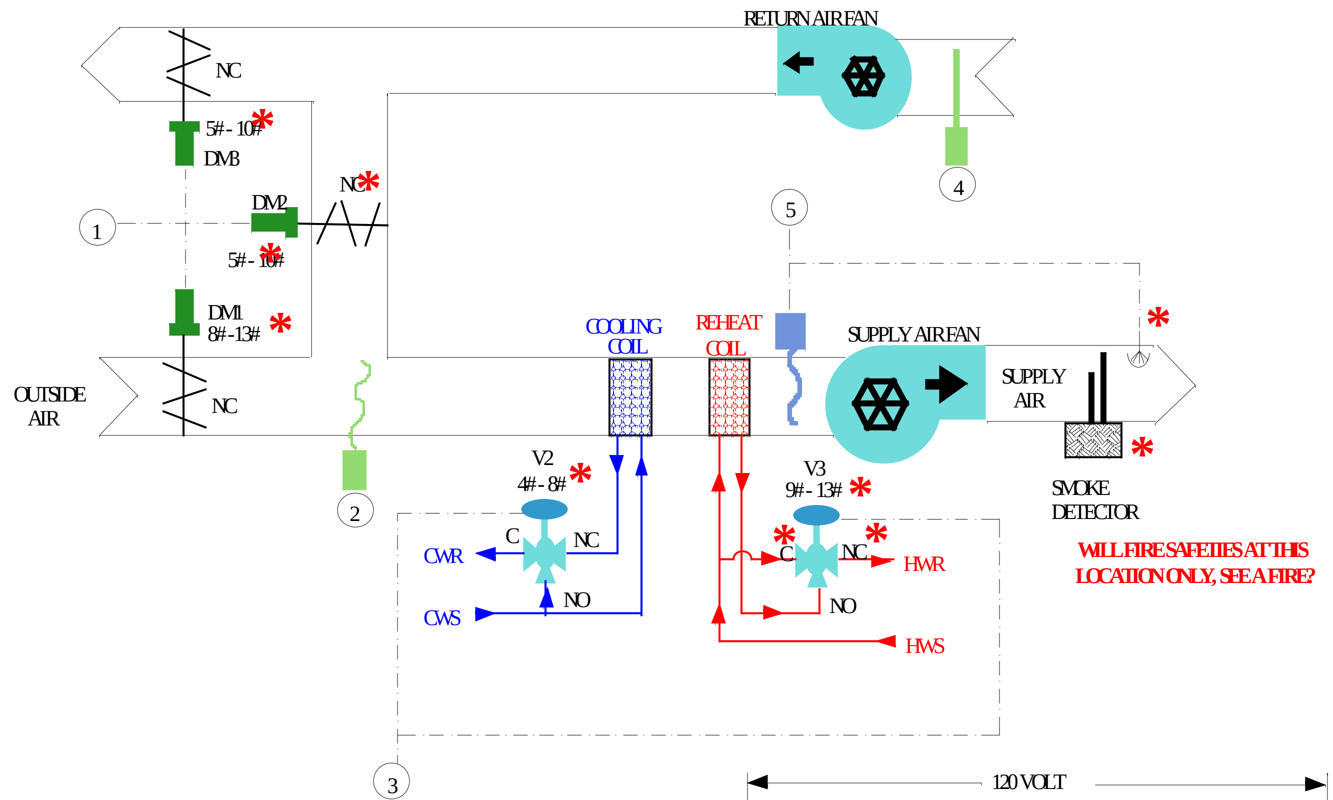
AN ALTERNATE CONSERVATION CONTROL TECHNIQUE WAS DESIGNED AND INSTALLED. LOAD ANALYSING FROM THE WARMEST SAMPLE THERMOSTAT RE-ESTABLISHED THE CONSUMPTION REDUCTION.

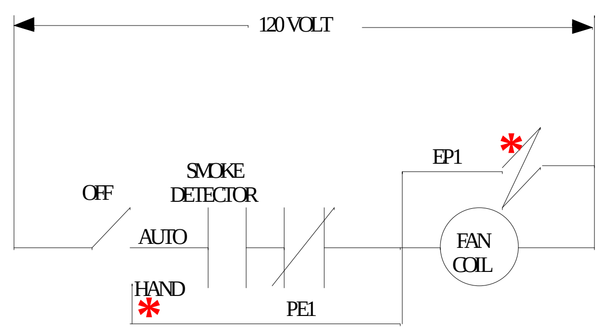
52.6% REDUCTION WITH EVAPORATIVE COOLING TECHNIQUE.

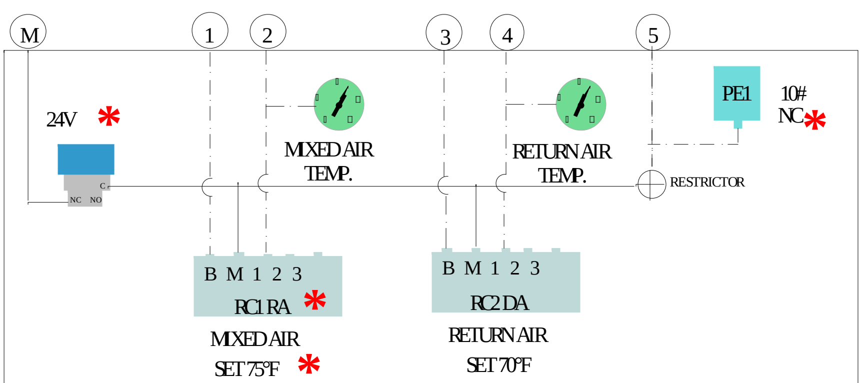
60% REDUCTION WITH ALTERNATE TECHNIQUE.

FAN SYSTEM WITH MANY ERRORS

* PROBLEM AREAS







IS THE HEATING, COOLING AND FREE COOLING SEQUENCED?
IS THERE MEANS FOR MINIMUM VENTILATION?
HOW EFFECTIVE WILL THE MECHANICAL COOLING BE AT 95°F OUTSIDE?

ANALYSTS OF PNEUMATIC SYSTEMS LIMITED (APS)
(905) 640-2333

JOB	APS BASIC CONTROLS
SYSTEM	SYSTEM OF MANY ERRORS
ADDRESS	
DATE	
ENGINEER	
CONTRACTOR	
DESIGNER	DS
DRAWN	DS
REVISIONS	
DRAWING #	