Critical Zone Reset Operation

The preceding discussion focused on fan capacity control. Any scheme to maximize part-load horsepower savings must also address mechanical cooling capacity control. We have assumed that fan horsepower savings are always preferred over compressor horsepower savings; for any load decrease, we save more horsepower by reducing airflow than by increasing air temperature. We have also assumed that mechanical cooling capacity in a VAV system is controlled by supply air temperature. As fan airflow decreases, or increases, cooling capacity is automatically decreased, or increased, to maintain a constant supply air temperature.

Figure 8 illustrates the simple logic of critical zone reset operation. The objective is to control duct static pressure to keep at least one terminal unit wide open, so as to minimize fan horsepower. Therefore, duct static pres-
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sure at the fan outlet is sensed and controlled to a set point, but the set point is reset based on terminal unit position. If all terminal units are closed somewhat (less than 95 percent open, for instance), less cooling is needed. To decrease available cooling, first lower duct static pressure in small increments until minimum fan capacity is reached, then raise the supply air temperature in small increments.

On the other hand, if any terminal unit is wide open, (99 percent open or more, for instance), additional cooling is needed. To increase available cooling, first lower the supply air temperature in small increments until the design set point is reached, then raise the duct static pressure in small increments. (Note that the 95 to 99 percent open range is for illustration purposes. In actual practice, a wide range such as 85 to 95 percent may be required for stable system operation.)

Following is a detailed sequence of operation for a critical zone reset system:

- At design flow, the supply air temperature is at design set point, duct static pressure at the fan outlet is at design set point, the inlet vanes are wide open, the terminal units are open to various positions, and the critical zone terminal unit is nearly wide open (between 95 and 99 percent open).

- As the critical zone load decreases, less cooling is needed so the critical-zone terminal unit closes slightly; all terminal units are now somewhat closed. In response to the new terminal-unit positions, the duct static-pressure set point is reset by a small amount to a lower value. The inlet vanes close slightly, creating a new fan curve with a slightly lower fan static pressure and airflow. In response to the lower duct static pressure, the critical-zone terminal reopens slightly so that it is more than 95 percent open.

- Further load decreases prompt similar reactions until the duct-static-pressure set point is at a predetermined minimum value or until the inlet guide vanes are at minimum position. In either case, if the critical zone load decreases further, causing the critical zone terminal unit to close somewhat, the supply air-temperature set point is increased slightly, while the duct-static-pressure set point is held constant. As a result, the temperature of the supply air rises slightly. In response to the warmer supply air, the critical zone terminal reopens slightly so that it is more than 95 percent open.

- Additional load decreases result in similar incremental increases in the supply-air-temperature set point until a predetermined maximum value is attained. At this point, the VAV system is at its absolute minimum cooling capacity and further load decreases result in no control system response.

- If the critical zone load increases, the critical zone terminal unit opens slightly. In response to this new terminal-unit position, the supply-air-temperature set point is decreased slightly, while the duct-static pressure set point is held constant. As a result, the temperature of the supply air drops slightly. The critical-zone terminal closes slightly in response to the cooler supply air so that it is less than 99 percent, but more than 95 percent, open.

- Further load increases prompt similar reactions until the supply-air-temperature set point is at the design set point.
point value. If the critical zone load increases further, the duct-static-pressure set point is increased slightly, while the supply-air-temperature set point is held constant at the design value. As a result, the inlet guide vanes open slightly, causing duct static pressure and supply airflow to increase. In response, the critical-zone terminal closes slightly so that it is more than 95 percent, but less than 99 percent, open.

- Additional load increases produce similar incremental increases in duct static pressure until the inlet guide vanes are fully open. At this point, the VAV system is at its maximum cooling capacity and further load increases result in no control system response.

Real VAV Systems

Critical zone reset works in a simple one-zone system, but what about real systems? Real VAV systems contain many zones with diverse airflow needs. We still want to keep the critical-zone terminal wide open. But where is it? How do we select the “critical” terminal unit in a complex system? Since VAV systems have diverse load profiles, the critical terminal unit may not be the same at all times of the day or during all days of the year under all load conditions. We could calculate the theoretical critical zone for any load condition, but that would take an extensive duct system and building load model. We could “guess” at the critical zone and monitor the position of the terminal with the longest path from the fan. Or, we could monitor the position of several zones and use the position of the most wide-open zone as our critical position. But, in fact, the best way to select the critical zone is to monitor all of the terminal units and use the most wide-open position in the entire system as our critical-zone terminal position.

Real VAV systems have “bad” zones.

Bad zones are either improperly designed or inappropriately operated. In either case, the result is a zone in which the zone-temperature set point cannot be satisfied in a reasonable amount of time by design airflow at design air temperature. The zone terminal unit simply moves to the wide-open position and stays there. In a VAV system with pressure-independent terminal units, no adverse operation results when a bad zone determines the duct static pressure. The bad zone becomes the critical zone and controls duct static pressure so that design airflow is maintained in the bad zone. However, in a pressure-dependent VAV system, the bad zone terminal stays open regardless of airflow to the zone. As a result, the duct static pressure rises to the design pressure at the fan outlet. This often overpressurizes the duct system, causing noisy terminals and leaking ducts. (Incidentally, the resulting increased airflow to the bad zone may, in some cases, have the
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beneficial effect of actually lowering the zone temperature to set point and temporarily fixing the bad zone, at the expense of excessive duct static pressure!)

**Real VAV systems are dynamic.**

Repositioning the inlet guide vanes in response to terminal position could have a destabilizing effect. To avoid “hunting,” the critical-zone-reset method includes an adjustable differential between increasing and decreasing the outlet-static-pressure set point. The static pressure controller can be operated so that duct static pressure is reset downward only when all terminal units are less than 95 percent open, for instance, and reset upward when any terminal unit is 99 percent open or more. If this differential does not result in stable operation, it can be increased as required with only a small operating cost penalty.

**Real VAV systems have minimum airflow zones.**

These zones require minimum airflow delivery, regardless of load conditions. If pressure-dependent terminals are used, minimum positions—not airflows—are set for each zone. When traditional duct-static-pressure controls are used, the terminal-inlet static pressure usually rises at part-load conditions (see Figure 5), so the minimum position can be set relatively low to obtain minimum flow. However, when critical zone reset is used, the inlet static pressure falls at part load (see Figure 6). Therefore, the minimum position must be set somewhat higher to assure that minimum flow is available at reduced inlet static pressure.

On the other hand, if pressure-independent terminals are used, minimum airflows are set and maintained. If reduced inlet static pressure causes a terminal unit to fully open, that unit becomes the critical zone terminal and minimum flow is maintained at minimum operating cost.

**Implementing Critical Zone Reset**

Critical zone reset is the best VAV static-pressure-control method, but how can it be implemented in a reliable and cost-effective manner?

Of course, the concept of critical zone reset could be implemented using traditional pneumatic controls on the VAV terminal units and a field-installed static pressure control system at the rooftop air conditioner or air handler. Some method of sensing terminal unit position and discriminating the maximum position would be needed, in addition to a duct-static-pressure sensor and controller. But field installation of many control components is costly. In fact, operating cost savings may not justify the first cost and installation cost additions required. Also, many pneumatic, field-installed control components and pneumatic tubing runs may significantly reduce the overall reliability of the system.

Critical-zone-reset control could also be implemented using analog electronic controls on the VAV terminal units and a field-installed electromechanical control system at the rooftop unit. Position-sensing transducers would be needed at each terminal unit and a discriminator circuit would be needed. Also, a duct-static-pressure sensor/transducer and controller would be needed. Installed cost would be high, and acceptable system reliability may be difficult to achieve.

The answer to implementing critical zone reset lies in direct digital control of the VAV system (DDC/VAV). A DDC/VAV system includes factory-installed DDC controllers on the VAV terminal units, factory-mounted rooftop unit or air handler controls, and an integrated building automation system that can communicate with both the VAV terminal-unit controllers and rooftop or air-handler controls. If Trane equipment and systems are used, the answer is the Trane Integrated Comfort™ system (ICS) concept of factory-mounted unit controls communi-
cating with powerful, easy-to-use Tracer® building-automation-system products.

Using the ICS concept, terminal-unit controllers and rooftop or air-handler controllers communicate serially with the Tracer building-automation-system controller via a serial communications link. This simple wiring is already field-installed for normal building monitoring and control. The factory-installed, DDC/VAV terminal unit controller already knows the position of the terminal unit. And this information is readily available at Tracer with no installed-cost penalty. Similarly, in many cases, the factory-installed, rooftop-unit or air handler controller already senses duct static pressure at the fan outlet and provides for static-pressure-set point reset via the serial communications link. The controls required for critical zone reset are largely standard, factory-installed controls so the additional cost for critical zone reset is very low. And factory mounted controls are carefully installed at the factory and 100 percent tested to assure system reliability.

Critical Zone Reset Advantages

**Low first cost.** Only one duct static pressure sensor is needed for both control and high-pressure protection. Multiple static-pressure sensors, transmitters, and discriminators are not necessary, even in complex duct systems.

**Low installation cost.** All controls, both at the terminal unit and the rooftop unit or air handler, can be factory-installed. Field mounting and wiring or piping of controls is eliminated.

**Low operating cost.** Part-load energy usage is maintained at the lowest possible level. Fan energy is minimized before mechanical cooling energy is reset. Critical zone reset delivers the energy savings potential of the VAV system.

**Easy to design.** Since the static sensor is at the fan outlet, the best location for the sensor is already determined. And no special high-duct-pressure protection is required for installations with fire dampers. The single static sensor eliminates the need for multiple-sensor system designs.

**Easy to install.** Only one static sensor to mount. No long multiple sensor runs are needed. If factory-installed controls are used, field mounting of control devices is virtually eliminated.

**Reliable operation.** Static-pressure sensing is simplified, eliminating installation, setup, and operating errors. The duct-static-pressure sensor is always upstream of the fire dampers. If factory-installed controls are used, all controls are tested prior to shipping and installation errors are eliminated.

**Quiet operation.** Lower duct pressure means quiet air delivery. Open terminal units with low inlet static pressures are much quieter than nearly closed terminal units with high inlet pressures. Critical zone reset delivers quiet comfort.

**Conclusion**

Critical zone reset works better and costs less than traditional VAV static pressure control methods. It will become the standard control method in the future. And, with Trane Integrated Comfort systems, the future of VAV system control is available now.

Trane believes the facts and suggestions presented here to be accurate. However, final design and application decisions are your responsibility. Trane disclaims any responsibility for actions taken on the material presented.
Northern California/Hawaii NEBB Chapter is Going to Hawaii in 2015

Our 2015 Northern California/Hawaii Chapter's Annual Meeting location has been changed and will be in Hawaii at the NEBB Annual Conference, April 16-18, 2015. This conference will be located at the Hyatt Regency Waikiki Beach Resort & Spa.

At the 2014 NEBB Annual Conference, our new NEBB President, Jim Huber and Executive VP, John Schulte personally talked with Audrey and I, expressing NEBB's hopes in seeing our Chapter membership at the Annual Meeting.

Last week at our local Board of Directors meeting, the Board decided to switch our 2015 and 2016 Chapter Annual Meeting locations to accommodate this opportunity for our members to experience a NEBB Annual Conference. For those Certified Professionals and Firms who will not be able to participate in the 2015 Annual Conference in Hawaii, I talked with our neighboring chapters, the Southern California Chapter and the Pacific Northwest Chapter located in Washington. They can accommodate our chapter members next year. The chapters’ fees for their annual meeting are similar to ours but may require additional transportation cost.

An advantage to going to Hawaii and attending the NEBB Conference, besides the location in general and likely vacation opportunity, is the ability to acquire 12 CEU hours that will satisfy your 2016 hours requirement also.

Your Board of Directors look forward to representing our Chapter at next year's Annual NEBB Meeting. We hope you will be joining us. Mahalo.

Steve Smith
I want to start off by thanking everyone for the opportunity to represent our Chapter as your new Chapter President. I have big shoes to fill with the people that have gone before me. As I mentioned at our annual meeting on March 27th, Curtis left his mark in this position by opening the door with a prominent ME (Capital) to accept NEBB in their specification. I missed mentioning that Randy Silva (previous Chapter President) had also left an impression during his term when he had us step out from under the SMACNA umbrella with the jurisdiction conflict of NEBB. That has allowed much more marketing, member interaction and advancement in our Chapter. Every time we have an annual NEBB meeting, No. Cal/Hawaii Chapter is referenced as being a leader in our industry in trying to improve where we are going. Audrey Kearns, Chapter Coordinator, is praised in every circle at the annual meeting. Many ask our Board of Directors attending the annual meeting how we do it as a Chapter and then discuss modeling us. This action and model was heavily influenced by Randy’s actions as our President and Audrey’s follow through.

When we are in a lead position as an organization, company or position of authority, it is like playing that kids game of “King of the Hill”. Many people question your decisions and intent. When at the NEBB meeting, the chapter representatives get the chance to share their challenges with each other in an effort to learn. Interesting stories get shared about what worked yesterday, does not work today and the drama we all share. Whether you are on your housing board, family club leader or business organization Board of Directors, we all seem to have the same issues in common. It is refreshing to be able to discuss these issues with our peers because, how often can we explain our daily issues with our spouses and they fully understand?

With that said, Art Deleon (TCC), Audrey Kearns and I just returned from the NEBB Meeting in Ft Lauderdale recently. The common tone of discussion at the meeting was the ANSI accreditation that NEBB is working towards. It appears that the direction that NEBB is going nationally with government approval of our program and locally (CEC Title 24) is being influenced by the ANSI accreditation requirements. We all have to step back, reflect and make changes to address the requirements. There are many more issues that will need to be addressed which is why NEBB is in an evaluation phase. NEBB hired a consulting firm in 2013 to assess our certification programs against the requirements for ANSI accreditation. The NEBB Board of Directors has appointed a task force to work with the staff team to address the various changes that will be necessary to position NEBB for accreditation. These changes are expected to be implemented in 2015.
In the meantime, NEBB is asking for contributing member volunteers for the NEBB Committees. There are constant changes in our industry that need to be addressed in our disciplines from research, procedures, marketing, documentation, by-laws, QAP, etc. A majority of NEBB’s growth and progress comes through volunteers. Not having enough volunteers allows competing organizations to pass us in industry value. As my dad (past Chapter President) would say, “Are you part of the solution or problem?” Note that we have the same issue of low volunteerism at our Chapter. At the recent BOMA event we had the same volunteers as usual: Audrey, Bill Jeffrey (PTB & Marketing committee), Amber Ryman (ACCO & Education Chair), Daniel Wong (WAM & Marketing Chair) and myself. We have a Golden Gate ASHRAE event on May 8th in San Francisco if you have time, contact Audrey.

Back to the Annual Meeting, there were many exciting sessions on industry subjects, government guidelines and company improvement suggestions. The amount of vendors was impressive at 16 this year. Shortridge and Alnor are getting serious competition. Your Chapter BOD was approached for input for the 2015 meeting in Hawaii. Audrey and I were encouraged to relay to our Chapter that NEBB is looking forward to seeing as many of our members attending as possible. It would be a shame to not have our local Chapter well represented at an annual meeting. I personally talked with President Elect Jim Huber and National Executive VP John Schulte and agreed to encourage all of you to attend at all possible. Jim received some member push back on the national level regarding the location, but when the member’s spouses found out about the location, the family vacation was planned. I know that Julie (my better half) and those I have talked with are planning to go to Hawaii and make a family trip of it. Your local and NEBB BOD hope you can make it. Seeing how other chapters and companies work is always interesting besides meeting your fellow Certified Professional’s. Update to follow.

Too much to share and keep under a 1000 words....Next newsletter I will discuss my goals as President, the National Meeting President notes for chapters, along with more local and NEBB updates.

### NEBB’s Need For Volunteers

When we were at the NEBB Annual Meeting, there was the standard talk of all the disciplines and their committees. As NEBB tackles the change of the times in our industry, each of the discipline’s committee is addressing their updates at varying levels. As mentioned in my President’s article, the addition of the ANSI accreditation has added additional items for NEBB to address. In turn, the Operational Procedures, training and testing will need to be re-addressed in greater detail for different disciplines. That means we have a significant amount of work in all disciplines that needs addressing by our volunteers.

NEBB is calling for your help. If you have experience in writing tests, training, engineering experience to help review procedures or just the field experience, NEBB can use your help. Many have expressed their discipline expertise to their clients; what better way to market that experience than to show your involvement in taking NEBB to that next level. Every Certified Professional has the capacity to help at some level. NEBB is hoping that you will be one of those that steps up to help our industry.

If working with your local Chapter interests you more, every one of our local Board of Directors could use your help on our committees also. Please contact Audrey Kearns for more information.
Final Air Balance Co., Inc. is a SMWIA Local 104 Independent TAB agency in its 14th year of business. They have completed over 900 projects of all sizes and scope during that time. Their clients range from Design Build, hospitals, high-rise building owners and general contractors.

Through the years they have developed a reputation as a leader within this industry. Such recognition is a result of their reliable guarantee of their work, an outstanding record of customer satisfaction, a comprehensive quality control and training program that all union Field Technicians must complete prior to obtaining certification.

Final Air Balance Co. was founded on the basic principles of integrity, respect and reliability with both their clients and employees. They are a highly disciplined and organized team of professionals, trained, skilled and certified to industry standards for performing the test and balance analyses of air distribution, hydronic flow systems, indoor air quality, commissioning assistance, and fire life safety systems.

Final Air Balance Company’s owners are Art and Mary De Leon. Currently the firm has 5 employees. Mary handles the administrative end of the business and Art does the estimating, project bids, and QA in the field. They have three technicians, Scott Brehmer, Samuel White and Anthony McMillen.

Art De Leon has been an active participant in the SMWIA Union & balancing community for 25 years. He started his apprenticeship in Los Angeles in SMWIA Local 105 in 1989. Art worked for several companies both in the Bay Area and in Southern California before starting his own union TAB firm in Sacramento with SMWIA Local 104 in 2000. In September of 2000 Art moved from Southern California to Grass Valley and opened doors for business October 1, 2000. At that time there were only 6 businesses in the area who handled commercial work. Being new to the area and knowing no one, Art started knocking on doors. He soon developed a close working relationship with Frank M. Booth Company and after one and a half (1 ½) years the firms was finally on firm footing.

There is a high percentage of work being done in Northern California that requires certification. His NEBB certification opened the doors for more jobs which is extremely important for independent companies to stay in business. Engineers were telling Art that he needed to get his certification for him to bid on their projects. They need to see a certification because that is a tangible that tells them you know what you are doing. With NEBB’s highly recognized organization and reputation, his NEBB certification, once received, opened doors for him. It gave them instant credibility when their company was new.
Art had heard that NEBB was the most stringent of the 3 certification organizations to obtain certification in, and thought it would benefit his new company the best at the time. To obtain the NEBB Certified Professional status, you have to have met very stringent requirements and have had to have passed not only a written examination but also a hands on practical examination. Art received his NEBB Certification in Testing, Adjusting and Balancing (TAB) in 2002. Now that Final Air Balance has been in business for years, it has shown his clients that NEBB and Final Air Balance is an organization with an outstanding reputation of high values and quality. His clients understand that when they receive the final NEBB Certified report, their project has been thoroughly tested. What has been documented in the report has been carefully analyzed and is a true reflection of the design intent, installation and all the components installed meet the submitted requirements. If not, they know it will be fully documented and summarized in the report.

Currently his personal certifications include NEBB Certified Professional, TABB Supervisor, TABB Commissioning Supervisor, TABB Sound/Vibration Supervisor, TABB Fire Life Safety Supervisor, and TABB Indoor Air Quality Technician. As a SMWIA Union member in NEBB, TABB, and ASHRAE, Art has continually pushed to not only increase his own education, but help influence the continued enhancement of the testing, adjusting and balancing field. This experience and research has opened up doors to new markets and approaches towards business.

When Art first opened his firm, Final Air Balance Co., Inc., he kept the company small while he learned the business. Art had total control over all the work being done. Was he more expensive? Yes, but if someone wanted it done right, they hired Final Air Balance. Final Air Balance had developed a quality reputation because of this work ethic. That work ethic took a huge toll on Art because he was doing it all himself and made sure it was done correctly step by step. There are no cutting corners in his balancing company. Art can go home at night, put his head on his pillow and sleep really well because he knows he did a job the correct way every time.

In 2011 Art decided to grow the company expanding to eight (8) technicians. At that time he moved his office from his home office space to a space in downtown Auburn. To obtain larger projects such as hospitals, the company needed more personnel to handle the extra work involved. Art always had the ambition to work on the larger facilities and projects and is glad he took the leap to grow the company. In 2013, Art made the decision to cut back the size of his firm. He was glad he took the opportunity to grow his firm and handle the larger jobs but is now glad to be out of it. That period of expansion was a valuable learning lesson for him personally. “It is a whole other level of responsibility you take on, especially the business end of it, when you take on larger projects. It was a lot of work to manage more personnel and a larger company” says Art. Downsizing his firm allowed Art to go back to what he likes best about this job and that is giving the customer the best service possible. It has allowed him more control over who he wants to work for.

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Mr. John Johnson – Senior Calibration Technician – john@engdynamics.com
Mr. Stuart McGregor – Senior Acoustical Engineer – stuart@engdynamics.com

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Northern California/Hawaii NEBB Chapter Has a New Board

The Northern California/Hawaii NEBB Chapter elected their 2014/2015 Board of Directors.

The Board of Directors was announced and officially took office at the Northern California/Hawaii NEBB Chapter’s Annual Meeting on March 27, 2014 in Fremont, California.

The 2014/2015 Board of Directors are: Steve Smith, Pacific Test & Balance, Inc., President; Vic Congi, Carter Air Balance, President Elect/Treasurer; Vic Congi, Carter Air Balance, President Elect/Treasurer; Art DeLeon, Final Air Balance, Inc., Technical Chair; Amber Ryman, ACCO Engineered Systems, Education Chair; Daniel Wong, Western Allied Mechanical, Marketing Chair; and Curtis Worley, Pacific Test & Balance, Inc., Past President.

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7100 Stevenson Blvd.
Fremont, CA 94538

Phone: 510-386-1270
E-mail: akearns@nocalhawaiinebb.org
www.nocalhawaiinebb.org