"Capacity Deployment System" AKA: Full Airflow Zone System (FAZS^{TM})

Introduction

FAZS^{TM} is not a typical zone control. It is designed for use in new home construction or retrofits with an upgraded duct system. When properly designed and installed the customer will enjoy a more comfortable home that automatically adjusts to meet varying internal and external heating and cooling loads. The concept is not complicated, 90% of the airflow goes to one zone at a time based on priority. By adding a FAZS^{TM} control board and three motorized control dampers the basic forced air heating, ventilation and air conditioning (HVAC) system is transformed into a state-of-the-art comfort system. Any HVAC system can now be divided into 3 evenly sized zones to take care of time-of-day-differences in heating/cooling demand. Providing 90% of the airflow allows designers to use load diversity and decrease equipment size to the minimum Manual J8 vales. The patented control scheme makes dump zones, bypass ducting, and other excess air solutions obsolete. For fresh air circulation the zone dampers are mechanically set/locked slightly open to allow 5% of the airflow to bypass into the closed zones. FAZS^{TM} control boards can be used in two-and-three story home applications to end the need for summer and winter damper positions. With FAZS^{TM} control boards Grandma's in-law suite in the walkout basement can be set in heating mode when the 1st and second floors are in the cooling mode. The initial installations received rave reviews from the HVAC contractors who found Don before the FAZS^{TM} control board was available after searching for the unique control sequence.

History

New code requirements are being driven by those who want to save energy and decrease the operating cost over a home's life. Due to the increasing cost of energy, net zero and low load homes will eventually become the norm. The American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) were preparing for the future in residential building when they defined a low load home (LLH) as one having 1,500 ft^2 of floor space to 1-ton of air-conditioning. Knowing the industry is moving towards net zero and LLH, the Air Conditioning Contractors of America (ACCA) were developing a design guide. They were faced with a challenge; traditional forced air HVAC equipment would not work in net zero and LLH applications. While contemplating the unique airflow challenges for a LLH, Don Prather had what he believes was an epiphany from God, the "full airflow zone system" concept came to him in a flash. He designed a home HVAC system using the FAZS^{TM} control concept and the required upgraded duct design. After it was presented to the committee, Hank Rutkowski the genius PE behind all of ACCA's residential design manuals, vetted the concept and named it "capacity deployment system". It was included in the LLH Manual with a detailed explanation in engineering terms. In order to prove the concept worked Don wanted to install a FAZS^{TM} control system. However, no zone control company built a zone control that was designed to open one zone and hold other zones closed based on priority. Don felt he had a fiduciary responsibility to bring one to the market so he came out of retirement and the FAZS^{TM} control board was created.

It will work well in homes being built to the new building codes. When an accurate Manual J8 load calculation is done they are already slightly over 1,000 ft^2 per ton.

That first FAZS™ control board installed was used to solve existing comfort problems by upgrading the duct system and adding return air pathways in a costal Florida home built in 2000. It exceeded initial comfort expatiations by easily taking care of large internal loads in a single zone without over cooling/heating other zones. In the humid Florida cooling season, the home's relative humidity remained in the mid-to-high 40% range. Installed in January of 2021, the FAZS™ control has operated without negative effects on the air conditioning equipment. One zone is north-west-facing-rooms, the second is north-east-facing-rooms, and the third is a great room facing-south-east-to-west. The three zones rarely call for a temperature change at the same time. If the power goes out, when it comes on the highest priority zone cools/heats faster than any other zone system can. Comfort control was maintained for the first time since the home's original construction. Energy usage decreased. Based on observation, and some early zone temperature monitoring the energy usage reduction is likely due to a combination of three things: shorter run times to satisfy a zone, not wasting energy by heating/cooling the two zones not calling, and not having to lower or raise the thermostat to take care of usage issues and time of day related load swings.

FAZS™ is the **only zone control** that meets the requirements for ACCA's *Manual LLH HVAC System Design for Low Load Homes* Section 14 Example 4. Don wanted to build a robust, easy to understand and install control panel. To make this happen, he teamed up with his friends at EWC Controls. They used an established EWC 3 zone control board and installed the patented/unique FAZS™ control sequences on it. Like EWC dampers, the control board is warrantied for 5 years plus it has EWC's automatically resetting polyswitch board protection. Better yet, the zone controller is manufactured in the U.S.A.

What Every HVAC Contractor Should Know But, Probably Doesn't

ANSI/ACCA 5 QI-2015 HVAC Quality Installation Specification

- The standard was written by contractors who wanted to establish a minimum requirement for the design and installation of HVAC equipment. In retrospect it should have been named: "The least you can do to design and install residential HVAC systems correctly."
- Manual D is not required in the *ANSI/ACCA 5 QI -2015 Quality Installation Specification* (QI). However, QI does require external static pressure measurements to prove the installation works (or other approved airflow measurement methods).
- ACCA's *Technician's Guide & Workbook for Quality Installations* follows the standard's procedural outline and explains how technicians in the field can meet the requirements. It is also available as an ACCA QTech course on line. The course is broken down into small bite sized sections that can be taken one at a time. When the technician passes the final test, a certificate of completion is generated that is good for CEH/CEU's for: NATE, RESNET, RSES, BPI, ICC code officials and HVAC Excellence.
- Appendix C Quality Assured Contractor Elements was actually developed to be a business plan. Every contractor should review it and add the missing pieces to their business plan.

Note: No contractor on the original QI committee had all of the elements included in their existing business plans prior to developing the standard.

ANSI/ACCA 2 Manual J-2016 (8th Edition) Residential Load Calculation:

- Manual J8 load calculations for airflow are proportional best guesses and are often more airflow than the selected equipment can produce.
- Manual J8 is a two-snapshot calculation based on a peak demand times and hours for the heating and cooling loads.
- Manual J8 values are oversized for 99% of the hours in a year.
- Manual J8 cannot be used for Florida rooms and rooms surrounded with window walls (Manual N can).
- Most of the Manual J8's completed do not have the correct inputs.
- A Manual J8ae Speedsheet that meets code requirements for many locations can be downloaded for free on the ACCA web site.

ANSI/ACCA Manual D -2016 Residential Duct Systems:

- Manual D calculations are designed to come up with the smallest duct size that can be used.
- Manual D calculations are based on set-duct-velocities in feet per minute that differ for supply (900 fpm) and return (700 fpm) duct.
- Manual D airflows are based on heating or cooling values utilizing the higher of the two for the final duct size design.
- The final total airflow used for Manual D duct sizing calculations is always more than the HVAC equipment can produce.
- Many of the fitting equivalent lengths in Manual D are dated and no longer are accurate for duct being built today (note: the overall calculations work out ok anyway).
- Almost all of the negatives related to sag and bends for flex duct are erased by sizing it one size larger than Manual D requirements.
- Duct designs for FAZS™ require more than one copy of final duct sizing sheet for Manual D in order to show full airflow sizing for all three zones.
- A Manual D Speedsheet that meets code requirements can be downloaded for free on the ACCA web site.

ANSI/ACCA 3 Manual S-2014 Residential Equipment Selection:

- Manual S provides sizing guidance for cooling that can be ignored if a separate dehumidification system is also installed (not recommended for most locations).
- The only heating requirement written into code for HVAC equipment is that it must maintain 68F in the center of the room where the thermostat is located.
- Manual S included a door under-cut chart for return air that proves the method will not work for airflows above 50-75 CFM.
- Manual S values are rarely calculated by HVAC contractors based on the expanded equipment data (it is not available for some equipment).
- Manual S equipment for a FAZS™ controlled system should be selected as small as possible. Due to the way the air is distributed it will still heat/cool zones faster than any other control system can. It allows designers to take diversity into account for designs.

- A Manual S Speedsheet that meets code requirements can be downloaded for free on the ACCA web site.

NOTE ON BALANCING AIRFLOW (ACCA Manual B)

There is no way that single zone duct system can be balanced to work perfectly for summer-winter, east-west, north-south heating-and-cooling load diversity. Without a traditional zone system, or a FAZS™ control and a full airflow duct system, there is no way to maintain all of the rooms near a temperature equal to the thermostatic set point.

AS EASY AS RIGHT VS WRONG

The real value provided by using ACCA's manuals is a designer can produce defensible equipment designs based on simplified engineering practices. Sadly, most of the HVAC contractors in the U.S. who claim to do Manual J8 load calculations and Manual D duct designs don't actually do them. When asked for them they cannot be produced. Based on this author's experience across the country, few HVAC contractors are calculating loads correctly. Often when produced they are a sham rigged to equal a rule of thumb size in order to get permits. Additionally, few contractors can show the expanded equipment data they need to establish the local output in Btuh for the equipment selected. Computer programs used to do the calculations require accurate inputs. Many are completed using inaccurate inputs. Few field installations match the Manual D sizing and length values used for design. Unfortunately, the actual design files are rarely kept except in areas with strict code enforcement or review practices. Manual S sizing requirements are often ignored often resulting in oversized equipment. Those who do designs and installations following the protocols in the design manuals and the QA Standard, understand the market advantage they have. Based on contractor feedback, it costs 10% more to do it correctly. However, the same contractors who implemented the procedures said the savings in callbacks more than offset the upfront cost and the value of having satisfied customers was incalculable.

Designing a Full Airflow Zone System Using Rules of Thumb for Making a Proposal
(Not recommended for a final design but better than the old rules!)

Building new homes with a FAZS™ control board requires an accurate load calculation to determine what areas should become the 3 zones. FAZS™ requires a duct design that allows HVAC system's full airflow to go to one zone at a time based on priority. Manual S guidance for the <u>minim-sized</u> HVAC equipment rather than the largest-size should be used.

If this author were to simplify the equipment sizing load calculation to a rule of thumb like most contractors use: homes being built to today's base codes will calculate out to over 1,000 ft^2 per ton. (when one sees smaller values used it is an indication the Manual J8 calculations should be questioned). Similarly, for net zero or low load homes or net zero homes the minimum base should be at least 1,500 ft^2 per ton. A FAZS™ control system provides over 200% of the Manual J8 required airflow to a single zone allowing it to heat/cool faster and adjust to very large internal and external load swings. That means smallest HVAC equipment that can be selected using Manual S will outperform the largest equipment size that can be selected with a traditional duct system in a zone.

Manual D duct design is universally required by code and most contractors need to fill out a Manual D spread sheet when pulling permits. The consensus among equipment manufacturers is a duct design should be the first thing verified during the initial equipment startup. Almost all of them provide table values utilizing external static pressure (ESP) measurements in inches of water column (IWC). The ESP is measured and the table provides a corresponding airflow in cubic feet per minute (CFM). ESP is the easiest, quickest, and most accurate method to establish the airflow for new equipment with clean filters. Other approved methods for establishing airflow may be used.

Manual D calculations are based on engineering numbers for standard duct fittings and duct lengths. When they are added together for the individual duct runs, this total becomes the equivalent length for each duct run. Additional components like air filters in the duct system's airflow path are then included in the calculation. The final total result is used to establish a friction rate (FR) in IWC/100 ft. The final duct friction rate is then plugged into the Manual D spread sheet and used to calculate the duct sizing. For net zero and LLH, an unaltered Manual D duct design will result in very small duct sizes and very low airflow to relatively large rooms and zones. For the full airflow zone system, a contractor should continue to use the friction method. The only change to that for a FAZS™ is, each zone needs to be designed for the HVAC system's full airflow. Within the individual zone runs the branch duct sizing should remain proportional to the zone's main trunk for the downstream airflow CFM.

For example: The manufacturers data for a 1.5-ton system states the operating CFM for the system is 610 in the OEM table at 0.5" ESP (wet coil). Many HVAC system designers have utilized a shortcut, and always use the Friction Rate of 0.1" water column (wc) or 0.08 wc and a duct slide rule or wheel for duct sizing. Using a duct slide rule or wheel once the duct size is rounded up, 0.1 friction rate specifies a 12" round steel duct for 610 CFM. Likewise, if a 0.08 friction rate is used, the duct wheel still specifies a 12" round steel duct.

What about sizing for the return duct? If an original equipment manufacturer (OEM) filter is replaced with a "high efficiency" filter from the hardware store, the additional airflow pressure drop must be accounted for (by making the filter area bigger preferably not by putting in a higher amperage fan motor that spins faster!). Since the return airflow is passive and not forced, many designers use half of the supply duct friction rate to design the return ducting. For a FAZS™ application the return and supply duct sizing to rooms in a zone can be the same size. This makes designing them easier especially when there are changes in the field. Since the supply is sized for the full airflow, the return does not need to be larger to work properly. If more air returns from the other two zones, the operating zone will have a slightly positive pressure. This is not a problem since the homes being built for energy savings are well sealed.

Duct Design for a FAZS™ Using a Rule of Thumb That Exceeds Manual D Requirements *(Recommended)*

A field calculation option for systems with duct runs 100 feet or less is based on the manufacturer's equipment opening sizes and the manufacturer's design airflow. The opening size of the supply and return in the OEM equipment can be utilized to calculate the duct size. The unit's output CFM is also used in the duct design equation. This design can be accomplished by converting the outlet size into square feet, and setting the duct slide rule or wheel on that size for the duct and for the OEM CFM. The resulting Friction rate on the slide rule or wheel is used for sizing the duct work. Returns can be sized the same way. The resulting duct size will always be larger than needed and the system ESP will be low for added energy savings.

Airflow into the duct equals airflow out and the velocity of the air into the space is determined by the pressure drop across the diffuser selected. To make sure the diffuser or return grill always works use a supply diffuser or return grill designed to fit a box that has a takeoff the same size as the duct it is being attached to.

Note on flex duct design: In addition to the duct being 100 ft long or less, the duct calculations when using most friction charts are for metal ducts. If one plans to use flex duct, a duct calculator like the Air Conditioning Contractors of America (ACCA) calculator should be used. Based on this author's field measurements and use of the ACCA calculator for flex, correcting the standard friction wheel or chart by increasing the airflow value by 20% will provide an equivalent duct size for flex. For example, when you want to increase 610 CFM by 20% the following formula works: 610 × 1.2 = 732 CFM. Using the metal duct wheel 710 CFM at 0.08 and you will find that you need a flex duct sized to just under 13". Designers should always round up in duct size to be safe.

Warning: For FAZS™ design the duct-work must be sized so the final ESP for the equipment (when each individual Zone is operating) is 0.5 IWC or less. The use of variable speed fans to force the airflow through smaller ducting to meet system minimum airflow designs is discouraged in FAZS™. Those "high efficiency" motors cost more to operate at the higher amperages and the higher speeds required to force high velocity airflow through a duct system that is too small. A properly designed FAZS™ Controlled HVAC system will operate quietly!