vitamin®

Cure for the Common Brand ®

2014 Press Clip Book for RMF Engineering

LAST UPDATED : August 4, 2014

3237 Eastern Avenue Baltimore, Maryland 21224 *tel* (410) 732-6542 *fax* (410) 732-6541 *email* info@vitaminisgood.com *web* vitaminisgood.com

building OPERATING management

July 7, 2014 // **NEWS**

Green Building Report: The Real Costs Of Major Energy Upgrades

By Stefan Domby

Part 1: Budget For Energy Upgrades Requires Fully Understanding Real Costs

BOTH IN THE PRIVATE AND PUBLIC sectors, building owners and facility managers are focusing on managing energy costs more than ever before. But as we all know, you have to spend money to save money. It's important for facility managers to develop a plan to ensure that they do not run out of money before completion of the project and that the project budget is justified.

To successfully map out your energy savings goals, you should understand three key challenges:

1. System selection based on energy savings and first cost.

2. Phased cost based on whether the building is occupied or unoccupied.

3. Estimating the true cost for energy retrofits.

Before you jump into energy modeling simulations, it is prudent to understand the limitations of your existing building.

For example, chilled beams can have a significant impact on energy reductions in both new and existing buildings. They also solve a number of fit issues in old buildings that were not designed to support a tremendous amount of ductwork. However, if your building envelope is not relatively tight, you have leaky windows, and infiltration does not allow you to control humidity, you may not want to use chilled beams if your budget does not include window replacements.

The point is, it's important to carefully review your HVAC system selections for constructability issues before you get too excited about energy savings. Also be aware of alternative solutions that may not be as mainstream but are just as effective; for example, induction chilled beams that are designed to condense water and can use normal chilled water temperatures of 42 degrees F, whereas chilled beams are designed for 60 degrees F chilled water and are not ideally suited for condensing duty. Have your engineer evaluate options that you can live with before you go to the energy simulation work.

Once you have a good understanding of the HVAC systems that can function in your building, you can begin to concentrate on the potential energy savings. It's important to perform a differential analysis of the energy you currently consume and the amount that the possible new alternative system will use.

Differential Analysis

The two energy simulation charts on page 14 demonstrate the energy consumption of a baseline constant volume system and the use of a chilled beam system. Note the shift in fan energy from one system to the other and the shift in percentage of where the energy is consumed within the building based on the system type. This particular baseline system was determined through the assumption of certain operating parameters of the building modeled after detailed conversations with the users and facility personnel. Whichever modeling software is used, key energy consumption factors should be carefully evaluated and validated. The best baseline information is often derived from actual utility bills or metering data within the facility itself.

An ideal way to achieve this is to fit your existing building with energy meters to provide a baseline from which your energy model will be compared against. Your energy modeler must be aware of how the building is metered so that when the input analysis is prepared, reasonable numbers can be assigned for plug loads, process loads etc., so as not to skew one way or the other the energy savings associated with the alternative HVAC system.

The alternative method is to build a baseline model of the existing HVAC system and obtain a reference energy signature from that model. There will be a fair amount of baseline assumptions — plug loads, process loads, U values, window SCs, fan/motor efficiencies, and occupancy schedules for actual building usages — but the key is to use those same assumptions for your alternative system and only change the HVAC parameters that you can specifically differentiate in your energy report. Again, the point is that without baseline energy consumption, the magnitude of your system savings could greatly impact your final life-cycle cost analysis.

The differential energy simulation of the new and existing system must be accurate, because it is the driving force for the decision to renovate and upgrade the building's HVAC system. This task will take time but it is the foundation of the analysis, so give the project its needed time.

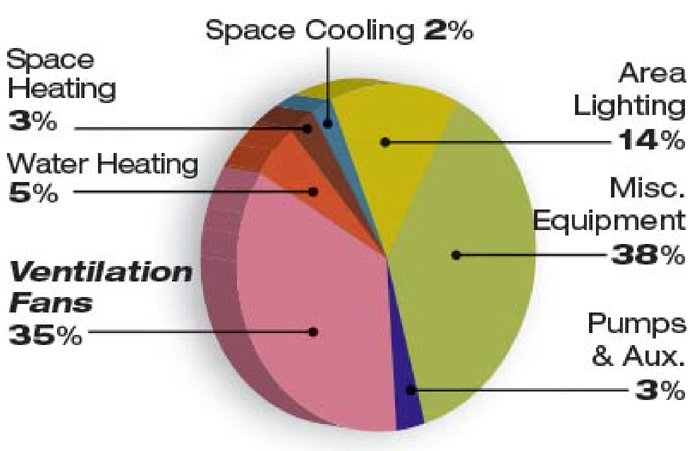
Energy Modeling Shows Large Savings

Modeling software shows that energy use by ventilation fans is reduced when a building migrates from a standard constant volume system to a chilled beam system. Overall energy use is dramatically reduced as well.

BASELINE DESIGN: CONSTANT VOLUME SYSTEM

	Electricity kWh (x1000)	Steam MBtu	Chilled Water MBtu
Space Cool	39.9	-	4,659.8
Space Heat	54.2	3,649.9	-
Hot Water	80.5	-	-
Vent. Fans	617.5	-	-
Pumps & Aux.	58.9	-	-
Misc. Equip.	672.5	-	-
Area Lights	256.5	-	-
TOTAL	1,780.1	3,649.9	4,659.8

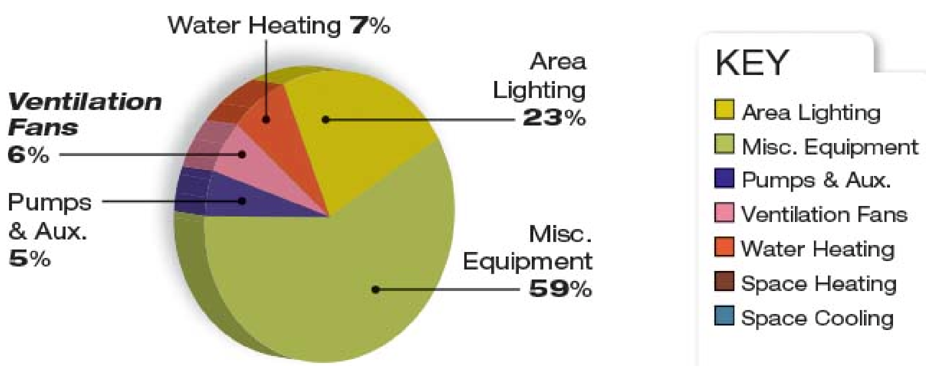
BASELINE ELECTRICITY



CHILLED BEAM SYSTEM

	Electricity kWh (x1000)	Steam MBtu	Chilled Water MBtu
Space Cool	-	-	2,852.0
Space Heat	-	2,539.7	-
Hot Water	80.3	-	-
Vent. Fans	71.6	-	-
Pumps & Aux.	60.7	-	-
Misc. Equip.	672.5	-	-
Area Lights	259.4	-	-
TOTAL	1,144.6	2,539.7	2,852.0

CHILLED BEAM ELECTRICITY



Part 2: True Energy Costs Play Important Role In Determining Energy Savings

As important as the energy savings are, understanding the cost of that energy is equally important. At the end of the day it comes down to money saved over money spent. Energy recovery on a 100 percent outside air handling DX unit may have an impressive energy savings to the modeling engineer, but with the combined cost of a gas-fired AHU section and gas that costs less than a dollar/therm, the facility engineer who is paying the bill may have a differing opinion. On the other hand, if the energy wheel avoids a significant demand electric charge, the energy wheel may be the solution. Make sure you understand the utility rate structure for the building and any unique ratchets that may apply.

The energy savings based on the energy conservation measures (ECMs) that have been modeled can occur on a component level (such as motors, variable frequency drives, controls and lights) or they may reflect the replacement of an entire system (such as going from constant volume to variable air volume or from variable air volume to chilled beams).

The first cost for the ECMs must be well described and supplemented with diagrams and sketches so that a qualified cost estimator or contractor can provide the appropriate cost to the ECM for each alternative modeled. This step is not a trivial matter. Replacing a motor with a high efficiency motor or providing a new VFD are not things that can be looked up in a book; the installed cost must be understood. The price of an air-handling unit is one thing but providing a crane to lift that unit to the roof is a real cost. Of course not all installation issues are as dramatic;

however, you must understand the basis of your comparison: is it the cost of the equipment or is it the installed cost of the equipment with labor?

No matter how great the destination, if the journey to get you there kills you, what does it matter? Such is the case with the difference between HVAC renovations in an unoccupied as opposed to an occupied building.

Think about it as a real life example: if you want to remodel your bathroom and you have to rent a hotel room for several months just to shower, you would probably just move out until the project is done. Or, if you have a good neighbor that will only charge you utilities and toilet paper costs, you'd utilize their bathroom.

Building owners are faced with similar dilemmas, but with a few more people to consider and much higher stakes. But, of course, any problem can be solved with the right amount of money. This where skilled cost estimators and contractors comes in. A detailed conversation should address swing space, moving costs, dust control, noise control, temperature control, temporary heat and AC, power outages, fire watches, etc. Replacing an HVAC system in a building takes a lot of money and developed phasing plans. A life-cycle cost report for the replacement of your HVAC system may not capture all the costs involved but it can give you an order of magnitude to help drive the discussion and decisions.

One thing is for certain, that hotel room is looking pretty good. Phasing the work in an occupied space can triple the cost of the project and can really ruin a life cycle cost evaluation, but many owners are faced with this very issue without the availability of a suitable swing space. So planning is everything. Plan to spend money, plan to work on premium hours, plan to phase the project so that whatever area is disrupted at night is returned to working condition the next day, and plan on an extended project schedule.

Part 3: Realistic View Of Energy Savings Helps Meet Targets

At this point, it may seem that energy savings take a back seat when renovating a building. The real question is how do you measure the importance of installing an energy saving system in a building? It goes back to what your goals really are. If you want the energy savings associated with a new building, you need to be realistic about how you get there.

System-Level Savings

Providing component based ECMs, such as lights, motors, and controls can be accomplished to some degree, but real savings come from the synergy of a newly designed system. The system has a lot of peripheral components that are required, but are not at the heart of the savings. The fan, motor, VFD, and VAV terminal units may save all the electricity, but you need ductwork, piping, and an air handler to make it all work. There are systems where plugging in a new fan, motor, and VFD may work but more than likely the ductwork may not be designed to allow the installation of VAV terminal units which in turn allow the fan, motor, and VFD to save energy. Likewise, if you have to replace a fan or motor in a 40-year-old air handler (AHU), shouldn't you replace the AHU because the walls and floors are probably rusted out and air leakage is a significant factor?

Once you get past the easy ECMs and focus on the system ECMs — where the real savings exist — first cost, associated costs, and phasing costs seem to really hurt the overall life-cycle cost of energy savings and you quickly understand that you cannot fund a project with energy savings alone. The first thing to consider, as is the case in establishing a baseline energy model, is establishing the real cost of doing nothing with your existing system. What is the real cost to maintain antiquated systems, clean ductwork, install supplemental AC units for under capacity systems, pay utility demand costs for not meeting power factor correction standards, and, ultimately, a replacement cost for your existing system? The new system you installed would have a 30- to 40-year life.

Capture the difference in maintenance cost of the new and existing systems up to the point when you consider replacement cost for the existing system. Identify demand costs in the baseline comparison; these charges can significantly impact the LCCA and payback results. Be realistic with phasing cost; it is real money, but it should be discounted in the LCCA or simple payback if the existing system is being replaced in 10 years and would also have a significant phasing cost.

No matter how detailed you are, it is highly unlikely that energy savings alone will result in a payback period under the guidelines of conventional wisdom such as 10 or 20 years. Understanding where the money is being spent, what portion of it is energy related, what portion is supplemental and what portion is phasing, is useful for facility managers to establish funding parameters.

Stefan Domby, PE, LEED AP, is an associate at RMF Engineering. Domby has significant experience in the design and analysis of mechanical systems serving healthcare, laboratory, institutional, federal, and industrial facilities. He can be reached at stefan.domby@rmf.com.

CONSULTING - SPECIFYING engineer

June 19, 2014 // **NEWS**

Power Plant Reliability

The ASME committee for reliability, availability, and maintainability helps power plant owners and operators achieve their goals.

By Brian Wodka, PE, CEM, LEED AP, RMF Engineering, York, Pa.

Power plant owners and operators have always struggled to control reliability, availability, and maintainability. Here are some common questions whose answers are not so common:

- How do I identify my exposures to risk?
- How do I mitigate them?
- How should I prioritize them?
- How can I effectively implement these changes to get the desired results?
- How do I best utilize my maintenance/repair resources?
- How do I obtain and sustain an effective preventive maintenance program?
- How can I justify the budget I need to keep the plant operating properly?

In response to these types of questions, ASME International created a Reliability, Availability and Maintainability (RAM) Committee to develop a standard to address these issues. The new RAM standard, issued for power plants toward the end of 2013, offers a very structured process to help owners, engineers, contractors, and operators coordinate and work effectively on RAM projects.

The concept of RAM is nothing new; it has been around for about 40 years. However, over the decades it has had multiple uses and interpretations. Many different organizations even created their own definitions. ASME decided to take on consolidating this plethora of information in response to the industry's demand for a standard that gets results.

Definitions

First, let's define RAM:

Reliability: The probability that something will operate for its designed interval under a specific conditions (the ability to maximize uptime).

Availability: The probability that something can operate at any given moment (the ability of your plant to operate when you need it).

Maintainability: The probability that something can be restored to operating condition in a specified amount of time (the ability to minimize downtime).

Equation No. 1: Defines availability as a function of reliability and maintainability.

$$Availability = \frac{Uptime}{Total\ time} = \frac{Uptime}{Uptime + Downtime} \approx \frac{Reliability}{1 - Maintainability}$$

How to get results

Availability is maximized when uptime is large and downtime is small. In other words, to achieve your availability goals, you want high reliability and high maintainability. So the ultimate goal of a power plant is to truly control availability, which is done by controlling reliability and maintainability. The question is, "How can I control reliability and maintainability?"

"If you can measure it, you can control it." This adage is the fundamental concept of a control loop. It is based upon deviation from a measured input parameter (setpoint) to initiate a change. This is also true when it comes to reliability, availability, and maintainability. The new RAM standard discusses the importance of identifying measurable parameters (based on your equipment and maintenance structure), regularly monitoring them and making the appropriate adjustments.

This new standard offers a very structured process to help owners, engineers, contractors, and operators coordinate to achieve the common goal.

The RAM process:

1. Predevelopment
   This is the phase where the owner gets the opportunity to discuss and define its requirements and goals for the power plant. Many factors are taken into account and must be addressed to ensure a comprehensive understanding of what needs to be accomplished. The owner establishes who is on the RAM team and their roles are assigned.

2. Program development
   In this phase, the design engineer incorporates the owner's RAM requirements and goals into the development of the contract documents (drawings, specifications, etc.). This is to ensure RAM is built into the design of the power plant. The contractor is involved in the construction and commissioning requirements also to ensure that the aspects of RAM are constructed as designed, validated, and verified.

3. Program implementation
   Until now, everything has basically been theoretical. In this phase, theory becomes reality as the RAM program gets implemented. The RAM standard lists requirements that must be addressed to provide direction and techniques for implementation.

4. Program revision
   Establishing a clear process for revision makes sure that the RAM program can be changed as needed. A RAM program is a living document that is to be regularly updated as changes occur in equipment, operating procedures, personnel, or purpose. This permits the program to transcend plant modifications and personnel turnover, effectively resisting obsolescence.

The standard provides the guidance so that RAM can be incorporated into all aspects of the power plant's lifecycle. All that is developed in each of these phases culminates in the RAM program manual. This is the physical product that identifies the customized program in its entirety for a specific power plant. This document helps to guide the RAM manager in sustaining the program throughout its lifecycle with measured and controlled results.

One of the most powerful statements in the standard is that it requires a budget to be developed for the implementation of the program. This gives the owner a clear understanding of the necessary maintenance costs required to mitigate risk and achieve goals.

Performance-based versus prescriptive

The standard is purposely brief and written at a high level. This is to offer the most diversity and freedom of design. The standard's strength comes from the fact that it is "performance-based" instead of "prescriptive." Prescriptive standards state their requirements in exact terms, usually in very precise detail. History has shown that prescriptive standards can be resistant to changes in technology, restrictive to innovation, and limiting in applicability. Performance-based standards tend to take the view of "the ends justify the means." They state what you need to get done and leave the means and methods to the engineers, owners, and operators. A performance-based standard maximizes the opportunity for compliance for power plants of various sizes, fuels, technologies, and functions. For these reasons, ASME is now encouraging performance-based standards over prescriptive ones.

The new ASME RAM standard is not a magical cure to all of your power plant's problems. Rather, it offers a structured, practical approach that can be customized to your specific needs to maximize your ability to achieve your reliability, availability, and maintainability goals.

Brian Wodka is a mechanical engineer at RMF Engineering and the vice chair of the ASME RAM Standards Committee. He leads the power plant assessment and reliability team at RMF Engineering and has performed power plant assessments and boiler inspections for the past 12 years. Wodka also sits on the Board of Boiler Rules along with the Board of Stationary Engineers for the state of Maryland. properly updated and coordinated, was a difficult challenge and very time-consuming. However, I quickly learned that BIM gave us the ability to make a change in the model and see that change seamlessly appear in both permit packages, saving us significant time and effort.

Ensuring Your Opinions Are Valued

Tips for the female engineer

I have been a design engineer and a Registered Professional Engineer in Maryland and South Carolina for over 20 years. I started my career in an engineering firm right after I graduated with a bachelor's of science degree in electrical engineering. Over my career, I have risen through the ranks in the firm from entry-level engineer to electrical principal engineer, in charge of many other professionals. My work has taken me all over the United States designing projects such as power plants and new hospitals.

During college, there was only one female in my classroom: me. It did not take long to realize this would be typical in the field. Entering into an electrical engineering design position in the construction industry here in the United States effectively meant that the majority of the females I would bump into would be either owners or architects—but very rarely engineers. Due to the underrepresentation of female engineers, I have at times been judged first as a woman and second as a registered professional engineer.

In the United States, the engineering industry is populated with an approximately seven-to-one male-to-female ratio [National Science Foundation, National Center for Science and Engineering Statistics, Scientists and Engineers Statistical data System (SESTAT), 2010]. As such, women may run into coworkers who doubt our credibility, question our understanding of the industry, and even wonder if we will climb ladders or enter confined spaces such as utility tunnels. I have found that many times these concerns or doubts are simply a reaction to not having previous interaction with female engineers. The good news? The number of female engineers is on the rise.

Beth Crutchfield

According to the *Digest of Education Statistics*, in the United States, 29% more females received engineering degrees in the last ten years, while the total number of female engineering degrees earned in the United States remained largely unchanged at 20% (ASEE.org "National Engineers Week Foundation," 2010).

Over the last 20 years, I have seen a profound change in how firms value females in the workplace. Firm leaders are realizing that women add diversity of thought, which makes teams more well rounded and position firms to grow and prosper. Over the next 20 years, I am confident that the American female engineer population will continue to expand, creating an even larger cultural shift in the industry.

In the meantime, here are some suggestions for workplace behavior that will ensure your opinions are heard and valued in any room.

Remain Assertive; Do Not Shy Away from *Professional* Interaction

There is no need to yell and scream, and you should always remain firm in your position in the face of opposition even if you feel like jelly on the inside. It may take some deep reflection to be able to stand up for yourself in a professional manner, but it is worth it. Over the course of my career, I have found that where women tend to find work-related conflict to be disruptive, most men find it inevitable in the normal course of business. Holding firm in your convictions is a key to gaining respect, especially once you are proven correct.

With that said, sooner or later after you show some level of assertiveness, someone may say something stereotypical about your role as a woman. It is the age-old attempt to demean or use your gender to gain control. Be ready for it with a response along the lines of "no, neither my emotions, nor your emotions, have anything to do with the issues/failures/problems that we are dealing with here. Let us understand that, and move forward with solutions."

Make Your Points Using a Linear, Fact-Based Approach

There are hundreds of books and articles on the hypothesis that men and women work and communicate differently. In my experience, that has been proven, and in analyzing those differences I have

Digital Object Identifier 10.1109/MWIE.2014.2308762
Date of publication: 7 May 2014

gained an understanding of how women and men can successfully work together. I have found that women that I know in the engineering industry tend to use cooperative methods to come to a solution. Women tend to talk to coworkers, collaborate on solutions, and gather insight from others. I have seen that some men tend to start with the problem, define the issues, and work toward a solution, oftentimes on their own.

I have learned that if you are good at what you do, the hardest part of the job can be making yourself heard.

To get our thoughts heard and received with credibility, we should not just jump straight to our answer when presenting an idea. Instead, we can set ourselves up for success by outlining the path we took, the issues we uncovered, examined, and resolved and ultimately, how we came to the correct result. Without sharing our process, others may mistakenly assume that we did not do the "homework" and guessed at a result or, worse, came to a conclusion as a result of gaining a consensus. It is a lot like school: show your work if you want full credit.

Be Confident In Your Capabilities

I can still remember the meeting like it happened yesterday: I was relatively fresh out of school, and we were discussing an issue with an electrical component in front of my boss, owners, architects, and contractors, and I grew frustrated that the team seemed to be avoiding addressing a major problem: an electrical room with questionable levels of safety. I knew I had the knowledge to help correct the situation, but I did not feel confident enough to interrupt the conversation and share my thoughts. Every time there was a lull in the discussion, I sought to get my point across but hesitated for a moment too long and the discussion ramped back up. Growing frustrated with myself, I excused myself for a moment and left the room to gather my thoughts. I took a few deep breaths and reminded myself that I knew just as much as the men in the room and I deserved to be heard. I went back in, waited for a natural pause in the conversation and stated that I could resolve the issue if given a few minutes to explain what I knew.

For me, as a young woman and relatively new engineering graduate, standing in front of a group of men was initially intimidating, but after I began to discuss what I knew about the issue and how to resolve it, I gained more confidence in myself and could see that I was gaining the confidence of the men around me. After I finished, the room was quiet. The first words out of the owner's mouth were "We always thought you knew what you were doing, and you proved it today! Now, let us all figure out how to make your solution work as a team."

At the end of the day, I realized that torturing myself over my concerns about my abilities was a stressful, inefficient use of time. I have learned that if you are good at what you do, the hardest part of the job can be making yourself heard.

I have seen some of my female coworkers leave the industry because they feel like the cards are stacked against them. They feel undervalued and underappreciated. As women, we need to celebrate our inherent value in the industry and find our own individual techniques for strengthening our shortcomings and maximizing our abilities.

High school girls that I mentor frequently ask me, "If you had to do your career over again, what would you do differently?" My answer to them is always the same: learn to trust yourself and your education early on. If you trust yourself, you will have the confidence to stand shoulder-to-shoulder with your coworkers (no matter their gender or experience in the industry) and use your intelligence to solve the issues at hand.

—Beth Crutchfield,
Electrical Principal
RMF Engineering
Charleston, South Carolina

wie

May 30, 2014 // **NEWS**

Safety Relief Valves: Avoiding Horror Stories

By Vince Basilio, P.E.

Part 1: Safety Relief Valves: Avoiding Horror Stories

As an engineer, I'm always fascinated when the scariest horror movie scenes take place in a mechanical room or a boiler plant. While all of the other viewers are petrified, I'm locked in, even rewinding it just to get a good look at the equipment.

Maintenance and engineering managers know mechanical rooms in institutional and commercial facilities are not scary at all and that, in fact, they are essential to facility operations and the organization's mission. The equipment produces and circulates heated or cooled air, and it pumps and distributes the necessary gases and fluids to where facilities need them.

For the benefit of facility operations and occupants and the general public, it is paramount that managers implement proper safety procedures and that front-line technicians comply with them at all times. Among the essential components in the safe, and efficient operation of HVAC systems are safety relief valves.

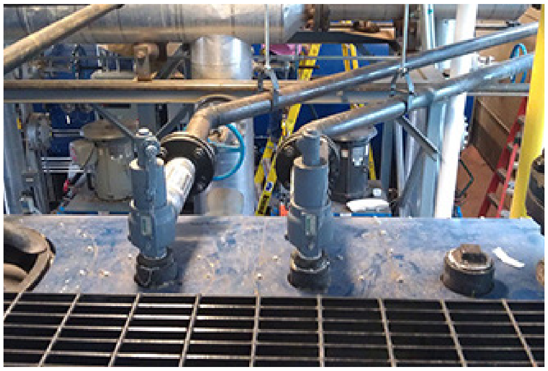
Part 2: Taking Inventory of Safety Relief Valves

Safety relief valves are designed to ensure that whatever they connect to does not blow up. All mechanical systems that involve heated liquids or gases, such as hot water and steam, or pressurized gases, such as compressed air, have safety relief valves that protect for unplanned conditions. Examples of such situations include:

- A key component — such as a sensing, logic, or control device — involved in the control of the amount of heat or pressure in a system can fail.
- An operator can accidentally trap fluid in a heat exchanger, such as when performing maintenance and leaving the valves shut.
- An explosion can occur during a fire, which is the last thing emergency personnel need to worry about.

The safety relief valve is not involved in the normal control of the system. Rather, it is waiting in the wings, ready to jump into action when something goes wrong. If something does go wrong and the valve is not in place to do its job, the situation will be worse than any horror movie.

Take inventory
The first step in maintaining a system's safety relief valves is taking inventory. Technicians should make a list of all safety relief valves. The failure of a half-inch safety relief valve can result in enough damage to make the newspapers and bring on the lawyers. Keep this list active and available to all applicable personnel.



High-temperature water application with expansion joint at the outlet.

High-pressure steam boiler with multiple relief valves and drip-pan elbow.

Label each valve — if it is not already labeled — so everybody can positively identify it. Record which tank, pipe, heat exchanger or other equipment it serves.

Record the set pressure. If the system pressure is higher than the set pressure of the relief valve, you have a big a problem that technicians need to address immediately. If the valve label is missing, painted over, or illegible, get a new valve.

Record the rated flow, list the reason the safety relief valve was installed, and the way it is supposed to function. For example, when it relieves, is it supposed to blow a great deal or little? Is it in place to protect a vessel when there is an external fire, to protect lower-pressure rated equipment downstream of a pressure-regulating valve or to protect from the controls of a boiler running away? If you cannot answer any of these questions, call the original design engineer. Knowing the valve' purpose helps operators better understand their systems, identify problems, and troubleshoot them. Engineers often will install a safety relief valve for a specific condition, so it is imperative that operators understand the reason so they can take care of it.

Record the system's normal operating pressure or pressure range. If the relief valve vents into a pressurized system such as a return system, record that normal operating pressure or pressure range.

Part 3: Observing and Correcting Relief Valve Piping Issues

While taking inventory, technicians should visit each location and observe the piping. If a relief valve is leaking, fix or replace it. Once the seat of the valve becomes too worn, it will not work properly.

Are there isolation valves upstream of the relief valve that could prevent it from protecting what it was designed for? That is a huge red flag. If a system can never go out of service and a technician needs to take a relief valve out of service, selector valves can ensure one valve is in service while the other valve is locked out so technicians can remove it for testing or repair.

Low-pressure steam boiler with drip-pan elbow. Vent pipe is not supported.

Look at the relief vent pipe, and understand all of the key components: where it goes; if it is in a safe location; if it reduces in diameter at the outlet, etc. If the pipe does reduce, an engineer might be able to perform calculations to verify whether the vent pipe size reduction is acceptable. As a rule of thumb, when multiple relief valves join, the area of the resulting tee and pipe should be at a minimum the sum of the two pipes joined.

If the relief valve vents steam, there should be a drip-pan elbow at the outlet of the relief valve. The elbow serves a number of functions. It ensures the vent pipe does not have water sitting at the valve opening, which can cause water hammer when it pops. It keeps liquid off the valve that could cause minerals to deposit or corrosion and seal the valve shut. It also allows air to enter the vent pipe and aids in reducing the backpressure on the valve.

Make sure the drip-pan elbow drain is not plugged and goes to a open drain so it can be observed. The vent piping needs to be supported separately from the discharge of the valve, or the valve can be torqued, and it might not go off. Ensure that it can never thermally grow down onto the valve body. Remember, the vessel or pipe it connects to probably is going to thermally grow, so do this inspection when the system is operating, and make sure there is a gap between the valve and the pipe. If there is a mist eliminator in the steam vent pipe, remove it. If mist is coming out of the vent pipe, repair or replace the valve.

Part 4: Schedule Regular Safety Relief Valve Inspections

Record the year the valve was installed and when it needs replacement or repair. From there, make a schedule for regular testing of each safety relief valve. Different safety relief valves have different requirements. Either refer to the original instructions, which are available on the manufacturer's web page, or perform it at least once a year.

Steam application with no drip-pan elbow and outlet is restricted from thermal growth.

In some cases, when a relief valve pops such as when it is tested, the valve will not reseat, and the fluid or gas might weep. This is not a reason to forego the testing. It is a reason to be prepared. For critical systems, have an extra relief valve that can be sent to a certified shop for re-stamping, and time the replacement during a planned outage.

When testing steam system relief valves, observe whether steam blows out the drip-pan elbow instead of through the vent pipe. This could be a sign of an undersized vent pipe, and it can be a dangerous situation to somebody who happens to be next to the valve when it goes off.
Review the list with all operators and related personnel who work with the systems.

Do the right thing

If you follow the recommendations above, you are doing your part. Your organization might hire inspectors from an insurance company that check on boilers and pressure vessels, but they might not check all of safety relief valves, so do not rely solely on them. Do your own inspections and tests.

For more information about safety relief valves, consult the American Society of Mechanical Engineers, which governs the design of most safety relief valves — how they are sized, what types, how much capacity is required, etc. — and the National Board of Boiler and Pressure and Vessel Inspectors, which governs the certification of the valves and deals with manufacturers and installations.

The old saying, "the only thing necessary for the triumph of evil is that good men do nothing" applies here. Managers can avoid creating real-life horror stories by doing the right thing and meeting the responsibility to protect the safety of facilities and everyone in them.

Vince Basilio, P.E., CEM — vince.basilio@rfm.com— is a mechanical engineer at RMF Engineering with 20 years of experience as a consulting engineer in the steam industry. He is also an associate National Board Inservice Commissioned Inspector. He has extensive experience in utility distribution system designs and stress analysis of steam systems ranging in pressure from 40-1,000 psig and temperatures of 300-1,000 degrees. He has evaluated and designed steam-related systems, including feedwater, condensate, continuous blowdown, blow-off, coal handling, compressed air — plant and instrument quality — fuel oil (No. 2 and No. 6), natural gas, propane gas, biogas, chemical treatment, water treatment — reverse osmosis, zeolite softening, condensate polishers, mixed bed polishers, magnetic filters and anion and cation units — and cooling systems. He is recognized as a leader in applications of low NOx-producing burners for new and existing boilers.

COLUMBUS
BUSINESS FIRST

June 10, 2014 // **NEWS**

RMF adds civil engineering team at Columbus office

By Brian R. Ball

Baltimore-based RMF Engineering Inc. has doubled the staffing at its Columbus office with a civil engineering team about three years after setting up shop.

The company has announced the recent hiring of landscape architect Matt Burgdorf, construction administrator/civil designer Gregory Albrecht and construction project manager/civil designer Stephen Whalen.

The firm also has appointed civil engineer Vince Jarrett as the new division manager for the office at 5202 Bethel Reed Park.

Ashlene Larson, the outside public relations contact for the engineering firm, told me all four RMF newcomers are from the Jones-Stuckey engineering offices in Columbus, which is located upstairs in the same building where RMF leases space.

"Prior to adding the civil team," Larson told me in an email, "the Columbus office offered mechanical, electrical, utility distribution and commissioning services."

There are now 8 people in the RMF's Columbus office, which opened a little more than three years ago at 2323 W. Fifth Ave.

Its client base in Ohio includes Ohio State University, Ohio University and Case Western Reserve University.

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

May 5, 2014 // **NEWS**

Laser Mapping and BIM

Using 3-D imaging to survey conditions within buildings

By STEFAN DOMBY, PE, LEED AP,
RMF Engineering Inc.,
Baltimore, Md.,
and MIKE MORGAN, AIA,
Waldon Studio Architects,
Columbia, Md.

While we may not realize it, 3-D imaging is part of our daily lives. Every time we access Google Maps for directions to a new destination, for example, we are employing 3-D imaging. This same technology—or a variation of it, laser mapping—is now available for use by architects and engineers for surveying building conditions and exterior elevations, which then can be integrated into building information models.

Building information modeling (BIM) is used to cultivate and foster a client's vision. With laser mapping, the effectiveness of BIM can be enhanced. Benefits of laser mapping include expedition of a design team's efforts, field-investigation time savings, increased accuracy of field data with definition of actual location, reduced safety risk (personnel do not have to climb ladders or reach around equipment), and further development of client electronic files of existing conditions. One of the most significant benefits is that engineers can spend their time more effectively, addressing actual engineering issues, rather than drafting issues. Yet despite these advantages, many design professionals shy away from laser mapping because of a lack of understanding of what it is and how to incorporate it into a project.

With 3-D laser mapping, laser beams rapidly scan the shapes of objects, and the time for the beams to travel to each point on the objects is calculated. From this scan, point clouds—data points that each are given an "X," "Y," and "Z" coordinate—are developed. The more beams projected in a given area and time frame (density), the more defined an image will be, resulting in a better end product. Density can be varied based on how detailed the survey needs to be, along with how many target points are used. Density and number of target points correlate directly to the cost of a scan. The use of 3-D laser mapping, along with increased computer power, is making imaging technology more effective, more precise, and more usable across platforms.

This point cloud from a laser scan (left) was used to create a detailed survey of existing conditions. This 3-D model (above) represents what the space will look like when work is complete. The laser scan helped the design team to determine ceiling heights and floor-plan constraints.

An associate with RMF Engineering Inc., Stefan Domby, PE, LEED AP, has significant experience in the design and analysis of mechanical systems serving health-care, laboratory, institutional, federal, and industrial facilities. He routinely uses computer-modeling techniques to support his analysis and design of hydronic and process piping systems. His other areas of expertise include energy-system-performance modeling, chilled-water-distribution-system analysis, and engineering economic analysis. Mike Morgan, AIA, is a vice president of Waldon Studio Architects. As an architect and general design-build contractor, he has provided turnkey solutions affecting more than 400,000 sq ft and 2,000 people for projects totaling $13 million in design, renovation, and relocation services. His projects require strong team- and consensus-building skills and an ability to deliver practical, high-quality design solutions within strict budget and time constraints.

Key Factors

The million-dollar question is how do you know if a BIM project is a good candidate for laser mapping. Key considerations are:

• *Requirements.* Has the owner or agency operating the building requested 3-D mapping? Increasingly, 3-D modeling is being required, especially by government agencies that have to maintain and operate buildings over many decades while administrating renovation projects. For many government buildings, CAD drawings are lacking, which makes identifying areas during the troubleshooting and concept phases difficult. In such situations, 3-D mapping can be particularly useful.

• *Time and cost.* What is the opportunity cost of not using 3-D laser mapping? When you consider the time it takes experienced designers to verify and document all existing conditions, especially with multiple utilities in a condensed area, 3-D modeling becomes much more cost-effective. The use of laser mapping frees up resources for valuable tasks, such as preparing preliminary calculations and developing conceptual layouts, and it expedites coordination of disciplines. Manipulation of a building information model to test-fit various design scenarios is paramount to productivity and quick client turnaround. Whether a project is of considerable size or has been fast-tracked, the time and efficiency benefits of using 3-D modeling can outweigh the expense of the technology itself.

• *Product quality.* Will laser mapping lead to a better end product? If a renovation is extensive and there are potential conflicts with existing utilities, 3-D laser mapping can make the design more accurate while minimizing cost overruns and delays.

Case Study

RMF Engineering Inc. and Waldon Studio Architects (WSA) used 3-D imaging to design the renovation of a 2,500-sq-ft area in the basement of a building on the campus of the National Institutes of Health (NIH) in Bethesda, Md. The project had a number of critical requirements, including the installation of a dedicated HVAC system, the raising of ceilings to accommodate large video screens, and minimal interruption of existing services and daily operations.

A detailed field survey was conducted to verify the routing and location of all existing utilities. Some of the utilities, such as domestic water and sanitary piping, are to remain in place, while others, such as supply and return ductwork and large electric and local-area-network conduits, are to be relocated to accommodate architectural renovations. The sprinkler piping, chilled water, and heating water are to be extended and connected to the new HVAC equipment.

The project was a great candidate for 3-D modeling because of the significant number of utilities (plumbing, chilled and hot water, laboratory services, ductwork) in a small area, as well as the extensive nature of the renovation. The design team was able to do basic project planning, such as perform preliminary calculations, develop conceptual layouts, and make major decisions regarding system selection, while the 3-D imaging was being prepared. This accelerated the design process by at least several weeks.

The laser-mapping process needs to be incorporated at the onset of a BIM project. For the NIH renovation:

1) A third party specializing in the use of laser-mapping equipment—TransCon Imaging Solutions—was brought in. Multiple scans were taken to identify the various utilities, which were stacked above one another. These scans were combined to create an accurate 3-D representation of the space. This part of the project, including setup, scan, and travel time, took less than a day. The more compact the utilities (and, of course, the larger the area), the greater the number of required scans.

2) Once the laser scan was completed, the data was sent to the design team and converted using BIM software. WSA cut sections through the point clouds and built all of the piping, ductwork, and equipment components. This took about three days.

3) The basic BIM product was delivered to the engineering team. RMF's first task was to check the alignment of all of the images and make adjustments as needed.

4) Once the building information model displayed all existing conditions accurately, a follow-up field survey was conducted. The team identified the type of utility associated with each image in the point cloud, as well as properties of the utilities, such as type of piping and whether the piping was insulated. The follow-up survey was essential to addressing questions that could not be answered by the building information model.

The time spent developing a dimensional layout and routing all of the utilities was greatly reduced.

Without the use of 3-D imaging through laser mapping, the field portion of the project would have taken approximately two weeks. Instead, it took only about three days. Not only did laser mapping save time in the field, it saved time in creation of the model and increased the accuracy of the final documents. This saved both architectural and engineering time and helped to enhance coordination between the architecture and engineering teams. Because of the size, time frame, and complexities of the project, the use of 3-D laser mapping was well worth the expense.

Although construction on the NIH project has yet to begin, the information about the existing utilities obtained from the 3-D model is expected to help the construction team to avoid time delays and cost overruns attributed to existing conditions. This is especially critical with a client that, like NIH, wants to minimize downtime and remain operational throughout renovation.

Conclusion

As with all emerging technologies, as 3-D laser mapping becomes more refined and costs are reduced, use and effectiveness will increase. As the technology evolves, it will become another tool design professionals use to improve the quality of delivered products and increase efficiency.

Did you find this article useful? Send comments and suggestions to Executive Editor Scott Arnold at scott.arnold@penton.com.

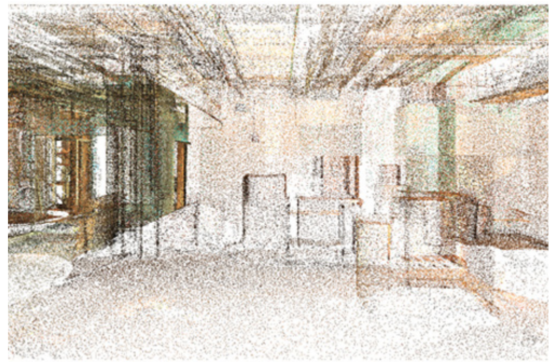
HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING

May 5, 2014 // **NEWS**

Laser Mapping and Building Information Modeling (BIM)

Using 3-D imaging to survey conditions within buildings

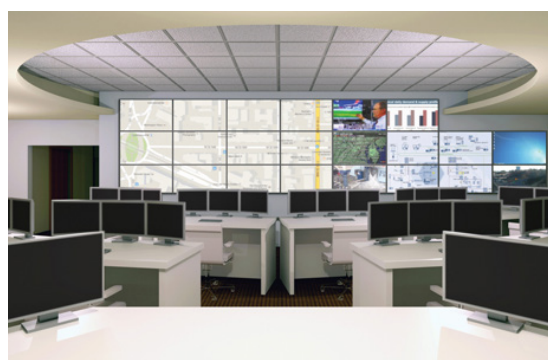
By STEFAN DOMBY, PE, LEED AP, RMF Engineering Inc., Baltimore, Md., and MIKE MORGAN, AIA, Waldon Studio Architects, Columbia, Md.



This point cloud from a laser scan was used to create a detailed survey of existing conditions.

While we may not realize it, 3-D imaging is part of our daily lives. Every time we access Google Maps for directions to a new destination, for example, we are employing 3-D imaging. This same technology—or a variation of it, laser mapping—is now available for use by architects and engineers for surveying building conditions and exterior elevations, which then can be integrated into building information models.

Building information modeling (BIM) is used to cultivate and foster a client's vision. With laser mapping, the effectiveness of BIM can be enhanced. Benefits of laser mapping include expedition of a design team's efforts, field-investigation time savings, increased accuracy of field data with definition of actual location, reduced safety risk (personnel do not have to climb ladders or reach around equipment), and further development of client electronic files of existing conditions. One of the most significant benefits is that engineers can spend their time more effectively, addressing actual engineering issues, rather than drafting issues. Yet despite these advantages, many design professionals shy away from laser mapping because of a lack of understanding of what it is and how to incorporate it into a project.



This 3-D model represents what the space will look like when work is complete. The laser scan helped the design team to determine ceiling heights and floor-plan constraints.

With 3-D laser mapping, laser beams rapidly scan the shapes of objects, and the time for the beams to travel to each point on the objects is calculated. From this scan, point clouds—data points that each are given an "X," "Y," and "Z" coordinate—are developed. The more beams projected in a given area and time frame (density), the more defined an image will be, resulting in a better end product. Density can be varied based on how detailed the survey needs to be, along with how many target points are used. Density and number of target points correlate directly to the cost of a scan. The use of 3-D laser mapping, along with increased computer power, is making imaging technology more effective, more precise, and more usable across platforms.

Key Factors

The million-dollar question is how do you know if a BIM project is a good candidate for laser mapping. Key considerations are:

- **Requirements.** Has the owner or agency operating the building requested 3-D mapping? Increasingly, 3-D modeling is being required, especially by government agencies that have to maintain and operate buildings over many decades while administrating renovation projects. For many government buildings, CAD drawings are lacking, which makes identifying areas during the troubleshooting and concept phases difficult. In such situations, 3-D mapping can be particularly useful.

- **Time and cost.** What is the opportunity cost of not using 3-D laser mapping? When you consider the time it takes experienced designers to verify and document all existing conditions, especially with multiple utilities in a condensed area, 3-D modeling becomes much more cost-effective. The use of laser mapping frees up resources for valuable tasks, such as preparing preliminary calculations and developing conceptual layouts, and it expedites coordination of disciplines. Manipulation of a building information model to test-fit various design scenarios is paramount to productivity and quick client turnaround. Whether a project is of considerable size or has been fast-tracked, the time and efficiency benefits of using 3-D modeling can outweigh the expense of the technology itself.

- **Product quality.** Will laser mapping lead to a better end product? If a renovation is extensive and there are potential conflicts with existing utilities, 3-D laser mapping can make the design more accurate while minimizing cost overruns and delays.

Case Study

RMF Engineering Inc. and Waldon Studio Architects (WSA) used 3-D imaging to design the renovation of a 2,500-sq-ft area in the basement of a building on the campus of the National Institutes of Health (NIH) in Bethesda, Md. The project had a number of critical requirements, including the installation of a dedicated HVAC system, the raising of ceilings to accommodate large video screens, and minimal interruption of existing services and daily operations.

A detailed field survey was conducted to verify the routing and location of all existing utilities. Some of the utilities, such as domestic water and sanitary piping, are to remain in place, while others, such as supply and return ductwork and large electric and local-area-network conduits, are to be relocated to accommodate architectural renovations. The sprinkler piping, chilled water, and heating water are to be extended and connected to the new HVAC equipment.

The project was a great candidate for 3-D modeling because of the significant number of utilities (plumbing, chilled and hot water, laboratory services, ductwork) in a small area, as well as the extensive nature of the renovation. The design team was able to do basic project planning, such as perform preliminary calculations, develop conceptual layouts, and make major decisions regarding system selection, while the 3-D imaging was being prepared. This accelerated the design process by at least several weeks.

The laser-mapping process needs to be incorporated at the onset of a BIM project. For the NIH renovation:

1) A third party specializing in the use of laser-mapping equipment—TransCon Imaging Solutions—was brought in. Multiple scans were taken to identify the various utilities, which were stacked above one another. These scans were combined to create an accurate 3-D representation of the space. This part of the project, including setup, scan, and travel time, took less than a day. The more compact the utilities (and, of course, the larger the area), the greater the number of required scans.

2) Once the laser scan was completed, the data was sent to the design team and converted using BIM software. WSA cut sections through the point clouds and built all of the piping, ductwork, and equipment components. This took about three days.

3) The basic BIM product was delivered to the engineering team. RMF's first task was to check the alignment of all of the images and make adjustments as needed.

4) Once the building information model displayed all existing conditions accurately, a follow-up field survey was conducted. The team identified the type of utility associated with each image in the point cloud, as well as properties of the utilities, such as type of piping and whether the piping was insulated. The follow-up survey was essential to addressing questions that could not be answered by the building information model.

The time spent developing a dimensional layout and routing all of the utilities was greatly reduced.

Without the use of 3-D imaging through laser mapping, the field portion of the project would have taken approximately two weeks. Instead, it took only about three days. Not only did laser mapping save time in the field, it saved time in creation of the model and increased the accuracy of the final documents. This saved both architectural and engineering time and helped to enhance coordination between the architecture and engineering teams. Because of the size, time frame, and complexities of the project, the use of 3-D laser mapping was well worth the expense.

Although construction on the NIH project has yet to begin, the information about the existing utilities obtained from the 3-D model is expected to help the construction team to avoid time delays and cost overruns attributed to existing conditions. This is especially critical with a client that, like NIH, wants to minimize downtime and remain operational throughout renovation.

Conclusion

As with all emerging technologies, as 3-D laser mapping becomes more refined and costs are reduced, use and effectiveness will increase. As the technology evolves, it will become another tool design professionals use to improve the quality of delivered products and increase efficiency.

An associate with RMF Engineering Inc., Stefan Domby, PE, LEED AP, has significant experience in the design and analysis of mechanical systems serving health-care, laboratory, institutional, federal, and industrial facilities. He routinely uses computer-modeling techniques to support his analysis and design of hydronic and process piping systems. His other areas of expertise include energy-system-performance modeling, chilled-water-distribution-system analysis, and engineering economic analysis. Mike Morgan, AIA, is a vice president of Waldon Studio Architects. As an architect and general design-build contractor, he has provided turnkey solutions affecting more than 400,000 sq ft and 2,000 people for projects totaling $13 million in design, renovation, and relocation services. His projects require strong team- and consensus-building skills and an ability to deliver practical, high-quality design solutions within strict budget and time constraints.

building OPERATING management

May 5, 2014 // **NEWS**

FIre Alarm Testing

By James L. Wise, Jr.

Part 1: Why Test New Fire Alarm Systems?

During my 42-year career as a design engineer I have tested hundreds of fire alarm systems — and only a handful of these systems were found to be fully functional as installed and ready to go at the time of the testing.

Fire alarm systems are supposed to be certified by the installer to be 100 percent complete per plans and specifications, fully functional, and ready for use prior to the building being issued an occupancy permit. Yet a lot of building permits are issued based upon random testing or a system printout indicating that all devices are functioning rather than a thorough examination.

Let's face it: Design professionals are not infallible. Nor are the fire alarm system manufacturers, the installing contractors, the building owners, or the Authority Having Jurisdiction (AHJ). We all make mistakes because we're human and products sometimes fail because, well, they are designed, manufactured, and installed by humans. But that's all the more reason for building owners and operators to ensure a thorough test of fire alarm systems is performed. Especially knowing that most fire codes have been created as a result of a fire disaster where the loss of human life has occurred.

Above all, the design engineer of record, the AHJ, and the building owner are charged with the primary responsibility of protecting the welfare and safety of the public while they occupy the building. This responsibility should always be paramount when designing, constructing, testing, and maintaining a fire alarm system.

The journey of designing, installing and commissioning a fire alarm system follows a path that is governed by numerous codes on the national, state, and local levels. Since those codes are minimum requirements, the designer, and the building owner must determine how far to go beyond the minimum requirements, if at all. Along this design path there are code and budget issues to resolve, changes to the building structure, as well as the HVAC systems that all affect the system design. Larger scale projects of 100,000-gross-square-feet present the design engineer with a monumental challenge to keep abreast of all changes to the building and building systems in order to keep the fire alarm system code-compliant. The simple addition of a firewall during design or construction can trigger massive changes to the fire alarm system, as well as other systems.

Fire alarm systems have come a long way since the first 'fire detector' was introduced in 1863 by Alexander Ross. The evolution to today's fire alarm systems has also increased the complexity of the systems. The majority of fire alarm systems installed for today's buildings are of the addressable type. Each heat and smoke detector communicates its status to the fire alarm control panel over a wired network cable. The fire alarm control panel then makes decisions as to what, if any, action needs be initiated such as sounding the general alarm, notifying the monitoring service, shutting down HVAC units and closing associated smoke dampers, initiating smoke removal systems, releasing smoke doors, etc. These systems consist of hundreds, if not thousands, of components when you consider all of the circuit board components within the fire alarm control panel, as well as the addressable device components. Microprocessors alone can contain thousands of components.

Part 2: Testing New Fire Alarm Systems Can Reveal Serious Problems

The following are real-life examples of when thorough testing of new fire alarm systems was crucial to a building and its occupants because the test revealed serious problems.

Case I (Contractor): A contractor installing an addressable fire alarm system for a university residence hall project notified the design engineering firm that the system was ready to have the engineer come out and test the system; they even signed and submitted the NFPA 72 Inspection and Testing Form for review. The first tamper switch tested was incorrectly wired. The fire alarm control panel did not show or sound a “trouble” alarm when this valve was closed, but when opened it sounded the “trouble” alarm. A review of the junction box showed that the wires had been reversed. As the testing progressed, more installation mistakes were discovered and the testing was subsequently halted. The contractor was instructed to go back and test every device and reschedule the engineer’s test. About a week later the system was re-tested and, aside from a few minor non-functional items, everything performed as designed. Without the thorough examination, the fire alarm system would have been in place, but completely unfit to work properly.

Case II (Local AHJ). An addressable fire alarm system was designed for a 107,000-gross-square-foot, four-story building that was being renovated into a college classroom building. Before the engineering firm could have the system tested by the installing contractor, the city fire department performed its fire alarm test of the system and gave its approval by issuing the occupancy permit. The installing contractor did not want to repeat the test for the engineer. After convincing the contractor to test the system, it was discovered that none of the smoke damper power circuits had been connected to the fire alarm system; thus, all dampers were energized and in the open position regardless of that damper’s duct-detector status. When test smoke was injected into the HVAC ducts to test the operation of duct detectors, thick smoke was dispersed throughout the floor that was being tested. So here was a system where the local AHJ didn’t review the plans and didn’t know about the dampers, so none of the dampers were tested. Yet the contractor was ready to turn the system over to the owner. Imagine what could have happened if a catastrophic fire had occurred and all the dampers were in the open position permitting the smoke to pass through the HVAC system.

Case III (Engineer). For a new 105,000-gross-square-foot, three-story college classroom/laboratory building, an addressable fire alarm system was designed. The engineering firm had painstakingly coordinated the locations of the smoke detectors with the lights and HVAC diffusers in the corridors, being sure to maintain proper spacing from device to device and from the ends of the corridors. However, while performing the final testing with the contractor, engineers discovered several vaulted ceilings in the main building lobby that were separated by bulkheads that dropped down, creating “beam pockets.” These “beam pockets” would contribute greatly in slowing down the ceiling jet as it traveled across the ceiling to a point where a delayed detection would occur from any detectors in adjacent areas. Detectors had to be added to these “beam pocket” areas in order to be code-compliant. Had the engineers not gone through the testing procedures, the architectural changes to the ceiling plans would have gone unnoticed, and the fire alarm system would not have been in compliance.

The point of the three cases presented is that we can all make mistakes. In Case I, the contractor certified the system to function correctly even though system devices were wired incorrectly. In Case II, the AHJ wasn’t aware of the smoke dampers that should have been connected to the fire alarm system and signed off on the system. In Case III, the engineer completed the design only to discover in the field that additional devices had to be added to achieve complete detection coverage in the lobby. Again, we’re not infallible.

Part 3: Nine Reasons Building Owners Should Have New Fire Alarm Systems Tested

Understanding that fire alarms are life safety systems, it is important to make their effectiveness a chief concern for all building operators. There are at least nine good reasons building owners should have new fire alarm systems tested. Cost, inconvenience, and lack of time or knowledge are common but unacceptable reasons to not thoroughly test your fire alarms — and the responsibility to do so lies with everyone.

Professional engineers and designers should make every effort to have a trained and competent person thoroughly test every new fire alarm system that they design. This would be over and above any testing performed by the system installer. Building owners should also make it mandatory that the fire alarm system be tested by the engineer of record. This includes every device in the building along with the automatic notification to the monitoring service if used. When finished, the engineer of record should issue a comprehensive record of the testing to the owner, contractor, and local AHJ. This also serves as a valuable record in the event you find yourself having to defend the design in a court of law.

So how can a thorough fire alarm test positively impact your building?

1. It will save lives. According to the National Fire Protection Associations (NFPA), most fire deaths are not caused by burns, but by smoke inhalation. Often smoke incapacitates so quickly that people are overcome and can't make it to an otherwise accessible exit. Fire alarm and detection systems are designed and installed to detect and warn the occupants of a building during the incipient stage of the fire. A system that is designed and installed correctly provides adequate time for the occupants to safely evacuate a building and to alert local first responders to the impending danger.

2. Proper testing assures you that the fire alarm system is operating at optimum performance and the integrity of the system has not been compromised during or subsequent to the installation.

3. Conducting initial system tests helps verify that the installation complies with the design documents and meets all the applicable requirements found in NFPA 72 and any other applicable codes or standards. In addition, the initial testing will verify that every portion of the system operates in accordance with the detailed sequence of operation.

4. Early detection plays a significant role in protecting the safety of emergency response personnel. Most alarm systems provide information to emergency responders on the location of the fire, speeding up the fire control process.

5. Property loss can be reduced and downtime for the companies located in the building can be minimized through early detection because control efforts are started while the fire is still small.

6. The most stringent standards and guidelines are meaningless unless the system has actually been proven to perform as designed.

7. Proper testing prevents false alarms and associated costs when fire trucks are unnecessarily dispatched to the building.

8. Without proper testing, the engineer of record cannot attest to or document with any certainty what state the fire alarm system was in at the time the system was turned over to the owner.

9. The engineer of record could be open to professional negligence in some states if they do not review or certify that the fire alarm system was installed to meet the plans and specifications. The building owner can also be held negligent if proper testing was not performed and documented.

Testing guidelines need to be tailored to individual project requirements and as the project grows, so does the complexity of the testing requirements. Experienced design professionals should be engaged to develop the testing guidelines and witness testing as it occurs.

James (Jim) Wise is an electrical engineer and associate at RMF Engineering, Raleigh, N.C. He has more 42 years of experience designing electrical systems. His design specialties include emergency power generation, uninterruptible power supply systems, fire alarm systems, and power distribution for various facilities and campus environments. He can be reached at jim.wise@rmf.com.

FACILITIES manager

April 30, 2014 // **NEWS**

APPA Leadership in Educational Facilities

Business Partner Whitepaper Series

Wake Forest University – An Investment Renewed

By Gregory A. Carnathan, PE, CEM, LEED AP
Mechanical Project Manager / Associate at RMF Engineering

RMF Engineering
Reliability. Efficiency. Integrity.

Business Partner Whitepaper Series

Published by APPA
1643 Prince Street
Alexandria, Virginia 22314-2818
www.appa.org

APPA is the association of choice serving educational facilities professionals. APPA's mission is to support educational excellence with quality leadership and professional management through education, research, and recognition.

APPA's Business Partner Whitepaper Series highlights the wealth of knowledge, experience, and expertise of our Business Partner members through case studies, research reports, product development, and industry insights. The whitepapers in this series are provided by the Business Partner firm and edited and produced by APPA staff. For more information, contact Steve Glazner at steve@appa.org.

In 1956, Wake Forest University moved from the town of Wake Forest, North Carolina, to a spacious campus in Winston-Salem (Figure 1).

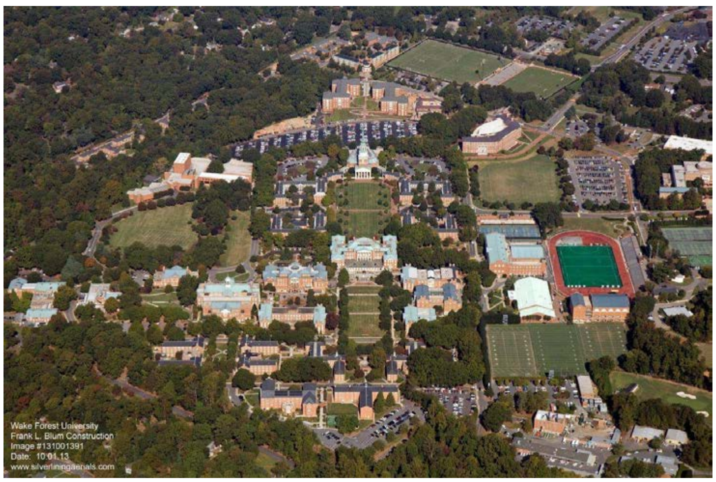


Figure 1 – Wake Forest University as viewed from the air in Winston-Salem, NC.

One of our engineers discovered the hard way that the University had relocated after driving to the town of Wake Forest for a kick-off meeting only to find the university was over 100 miles away. The move to Winston-Salem, with all its perks, supported their vision for growth, and allowed them to build an entire university from scratch on a greenfield property. They wisely made a long-term investment in a robust central steam plant (Figure 2) with a 1.5 mile looped, walkable, tunnel system. The return on their investment has been tremendous. For 60 years, the steam plant has reliably and efficiently met campus heating demand.

Figure 2 – The Central Steam Plant was constructed in the 1950s and has provided 60 years of reliable steam service to campus. Operators take great pride in the plant and have kept the facility spotless since it opened.

First signs of required upgrades came, as expected, in the condensate system. From 1997 to 2010, WFU and RMF Engineering partnered to replace the entire condensate system one section at a time. However, even after 60 years, the steam lines are still in great shape, a testament to a good chemical treatment program and a dry tunnel system.

Until the winter of 2013, steam for the campus was generated by two original 50,000 PPH Erie City Iron-Works boilers. Boilers 1 and 2 are large vertical water-tube, neutral draft units and in 1998, the boilers were converted from coal to gas/oil fuels and given modernized controls and feed water economizers. However, most of the other plant sub-systems, including the dearerator and condensate tanks, were still original.
With aging plant equipment and 500,000 square feet of new growth projected for the campus over the next five years, WFU began planning for the next 60 years.

The university partnered with RMF Engineering Inc. to develop the scope and design, and administrate the construction of the infrastructure project. The engineering tasks included master planning and energy analysis, along with mechanical, electrical, and structural engineering. Architectural work was completed by BBH Design in Charlotte. The key project goals included reduced emissions, higher energy efficiency, increased capacity, and improved reliability.

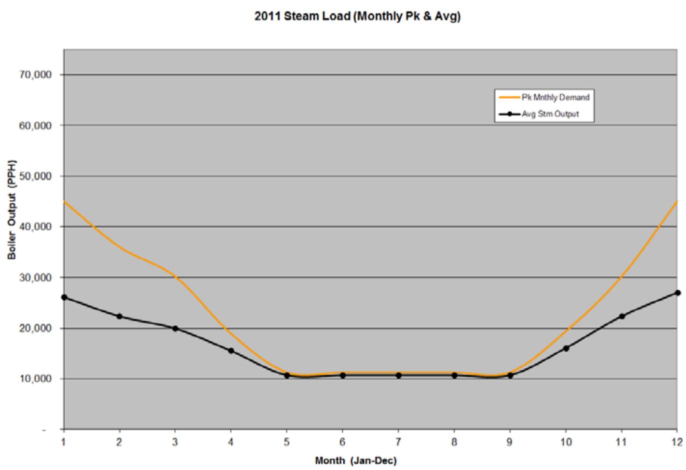


Figure 3 – Understanding campus steam demand on an annual basis is critical for optimal equipment sizing.

RMF began the advanced planning process by evaluating the steam loads and the new boiler selection. A load profile was developed for year 2011, and then projected for five year and full campus build-out. The 2011 peak steam load was estimated to be 45,000pph with summer and shoulder season loads ranging from 6,000-10,000pph (Figure 3).

With this data in hand, it was clear that Boilers 1 and 2 were operating below their ideal firing range for most of the calendar year. The five year projection boosted peak loads to 65,000pph and future full build-out peak load was modeled at 90,000pph (Figure 4). While peak loads would increase substantially over time, very little summer and shoulder season load was anticipated.

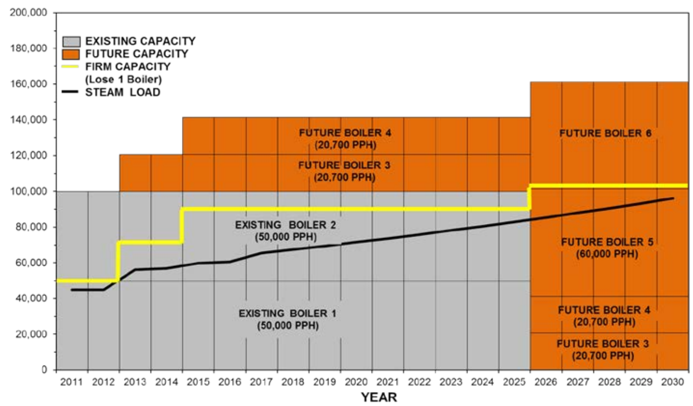


Figure 4 – New boiler design capacities were aligned strategically with both present and future campus steam load demands.

The next task was to select a boiler that could provide firm capacity (n+1) to accommodate the increased peak load and at the same time function optimally during low to moderate load conditions. While the initial temptation was to follow an older campus master plan strategy to add another 50,000pph boiler to the plant, the team determined that a smaller incrementally sized boiler would be a more ideal solution. After various boiler options vetted extensively, two 20,700pph (600 BHP) fire-tube boilers were selected for the application. One unit would be installed in 2013, while the second would be installed in a later project phase.

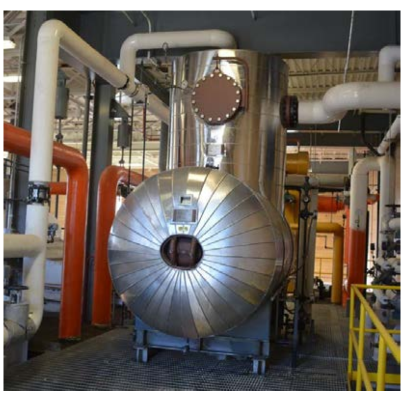


Figure 5 – Out with the old and in with the new. After cutting a large opening in the plant roof, existing coal scales were removed and a new 95,000lb/hr dearerator was installed. A dearerator is used to mechanically remove corrosive oxygen from condensate saving both water and chemicals.

Next the team focused on the renewal of key plant subsystems by completing a high level capacity and failure analysis for each system. To bolster plant auxiliary system reliability, a new full sized dearerator (Figure 5), condensate surge tank (Figure 6), condensate pumps, and feed water pump were added to the design. In order to maintain reliable working order of each redundant subsystem, customized wet-layup and operational techniques were developed. The offline dearerator would be kept warm using flash steam recovered from the plants high pressure drip stations. Both condensate tanks would be kept in service at all times using a piped equalizer connection and staged control of make-up water systems.

Figure 6 – A new condensate tank and pump set normally work in parallel with the original condensate system yet the older receiver to be taken off line for inspection and maintenance while the plant remains in operation.

Using a smaller incremental boiler size also freed up capital from the project budget to provide additional energy enhancements within the original project budget. Various energy conservation measures were modeled and evaluated using life-cycle cost economics (Figure 7). Fuel and steam records indicated that the existing plant had been operating at 78 percent fuel to steam efficiency on an annual basis, while the new boiler and selected energy upgrades would allow the plant to operate at 85 percent overall efficiency. Chosen options included fully metered combustion controls with oxygen trim, flash steam recovery, continuous blow-down heat exchanger and an innovative flue gas heat recovery system.

ENERGY CONSERVATION MEASURES
WAKE FOREST UNIVERSITY - BOILER ADDITION

OPTION NO.	DESCRIPTION	ANNUAL ENERGY DATA: INSTALLATION COST ($)	ANNUAL ENERGY DATA: PLANT FUEL TO STEAM EFFICIENCY (%)	LCCA ECONOMIC METRICS: SIMPLE PAYBACK (YRS)	LCCA ECONOMIC METRICS: FIRST YEAR ROI (%)
	EXISTING PLANT		77.8%	---	----
BASE	2x 600 BHP FIRETUBE BOILERS (N+1) [41,400 PPH]	BASE	81.7%	---	----
1	TRADITIONAL FEED WATER ECONOMIZER	$114,814	84.0%	3.8	26.2%
2	FW ECONOMIZER AND CBD HEAT EXCHANGER	$204,874	84.5%	5.3	19.0%
3	CBD HX AND CBW FEEDWATER AND MAKEUP WATER ECONOMIZERS	$281,157	85.5%	5.4	18.4%
4	CBD HX AND DCI FEEDWATER AND CONDENSATE ECONOMIZERS	$800,160	85.8%	14.2	7.1%

Figure 7 – Energy conservation was a major project goal. Energy conservation measures developed then modeled using a life-cycle type net-present value analysis.

Design of the heat recovery system began with an evaluation of potential in-plant heat sinks. Options to pre-heat condensate return and softened make-up water were reviewed. Analysis of plant condensate revealed that the consistent 190F temperature was outside the upper temperature boundary for pre-heating with flue gas. While a smaller flow volume, the lowest temperature heat sink at the WFU plant was softened water make-up. Pre-heating plant make-up water proved ideal for this application since supply temperatures were typically less than 70F.

The selected twin-circuit heat recovery system utilizes 350F flue gas from the new boiler and discharges it to the atmosphere at as low as 180F through a double-wall stainless steel stack. Flue gas first passes through a carbon steel feed water heat exchanger, followed by a stainless steel make-up water condensing heat exchanger. Both economizers are indirect-circuit type, meaning that the flue gas does not come into physical contact with feed water or make-up water (Figures 8 and 9).

Figure 8 – Boiler three occupies a slot in the plant originally designed for a unit more than three times its size. The new boiler is a perfect fit to add capacity and improve plant efficiency.

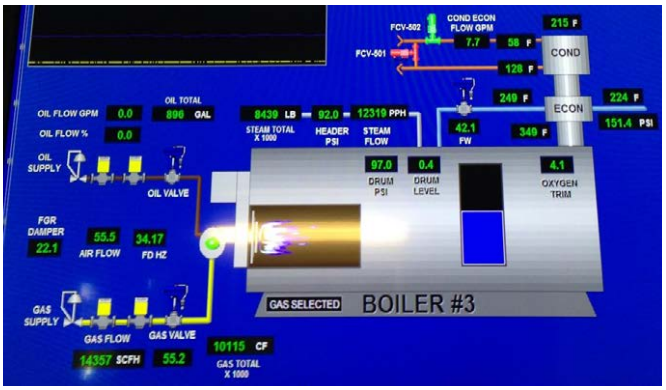


Figure 9 – A graphic of boiler 3 in operation illustrates the heat recovery system heating plant make-up water from 58F to 128F using flue gas energy that would otherwise be sent straight to the atmosphere.

Boosted by energy recovery, boiler 3's rated fuel to steam efficiency could be as high as 90 percent. Boiler 3 and its associated heat recovery system have been operational for several months and are performing well on natural gas relative to older plant boilers. For the month of December 2013, the new boiler averaged 86 percent fuel to steam efficiency while the existing boilers averaged only 75 percent (Figure 10).

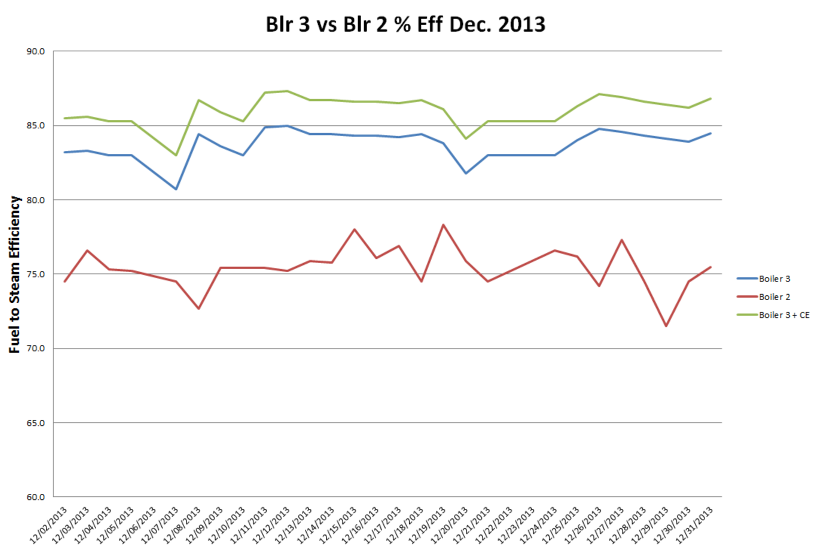


Figure 10 – In its first real efficiency test, boiler 3 passed with flying colors. The new unit averaged 86% operating efficiency while existing boiler 2 managed only 75% over the same time period.

Repurposed space in the boiler plant was utilized for a new centralized control room (Figure 11). This room will be the WFU engineering equivalent of NASA's "Mission Control." The room houses operator work stations, boiler plant controllers, variable speed drives, and several large control monitors. The control room also boasts large windows and a clear line of site to the boilers. When training is completed, plant operators will be able to continuously monitor boiler plant, chiller plant, and building operations. Centralized monitoring has allowed WFU operations and maintenance staff to be more proactive in response to hot and cold calls and ultimately provide better service to its users.

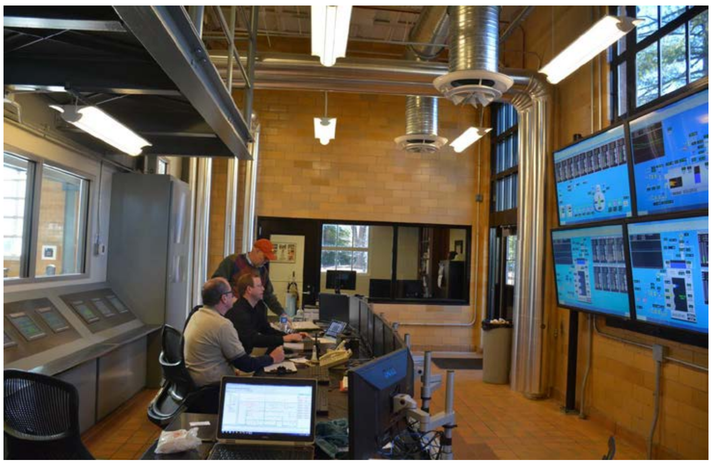


Figure 11 – Dubbed "Mission Control," the new Utilities Operations Center allows to continuously monitor boiler plant, chiller plant, and building operations. Assistant utility director Ed Bullington and plant supervisor Jimmy Nifong keep a close watch on campus.

Conclusion

The WFU central steam plant has been effectively renewed for many years of reliable service to the campus, while the addition of a highly efficient boiler and heat recovery system will substantially reduce annual fuel costs. Redundant plant subsystems bolster plant reliability and allow for an abbreviated annual shut-down period. Campus maintenance has also taken a step towards the future with the new Utilities Operations Center. Based on this investment in campus heating, the university is poised to better accomplish its mission in the future.

Greg Carnathan is a mechanical engineer and project manager at RMF Engineering with extensive experience in the design and analysis of central chilled water, steam and heating water systems in various campus environments. His responsibilities regularly include project management, system selection, multi-discipline coordination, specifications, cost estimating, life-cycle cost analysis, existing conditions surveys, and construction administration and steam/chilled water master planning. He can be reached at greg.carnathan@rmf.com.

April 30, 2014 // **FACILITIES MANAGER *INSIDE* APPA NEWSLETTER**

Greg Carnathan's white paper on Wake Forest University was issued in Facilities Manager's Inside Appa newsletter.

HOME PAGE

Inside APPA

LEADERSHIP IN EDUCATIONAL FACILITIES

April 30, 2014
Vol. 14, No. 9

Welcome to *Inside APPA*, your biweekly electronic news source for regional and international APPA events, programs, publications, and industry information.

Questions? Comments? News?
Contact Steve Glazner, Editor
Visit APPA's Virtual Membership Directory
Read Inside APPA archives

CONNECT WITH US:

APPA Events

May 22, 2014
APPA Facilities Drive-In Workshop (spons. by 3M)
East Lansing, MI (Michigan State University)

Jun 24, 2014
APPA Facilities Drive-In Workshop (spons. by Tandus-Centiva)
Lexington, VA (Virginia Military Institute)

Jun 25, 2014
APPA Facilities Drive-In Workshop (spons. by Armstrong International)
Lexington, VA (Virginia Military Institute)

Jul 10, 2014
Credentialing Prep Course (CEFP & EFP)
Richmond, KY (Eastern Kentucky U)

Jul 20, 2014
APPA Senior Facilities Officers (SFO) Summit
San Diego, CA

Jul 20, 2014
APPA Emerging Professionals (EP) Summit
San Diego, CA

Jul 21-23, 2014
APPA 2014: Centennial

CONTENTS

BUSINESS PARTNER WHITEPAPER SERIES

RMF Engineering
Reliability. Efficiency. Integrity.

Wake Forest University – An Investment Renewed

By RMF Engineering

The Wake Forest Central Steam Plant was constructed in the 1950s and has provided 60 years of reliable steam service to campus. Until the winter of 2013, steam for the campus was generated by two original 50,000 PPH Erie City Iron-Works boilers. With aging plant equipment and 500,000 square feet of new growth projected for the campus over the next five years, WFU began planning for the next 60 years. The university partnered with RMF Engineering Inc. to develop the scope and design, and administrate the construction of the infrastructure project to renew the central steam plant. The key project goals included reduced emissions, higher energy efficiency, increased capacity, and improved reliability. Based on their investment in campus heating, the university is poised to better accomplish its mission in the future. Read the full success story in this whitepaper.

April 23, 2013 // **NEWS**

Ten Considerations for Conducting a Health Care Facility Assessment

Whether health facilities professionals are assessing their hospitals themselves or employing assessment professionals, they must carefully consider the type of examinations required to determine the goals and strategies of any upgrades.

A discussion of the areas covered in an assessment of an existing facility will help health facilities managers, owners and consultants become more comfortable defining the correct approach to take with their facilities.

A healthy indoor environment within an operating room can only be guaranteed if it is verified.

Top considerations

In general, a health care facility assessment will look at 10 key areas to determine the overall condition of the structure:

1. Building construction. A health care facility's envelope greatly influences its indoor environment and impacts the scale of the HVAC system's operation. The building life expectancy depends on the condition of the structure and the envelope as well as other major building components. The age and location of the building will help determine the original building codes, which may have influenced the materials used in construction and envelope characteristics.

Researching the building construction will point out things to look for during assessments. Does the building need asbestos abatement? Do single-pane windows and a loose envelope cause excessive infiltration? Does the local climate warrant a check for humidity issues such as mold and water damage? What free space does the building have? An evaluation of ceiling heights and respective plenum heights will help determine if the building has adequate room to support additional ductwork, piping and other utilities. Similarly, an assessment of utility shafts and closets will help identify future upgrade limitations.

2. Indoor environment. Studying the indoor environment of a health care facility is an essential part of any assessment effort. During initial site visits, facilities professionals should spend some time getting to know the building using sight, sound and smell. Their physical senses often will allow them to identify areas with problematic conditions, which then can be more precisely tracked. For example, data loggers can be used to track temperature, humidity, noise and lighting levels.

Visual cues include observing lighting levels from space to space, available daylight, open or occupant-controlled windows and things that may seem out of place. Discoloration on air devices and the surrounding ceiling tiles may be a clear sign of dirty or missing filters. Air diffusers that are noticeably loud or unusually ramping up and down could indicate local or systemwide control or mechanical issues. Odors may indicate either inadequate ventilation or sources of contamination. Noticeable variation in odors from space to space also may be an indication of improper zone pressurization.

Ultimately, proper testing equipment should be used to verify assumptions, including data loggers, humidity meters and perhaps even indoor air quality (IAQ) meters. Verifying that relative humidity is controlled is crucial in a health care setting. Humidity and temperature changes between spaces that are drastic or outside the normal range could adversely affect patient comfort and infection control.

3. Noise. Proper noise control is critical to support a healing environment. Thus, it is important to locate the primary sources of noise within the health care facility. Typical sources of noise may include above-ceiling utilities, major equipment rooms, procedural areas and rooftop or exterior equipment or processes.

An original project design or application may have adequately accounted for noise and appropriate attenuation. However, variations in equipment and system performances, together with reprogrammed use of spaces over time, may create noise issue that did not originally exist. Patient and treatment rooms must be protected from adversarial noise impacts to the best extent possible. Similarly, new or recent noise complaints can be used to focus assessment attention and approach strategies.

4. Infection control. Each health care facility has guidelines for infection control to which the assessment professional must adhere. This will frequently require more time to carry out assessments than anticipated. For example, infection control risk assessment (ICRA) training is sometimes required when working within a facility. When work is performed within an occupied space, special enclosures may be required, such as ICRA carts. To minimize the exposure of dust and other contaminants to finished or occupied spaces, facilities professionals should ensure tacky mats are used and changed as necessary.

Gearing up for work in an operating room may require special attire and even infection control risk assessment equipment.

To review IAQ, facilities professionals should check that minimum outdoor air quantities are met, appropriate filtration is in place, and that airflow measurement stations function and alarm as required. Building pressurization should maintain cascading airflows with respect to areas of contamination. On the room level, air balance should be reviewed for negative pressures in isolation rooms and positive pressures in clean rooms. The airflow terminal equipment serving pressurized rooms must not compromise the pressure of the room. For example, a terminal unit with an automatic calibration cycle that strokes the dampers wide open and closed at specific intervals would not be appropriate in a 24/7 occupied pressure room. Instead, auto-zero modules that poll the velocity sensors do not affect pressurization and, thus, do not jeopardize the clean environment.

5. Building automation system. The modern building automation system (BAS) in health care not only means maintaining a comfortable, clinical environment, but also one with proper security and access control, with effective energy management and built-in fail safes for life safety. The BAS also may control lighting, domestic water and elevators as well as the various specialty systems in health care, including nurse call and paging systems, medical gas and vacuum systems and clinical refrigeration.

Commissioning and retro-commissioning-type assessments will approach the BAS from a functional testing perspective, using the BAS in testing the operations and alarms of each piece of controlled equipment. A condition assessment or energy audit may involve the BAS for data acquisition and energy management metrics. No matter the type of assessment, it is important to analyze the capabilities of the BAS versus how it currently operates. For instance, do the graphics reflect the current floor plan and equipment layout of the facility? Also, is trend analysis currently being performed to optimize systems operations? Web-based monitoring may be available, and even app-based monitoring for smart devices in the field.

Information dashboards also are available to help facilitate effective facility management for energy usage and utility analytics, air systems and air terminal equipment operation, domestic water, hydronic systems and plant operation, normal power, emergency power and its fuel system. Also available are dashboards that display health care metrics that are relevant to all stakeholders.

6. Operations and maintenance. Health care facilities are especially vulnerable when operations and maintenance activities are outsourced, because they generally are held to higher standards than most other types of facilities. This, in turn, presents challenges to staff awareness, training or simply the lack of adequate on-hand staff to operate and maintain sophisticated mechanical-electrical-plumbing systems and equipment to the levels required by health care facilities. Large personnel budgets notwithstanding, the BAS and the equipment it serves must make up for staffing shortfalls through increased capabilities, including expanded operational alarms.

No matter the type of assessment, it is important to analyze the capabilities of the building automation system versus how it currently operates.

Facilities professionals should consider how assessment efforts can help bridge these gaps or even strengthen an established operations and maintenance program. They should offer suggestions to streamline preventive maintenance activities and filter change routines as well as assist in configuring automated control system capabilities and analyzing collected data to be proactive. Facilities professionals also should look for opportunities to highlight and assist with Joint Commission requirements.

7. Emergency power. A health care facility's emergency power system must be robust against any emergency. This includes the BAS and local control panels, which tell major equipment to restart after any power interruptions. Verification of the wiring or programming of alarms during an emergency is recommended. Along with emergency power and control for major equipment, health facilities professionals also should look for emergency power and battery backup for all automated equipment.

Functional testing should include real-life scenarios whenever possible. Initiating a partial loss of power or a full loss of power will demonstrate whether the power transfer timing is appropriately set for the emergency power services feeding equipment, life safety and critical components. Proper operation and interaction of all emergency power system components, such as automatic transfer switches, generators, fuel oil system, paralleling switchgear and annunciation systems, also can be validated.

When functionally testing an occupied health care facility, special precautions are necessary to minimize risk to patient safety. Testing the emergency power system in an occupied facility may require the fire marshal or authority having jurisdiction be present, as well as the owner, the commissioning authority, the equipment vendors, controls technicians, electricians and any other stakeholders that may help implement a contingency plan.

8. Life safety. Because evacuation of a health care facility often is impossible, the life safety systems are the occupants' defense against fire, smoke or other related emergencies. As a result, the HVAC systems within health care facilities often incorporate more fire and smoke dampers and associated control scenarios than most other facilities. Identifying location and access to these components is especially beneficial while analyzing system airflow dynamics and identifying unanticipated increases in static pressure.

The life safety control sequences should be thoroughly verified. Major equipment often is designed for run-to-destruct operation in a life safety mode, where operating sequences and safeties may need to be configured to account for patient safety first, regardless of mechanical or electrical system components. Often, operating sequences and packaged equipment safeties are configured for the opposite to protect the equipment first and at all costs. The equipment is expendable; human lives are not.

Understanding of the versatile nature of these critical care systems will show typical conventions for unit sizing and capacities may not necessarily apply. What components may initially appear to be oversized may actually be driven by the need for the equipment to run in a life safety application. For example, return fans that serve double-duty as smoke evacuation fans in a life safety sequence may need to be sized for the life safety duty, yet only operate routinely at some reduced capacity for HVAC.

9. Redundancy. Almost all health care facilities incorporate redundancy requirements for the mechanical and electrical systems that serve them. Often times, the approach is to incorporate 100 percent redundancy for critical equipment, where one standby piece of equipment operates when the normal unit is taken out of service. This routinely requires a duplication of efforts in assessing system operations, controls and safeties; each piece of equipment must be adequately reviewed.

Taking this a step further, health facilities professionals should look for opportunities that may allow redundancy to yield energy savings opportunities or offer potential for strategies not previously considered. For instance, they can determine whether a simple control adjustment to operate each component together under a part-load condition makes better sense than running a single unit at full capacity. Or, if equipment will soon need to be replaced, they can consider alternative equipment sizing and configurations. Additional units can be sequenced to come on-line only when the running units reach full load operation.

10. Resilience. Where current safety approaches are structured primarily to reduce or eliminate the number of things that go wrong, resilience aims to increase and improve the number of things that go right. While the big picture approach must certainly address potential vulnerabilities, such as locating outside air intakes and critical equipment away from areas at or below ground level, attention also must be given to what may be perceived as smaller-scale items, which are no less important to resiliency. This ties back to the earlier example of making sure that automated control systems and components serving equipment and systems on emergency power are provided with emergency or back-up power provisions themselves, or those systems likely will not perform as expected when required.

So when assessing and evaluating health care facilities, professionals should continually ask whether the entire facility is resilient — not just code requirements or the primary components, but all pieces needing to function together.

CONSULTING - SPECIFYING engineer

April 21, 2014 // **NEWS**

BIM Turns Back the Clock

BIM has turned back the clock on the design process by putting the design professional into a virtual construction site.

By Paul J. Orzewicz, PE, RMF Engineering, Baltimore

Paul J. Orzewicz is a mechanical engineer/project manager at RMF Engineering.

The introduction of 3-D drafting or building information modeling (BIM) is beginning to restore my faith in the engineered drawing. But let's start from the beginning. When I began in this industry the terms "triangle," "straight edge," "pencil sharpener," and "French curve" (you forgot that one, didn't you?) could be heard throughout the office every day of the week. But in the late 1980s, computer-aided design (CAD) programs were unleashed into the engineering world and the electronic designer was born. And terms like "mouse," "tablet," and "x-y coordinates" became the norm.

At first, we all loved the idea of drawing an object one time and having the ability to copy it or mirror it over and over with just a few clicks of the mouse. It saved us so much time and money that soon everyone had to have a computer on their desk. Our contract drawings were being completed in record time, project deadlines were being met, and more work was coming through the door. Life was good … or was it? Looking back now, we see that something was lost when we transitioned from hand-drafted plans to electronic-drafted files. In my opinion, designers lost the ability to look at a drawing and see beyond the cyan and magenta lines to determine what is really important.

As with all technology, new ideas emerge, advancements are made, and before you know it, the next big thing is here. And CAD was no different. There's only one logical advancement from 2-D CAD drawings, and that's 3-D models. That's right, they are no longer called "drawings," they are now "models." But don't fret—as we advance into the BIM universe, we are simultaneously stepping back to our old ways. With this latest advancement, BIM forces us to see our designs like never before. We now must input that third coordinate: the z coordinate, that third dimension that makes us look at our drawing as if we were the installing contractor. It puts us in the contractor's shoes, allowing us to see complex installations like never before.

So when the INOVA Health System made the decision to build the INOVA Cancer Center Research Institute (ICCRI) to put all its cancer treatment and research departments under one roof, I knew immediately that BIM was going the play an important role in the success of this project.

Bringing together critically advanced medicine and cancer treatment research departments was certainly going to be a challenge for the architecture and engineering team. But the use of BIM allowed all of us to work together simultaneously in a single model, generating close coordination between all disciplines early in the design process.

The project had to be broken out into a core/shell package along with a separate fit-out package. Each package was to be permitted separately. I had worked on similar projects in the past, but nothing as complicated as this one. Addressing permit review comments and making changes to the drawings, and ensuring that both packages were properly updated and coordinated, was a difficult challenge and very time-consuming. However, I quickly learned that BIM gave us the ability to make a change in the model and see that change seamlessly appear in both permit packages, saving us significant time and effort.

So even though BIM is taking the engineering world into the 21st century, it has also turned back the clock on the design process by putting design professionals into a virtual construction site, where we can now view our designs in a 3-D perspective, and think like the installing contractor to reduce conflicts and change orders during construction.

February 28, 2014 // **NEWS**

Beth Crutchfield - Achievements: February 2014

Member Beth Crutchfield has been named a partner of RMF Engineering, a mechanical and electrical engineering firm with headquarters in Baltimore. She will be overseeing the day-to-day operations of the company's office in Charleston, S.C., where she will work to expand its business in the southeastern United States.

Crutchfield is an electrical engineer and project manager specializing in the design and construction of institutional buildings and health care facilities.

She is a member of IEEE Women in Engineering.

DEPARTMENTS | LEED + DISTRICT ENERGY

Model Building

Tim Griffin, PE, LEED AP, IDEA USGBC Liaison

Editor's Note: *"LEED + District Energy" is a quarterly column providing information about the U.S. Green Building Council's LEED rating system and how it applies to buildings served by district energy systems.*

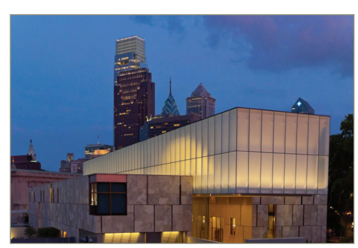
Were you one of those kids who liked to build models? I was! I built cars, planes, battleships, tall sailing ships, even the bridge of the starship *Enterprise*. Remember sitting on the porch because your mother did not want you smelling too much glue, spreading out the newspaper, painting miniature parts and following the instructions page by page as your creation slowly took shape? And not to forget my favorite part, putting on the decals at the end! Ah, the hours spent in quiet solitude working on these creations.

Alas, it is a new day. When my son was old enough, I went to the store excited to pick his first model upon which he too could spend hours of enjoyment. However, the long row of models in every toy section of department stores have gone the way of the fax machine. A relic of the past. It seems to have been replaced by the Xbox, iPad and on-demand videos. In a world with endless opportunities for entertainment, I guess there is no longer the need to dive into countless hours by oneself assembling intricate models, with no texting required. Sad. Seems something is being missed. I guess that is how our parents felt when we would spend the evenings watching television instead of reading a book.

VEOLIA ENERGY PHILADELPHIA

At last summer's annual IDEA conference, I was introduced to Elinor Haider, marketing director with Veolia Energy in Philadelphia. Her company was facing a problem common to district energy owners and operators across the world. Potential customers in the system's areas of operation were building new facilities with the intent of pursuing the U.S. Green Building Council's (USGBC's) LEED (Leadership in Energy and Environmental Design) certifications at various levels. Several LEED buildings were connected to Veolia's Philadelphia system already, such as the Barnes Foundation building and the Comcast Center, but new LEED applications were requiring more detailed information upfront. Prospective customers and their building designers needed to know how to account for the impact of Veolia Energy's district energy system in their LEED applications. More importantly, they needed to know if they could achieve more points toward their LEED certification goals by connecting into that system than they could by installing their own thermal energy systems.

This is a critical question that has a significant impact on a potential customer's decision. It is also not an easy question to answer as every district energy system is unique. In addition, the answer is going to greatly depend on the percentage of the proposed building's total energy that comes from district energy. This can vary greatly as, in general, buildings requiring significant amounts of outside air will use more energy in heating and cooling than buildings with low outside-air requirements. Customers want to know how many points their building



The new Barnes Foundation building in Philadelphia, a Veolia Energy customer, was awarded LEED Platinum certification in 2012.

Courtesy Veolia Energy Philadelphia.

can achieve if they tie into a district energy system. The answer is always, "It depends."

IT'S THE MODEL, STUPID!

I am always struck by how James Carville, the campaign director for Bill Clinton's 1992 presidential bid, turned a struggling campaign with a vague message around with the single message "It's the economy, stupid!" Most political campaigns struggle with a myriad of issues and get lost in what really matters. Carville recognized that the one clear issue concerning most Americans at the time in selecting a president was what the direct impact would be on their individual wallets. By redirecting the campaign to have a laser-like focus on the economy, Clinton's fortunes turned. So much so that he has been the only candidate to unseat a sitting president since 1980. Clinton's team relentlessly asked the question, Are you better off today than you were four years ago? In general, people felt they were not, and they voted accordingly. Four years later, as the economy had improved, the same campaign manager, focus and question helped keep Clinton in office for another four years.

For the past seven years, I have been working with IDEA to understand the direction of the LEED program as it relates to our industry and to ensure the treatment of district energy is both fair and reasonable. Like a political campaign, the issue is complicated and multifaceted. In LEED certification, there are three prerequisites that must be met and six credit categories where points can be achieved that are all impacted by the decision to tie into district energy. LEED considers issues such as your refrigerant type, how you measure and monitor your district energy equipment, commissioning, green power and renewables. However, after working with system owners and operators all over the world, I have come to the simple conclusion that in the vast majority of cases, "It's energy efficiency, stupid!"

Potential building customers, in considering whether to "vote" for tying into your district system or installing their own building thermal generation equipment, want to know which option will give them the most points when applying for LEED certification. With the rare exception of renewables (see my column in Third Quarter 2011 *District Energy*), the only factor with a significant impact on the decision comes down to energy efficiency. Therefore, the question is not how many points can be earned if the building connects to your district energy system. Rather, the question is, Will doing so earn more, fewer or the same number of points as installing standalone equipment? It really is a two-candidate race, and standalone equipment is your competition.

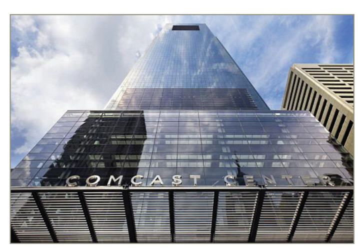
THE QUESTION IS, WILL CONNECTING TO YOUR DISTRICT ENERGY SYSTEM EARN MORE, FEWER OR THE SAME NUMBER OF POINTS AS INSTALLING STANDALONE EQUIPMENT?

A DIFFERENT KIND OF MODEL

A year ago, a colleague of mine, Dave Crutchfield, and I wrote an article on energy models for the Fourth Quarter 2012 issue of this magazine. In it, we described all that customers' building modelers must do to develop an building energy model that demonstrates to the USGBC how much more efficient their proposed buildings are than they would be if built to code-minimum energy efficiency guidelines, as outlined in the American Society of Heating, Refrigerating and Air-Conditioning Engineers' Standard 90.1. While the article described the information a building modeler requires from a district energy system owner, it also focused on putting those owners in the minds of building modelers so they could better understand what and why the information was needed and how it was being used.

Once the question that really matters to LEED-seeking district energy customers became clear to me, i.e., which option will give them the most LEED points, I realized a different kind of model is needed – one that will allow district energy system owners to compare their systems to a building customer's options. Although this model cannot specifically answer the question of how many points tying into your system will earn, it will clearly answer whether tying into your system will earn more, fewer or about the same number of points as putting in standalone systems. This puts owners and operators in a powerful negotiating position as they are armed with clear knowledge of what the competition can deliver. If their system provides more points than are possible with any other means of heating or cooling, that can be a strong marketing tool. If the comparison is a breakeven in terms of points, they can focus on marketing the many other benefits of tying into district energy. If they find that tying in provides fewer points than the alternative, they now have a tool to help identify what investments in their system can turn that around the fastest. In all three cases, district energy system owners are equipped with knowledge that is actionable.

Veolia Energy Philadelphia has assets of various age ranges. As is the case with most municipal district energy systems, some of its distribution systems are older and do not perform well in a LEED energy analysis. However, the company has a significant component of combined heat and power production within its facilities. CHP is one of the most energy-efficient means of generating electricity, and Veolia Energy's system does so at more than twice the normal power generating cycle efficiency. The USGBC recognizes this benefit and allows district energy systems to pass it on to building customers in terms of energy efficiency. The question for Veolia's Philadelphia system, which primarily sells steam, was how the benefit would apply to its customers and how would it compare to their option of installing an on-site boiler plant.



Veolia Energy customer Comcast Corp. earned LEED Gold certification in 2009 for the core and shell of its headquarters in downtown Philadelphia. The 58-story building is one of the tallest LEED-certified buildings in the U.S.

Courtesy Veolia Energy Philadelphia.

The model for Veolia Energy has three variables. They are the cost of natural gas, which is the company's primary CHP fuel; the cost of electricity; and the proposed efficiency of an on-site boiler plant with which they are competing. In the LEED analysis for CHP, a model must account for the cost of all of the input fuel, in this case natural gas, but gets to take credit for the costs of all of the electricity produced. So the lower the price of natural gas and the higher the price of electricity, the better Veolia does in the comparison.

Through the model, the company found that at today's current natural gas and electricity rates, even heating a facility with a 100 percent efficient on-site boiler plant could not earn as many points as the Philadelphia district energy system. This puts Veolia Energy in a strong marketing position, and the model gives the company a tool to demonstrate this result to potential customers and their designers. In addition, the model produced allowed the generation of a sensitivity analysis so Veolia could determine how much natural gas rates would have to increase, and/or electricity rates would have to decrease, before on-site boiler plants would be competitive.

A KID AGAIN

So, here I am building models again, just not around the aroma of cement glue. (Although my wife, kids and colleagues sometimes ask if I have been sniffing glue.) I can't wait to tell my parents that all of their investments in those modeling kits are paying dividends!

If your system does not have a model, you should consider having one built soon to determine where you stand with LEED, put the negotiating power back in your hands, prepare to answer customer inquiries and know where to invest your capital to improve your standing. As a district energy system owner, you will find this type of model is the best tool to address your system's impact on your customers' LEED applications.

Also, if you know where to find those cool car and ship modeling kits, let me know!

Tim Griffin, PE, LEED AP, is IDEA's liaison with the U.S. Green Building Council and serves on IDEA's board of directors. He is a principal and branch manager with RMF Engineering Inc., a firm specializing in district energy system planning, design and commissioning. A registered engineer and a LEED Accredited Professional, Griffin has a Bachelor of Science degree in mechanical engineering from North Carolina State University and a Master of Business Administration degree from Colorado State University. He authored the book *Winning With Millennials: How to Attract, Retain, and Empower Today's Generation of Design Professionals.* He may be reached at tgriffin@rmf.com.

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

December 31, 2013 // **NEWS**

In Case You Missed It: The Best of HPAC Engineering 2013

Craig Buck's article was also featured in "The Best of HPAC Engineering 2013" as one of the most-viewed pieces of content posted on HPAC.com for the year.

By Scott Arnold, HPAC Engineering

9. Chilled Beams in Health-Care Patient Rooms

Health-care patient-room design is dictated by rigid environmental and safety requirements, which severely limit the types of systems deemed suitable for HVAC. These requirements are evaluated continually, which, on occasion, opens the door to more progressive and lower-energy technologies. Such a time was 2011, when ASHRAE revised ANSI/ASHRAE/ASHE Standard 170-2008, Ventilation of Health Care Facilities, allowing the use of recirculating-type heating and cooling units within non-invasive areas of hospitals, Craig R. Buck, PE, LEED AP, HFDP, of RMF Engineering Inc. says in this November 2013 article.

GovCon Executive

December 30, 2013 // **NEWS**

RMF Engineering
Reliability. Efficiency. Integrity.

Craig Buck, Beth Crutchfield Join RMF Southeast Leadership Team

Craig Buck and Beth Crutchfield have been appointed to the leadership team at RMF Engineering's Charleston, S.C. office after helping develop the firm's practice there since the early 2000s.

They will help lead the office's day-to-day operations and expansion efforts in the southeast market, as well as oversee service offerings in their fields, RMF said Nov. 26.

Crutchfield is a 20-year veteran of the architecture and engineering field who has led projects in institutional building and healthcare work, while Buck joined RMF 15 years ago and is a mechanical engineer and project manager.

Buck also has worked with healthcare clients to design HVAC, plumbing and medical gas systems.

December 2, 2013 // **NEWS**

Craig Buck Recognition Plaque

Submission Type: Promotion

Current employer: RMF Engineering

Current title/position: Partner

Position level: Managing Partner

Previous position: Mechanical Engineer / Project Manager

Duties/responsibilities: Craig Buck PE, LEED AP, HFDP, was named partner of RMF Engineering thanks to his contributions to the South Carolina office's business growth. As partner, he will assist in the day-to-day operations of the South Carolina office as well as the firm's expansion in the southeast market. He will also oversee service offerings in his field.

BALTIMORE BUSINESS JOURNAL

December 2, 2013 // **NEWS**

Beth Crutchfield Recognition Plaque

Submission Type: Promotion

Current employer: RMF Engineering

Current title/position: Partner

Position level: Managing Partner

Previous position: Electrical Engineer / Project Manager

Duties/responsibilities: Beth Crutchfield PE, LEED AP was named partner of RMF Engineering having contributed to the South Carolina office's business growth. As partner, she will be assisting in the day-to-day operations of the South Carolina office as well as the firm's expansion in the southeast market. Additionally, she will oversee service offerings in her field.

THE BALTIMORE SUN
LIGHT FOR ALL

November 26, 2013 // **NEWS**

RMF Engineering Names Craig Buck as New Partner

People on the Move: November 2013

Baltimore-based engineering firm, RMF Engineering, has named Craig Buck PE, LEED AP, HFDP, a new partner out of the firm's Charleston, South Carolina office. Buck was chosen as a new leader of RMF, having contributed significantly to the South Carolina office's business growth since relocating there in the early 2000s to help develop the office. Buck will be assisting in the day-to-day operations of the South Carolina office as well as the firm's expansion in the southeast market. Additionally, he will take on a greater role by overseeing service offerings in his field. Buck, a mechanical engineer and project manager, is an RMF veteran with 15 years at the firm. He has extensive experience in designing HVAC, plumbing and medical gas systems for healthcare facilities. He is well versed in design standards and code requirements associated with healthcare facilities, having successfully designed systems serving a wide variety of specialized care areas within the hospital environment. Craig has worked on the renovation of the MUSC Basic Sciences Building, the new USC Student Health Center, the new Patient Tower for Christiana Care Health Services and multiple projects on the campus of Clemson University including the CURI Facility in Charleston.

THE BALTIMORE SUN
LIGHT FOR ALL

November 26, 2013 // **NEWS**

RMF Engineering Names Beth Crutchfield as New Partner

People on the Move: November 2013

Baltimore-based engineering firm, RMF Engineering, has named Beth Crutchfield PE, LEED AP, a new partner out of the firm's Charleston, South Carolina office. Crutchfield was chosen as a new leader of RMF, having contributed significantly to the South Carolina office's business growth since relocating there in the early 2000s to help develop the office. Crutchfield will be assisting in the day-to-day operations of the South Carolina office as well as the firm's expansion in the southeast market. Additionally, she will take on a greater role by overseeing service offerings in her field. Crutchfield, an electrical engineer and project manager, has a primary area of emphasis in institutional building and healthcare work. With 20 years' experience working in the architecture and engineering (A/E) field for construction projects, she is involved in all phases of development including schematics, design development, A/E coordination, construction documents, construction administration and commissioning. Her expertise encompasses designing medium and low voltage electrical distribution, standby power systems, interior and exterior lighting design with computerized calculations, fire alarm and special systems design. She has worked on Clemson's Academic Success Center, USC's new Discovery I Bioengineering Building and the MUSC Central Utility Plant built to provide utilities to the Ashley River Tower.

citybizlist BALTIMORE

November 26, 2013 // **NEWS**

RMF Names Beth Crutchfield and Craig Buck as Partners

RMF Engineering has appointed two new partners out of the firm's Charleston, South Carolina office: Beth Crutchfield PE, LEED AP and Craig Buck PE, LEED AP, HFDP. Both Crutchfield and Buck were chosen as new leaders of RMF, having contributed significantly to the South Carolina office's business growth since relocating there in the early 2000s to help develop the office.

Beth Crutchfield, RMF Engineering

"When it comes to selecting our partners, we're looking for committed, hard workers who have a proven ability to lead and advanced technical ability," said Duane Pinnix, president and CEO of RMF. "Beth and Craig are frontrunners in their respective fields and have consistently shown the ability to drive RMF to greater opportunities in a successful and sustainable manner, even under the most challenging scenarios where technical savvy and collaboration are a must."

According to Pinnix, both Crutchfield and Buck will be assisting in the day-to-day operations of the South Carolina office as well as the firm's expansion in the southeast market. Additionally, they will take on a greater role by overseeing service offerings in their corresponding fields.

Crutchfield, an electrical engineer and project manager, has a primary area of emphasis in institutional building and healthcare work. With 20 years' experience working in the architecture and engineering (A/E) field for construction projects, she is involved in all phases of development including schematics, design development, A/E coordination, construction documents, construction administration and commissioning. Her expertise encompasses designing medium and low voltage electrical distribution, standby power systems, interior and exterior lighting design with computerized calculations, fire alarm and special systems design. She has worked on Clemson's Academic Success Center, USC's new Discovery I Bioengineering Building and the MUSC Central Utility Plant built to provide utilities to the Ashley River Tower.

Craig Buck, RMF Engineering

Buck, a mechanical engineer and project manager, is also RMF veteran with 15 years at the firm. He has extensive experience in designing HVAC, plumbing and medical gas systems for healthcare facilities. He is well versed in design standards and code requirements associated with healthcare facilities, having successfully designed systems serving a wide variety of specialized care areas within the hospital environment. Craig has worked on the renovation of the MUSC Basic Sciences Building, the new USC Student Health Center, the new Patient Tower for Christiana Care Health Services and multiple projects on the campus of Clemson University including the CURI Facility in Charleston.

About RMF Engineering

Founded in 1983, RMF Engineering provides planning, design, engineering, commissioning and facility assessment services globally to clients in the healthcare, higher education, laboratory/research and government sectors. The firm leads the industry in the development of new engineering production methods and technologies, including Building Information Modeling (BIM), carbon reduction strategies, and in-depth assessment technologies. A privately held company headquartered in Baltimore, Maryland, RMF has more than 215 employees in 11 U.S. offices.


NOVEMBER 2013
CONSULTING - SPECIFYING
engineer
www.csemag.com
Data center
electrical distribution
systems | page 26
ASHRAE 189.1 | page 21
Integrating power and
life safety systems | page 38
Control sequences for
HVAC systems | page 44
CFE Media

Prescription for hospital, health care facility success

Hospital and health care facility projects are especially important due to their sensitive nature. Engineers charged with designing these buildings must take special care when working in these mission critical facilities.

PARTICIPANTS

Michael Chow, PE, CxA, LEED AP BD+C
Member/Owner
Metro CD Engineering LLC
Powell, Ohio

George Isherwood, PE
Vice President
Peter Basso Associates
Troy, Mich.

Michael Lentz
Associate
RMF Engineering
Baltimore

CSE: What sorts of challenges do hospitals and health care facilities pose that you don't encounter on other projects?

Michael Chow: Remodeling existing health care facilities and hospitals can be challenging due to the existing conditions and keeping the facility running 24/7 during construction. There may be a lack of record engineering drawings, labeling of HVAC systems, or electrical panelboard schedules. Also, there may be tight above-suspended ceiling space for new engineering systems (e.g., ductwork).

George Isherwood: The people who go to health care facilities are under stress. Whether they are the patient or a family member, they are often overcome by worry and concern. I believe this is important to keep in mind when designing systems in health care facilities. Making things easy and comfortable should be our highest priority.

Michael Lentz: The biggest challenges that I see in health care facilities are energy savings, maintenance, pressurization, and operational redundancy. With the current economic situation, health care, just like any other industry, has had to cut corners. New projects are demanding tighter budgets, and health care facilities are reducing their maintenance staff. This is a more serious concern in health care due to the nature of the facilities to care for patients. It is very difficult to meet the energy savings that are required by U.S. Green Building Council LEED, or even requested by the owner, and sometimes still meet the need of the patients and the facility. Tighter budgets also restrict what types of energy-saving measures the project can support. Budgets have also pushed for more maintenance-friendly equipment while trying not to lose quality or redundancy capabilities.

CSE: Looking into the future 2 to 5 years, how will the needs and characteristics of hospitals and health care facilities change?

Lentz: More and more health care facilities are outsourcing maintenance, which then requires a more maintenance-friendly design. This can greatly increase the cost of the project. Mechanical equipment needs to be more advanced in order to reduce maintenance. The mechanical equipment needs to communicate with the building management system (BMS) more so fewer staff members can monitor a larger number of pieces of equipment. The equipment needs more alarm points in order to troubleshoot problems quicker and easier. Also, more and more of the mechanical equipment is either being required to be or requested to be on emergency power. All of this affects the project budget and contributes to the rising cost of health care.

Isherwood: In my experience, I believe the health care industry is making great strides at changing the public's perception on what to expect when visiting medical and health care facilities. Health care facilities have always been a place you go when you're sick or injured. In the near future, that will continue to

Peter Basso Associates engineering projects, such as the Brehm Tower at the Kellogg Eye Care Complex at the University of Michigan, Ann Arbor, include specialized features such as laboratory facilities. Courtesy: Peter Basso Associates (Anton Grassl Photography)

change. I first noticed this when we went to visit my mother-in-law at our local hospital. She commented that her room was like a nice hotel. My oldest daughter attended a healthy cooking class, and my younger children wanted to go back for dinner after my mother-in-law was discharged. Looking at the design of hospitals, sometimes we become immune to the effects they have on the general public. My children's experience going to the hospital was one of excitement and learning, which is day and night to my memory in visiting hospitals as a child and a young adult.

Chow: We anticipate there will be more renovations to existing hospitals and health care facilities. The challenge will be to meet the future codes such as the number of receptacles in critical patient rooms increasing due to changes in NFPA 70: National Electrical Code (NEC). The existing electrical infrastructure may not be able to accommodate these changes without significant additions that many times are not accounted for in the initial construction budget by the owner of the facility.

CSE: How often are you called on to retro-commission hospitals and health care facilities, as opposed to new construction of a building? What are some key differences between the two?

Isherwood: In our experience, commissioning services are being purchased for new construction in hospitals, but the demand for retro-commissioning services is not as high. We believe this is because of the high monitoring of existing systems from outside review agencies. Even though these reviews are being completed, we believe most health care systems do not fully realize the benefits of retro-commissioning.

CSE: Since the Affordable Care Act passed, what shift in the types of hospitals and health care facilities work have you experienced? For example, a bigger workload, more retro work on existing facilities vs. new construction, etc.

Isherwood: I think health care networks are still figuring out how the Affordable Care Act is going to benefit them and they are holding back resources until the government uncertainty is clarified. We have experienced a shift toward smaller renovations and infrastructure projects.

CSE: How has the economy impacted your work in this area? Have you seen the number of projects decline with the recession, and improve now that the economy is on the uptick?

Isherwood: I believe the economy has not had a significant impact on the largely privatized health care design industry. I believe the implementation and shifting of resources from the adoption of the Affordable Care Act has overpowered any positive effects from the rising economy.

CSE: What factors do you need to take into account when designing building automation systems

(BAS) for hospitals and health care facilities?

Lentz: All major building equipment needs to be tied into the BAS and alarmed for malfunctions. This is due to the critical nature of the systems to function 24/7 and also due to most health care facilities reducing maintenance staff. Emergency power for the automated control system and local panels also needs to be accomplished. Again, due to the critical nature of the systems to function 24/7, the systems cannot shut down, and if the controls are not on emergency when power is lost, the units will not automatically restart after the 10-second delay.

Isherwood: Ease of service and the ability to understand the systems is crucial. Building controls are becoming more complex and maintenance staffs are being asked to do more with fewer resources. We need to make sure we design building control systems that will not become a burden on the staff, but a benefit.

CSE: How does implementing BAS in an existing building differ from designing controls for a new building?

Isherwood: There are a significant number of small hospital systems that have been using the same BAS for years. Some of these networks will no longer be supported by basic operating computer systems, let alone the BAS system. Also, different manufacturers have opened different control protocols for tying into a BACnet or similar common language. These challenges are huge for small hospitals, from both a solution and a cost standpoint.

CSE: What's the one factor most commonly overlooked in electrical systems in hospitals?

Chow: Understanding and incorporating the applicable codes and standards for a hospital is commonly overlooked. A hospital may be certified by The Joint Commission and an engineer designing a remodel may inadvertently overlook their standards and requirements.

> "**Understanding and incorporating** the applicable codes and standards for a hospital is commonly overlooked. A hospital may be certified by The Joint Commission and an engineer designing a remodel may inadvertently overlook their standards and requirements." *—Michael Chow*

Lentz: What equipment that the owner would like to see on emergency power and what the code actually allows on emergency power. For example, in a patient room, hospitals would like the lighting on emergency power on the life safety branch, but code does not allow lighting on a life safety branch. So in order to provide that, it would then require additional panels and transfer switches to put the equipment on emergency power, but results in increased project costs and space requirements.

CSE: Describe a recent project in which you had a complex standby, back-up, or emergency power design.

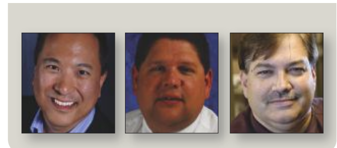
Lentz: Inova Women's Hospital has three 2 MW 5 kV generators paralleling with the utility system and four distribution sub-stations. Three 2 MW, 4.16 kV enclosed diesel engine electric generators (EGs) and auxiliary systems were provided in a designated outdoor yard, remote from the hospital central plant. The 2 MW emergency generators were paralleled through the emergency generator 5 kV paralleling switchgear (EGPS). The EGPS was configured with two outgoing main breakers to the normal 5 kV switchgear, one bus tie breaker, two emergency generator auxiliary load breakers, existing plant breaker, and three generator breakers. Although the generators were intended to be used as standby generators only, the use of a selective catalyst reduction (SCR) system was provided in the design. The SCR system reduces engine emissions, specifically NOx up to 90%, and has become a required component in most new generator installations to meet state/U.S. Environmental Protection Agency emissions requirements. The SCR system consists of an injection/mixing pipe, catalyst housing, solution storage tanks, solution transfer pumps, and associated control panels. The generator assemblies were contained in pre-engineered sound attenuated enclosures. The enclosures achieve a 40 dB(A) reduction of the generator set source noise, as measured at 1 meter from the enclosure.

CSE: What unique NFPA 99: Health Care Facilities Code issues have you encountered, and how have you resolved them?

Chow: The 2014 NEC has a proposed change to increase the minimum number of receptacles for a patient bed in a critical care area from 6 to 14 receptacles. This would coordinate the requirements between the NEC and NFPA 99.

CSE: How might the complexity and scale of fire/life safety systems in hospitals and health care facilities vary from other types of structures?

Lentz: Due to the fact that most health care facilities cannot be evacuated and have to be designed to defend a fire, in-place smoke control systems can become very complex. Smoke zones need to be designed so that when a zone



is alarmed, that specific zone can be kept at a negative pressure to the adjacent smoke zones in order to contain all of the smoke in the zone under alarm. We have found that the best way to accomplish this is under the smoke control sequence of operation, we convert the air-handling unit (AHU) that serves the smoke zone under alarm to 100% outside air. We are using the return fan now as a smoke exhaust fan. A modulating smoke control damper is installed on the supply air duct serving the zone, and it modulates to maintain the zone at a negative pressure. The supply air smoke control damper is controlled by a differential pressure sensor located at the doorways between the zone under alarm and all adjacent smoke zones.

CSE: What are some important factors to consider when designing a fire and life safety system in hospitals and health care facilities? What things often get overlooked?

Lentz: Smoke control systems are often overlooked, which can require a hospital to shut down critical AHUs during a fire/smoke alarm. Atrium evacuation systems and stair pressurization systems are also often overlooked, which can be very difficult to install and engineer after construction or even during the design process without a lot of redesign. When designing smoke control systems or atrium smoke evacuation systems within the building's normal HVAC system, what is generally overlooked is the fact that the components of the HVAC system now have to be UL listed for that use and now have activation or communication with the fire alarm system.

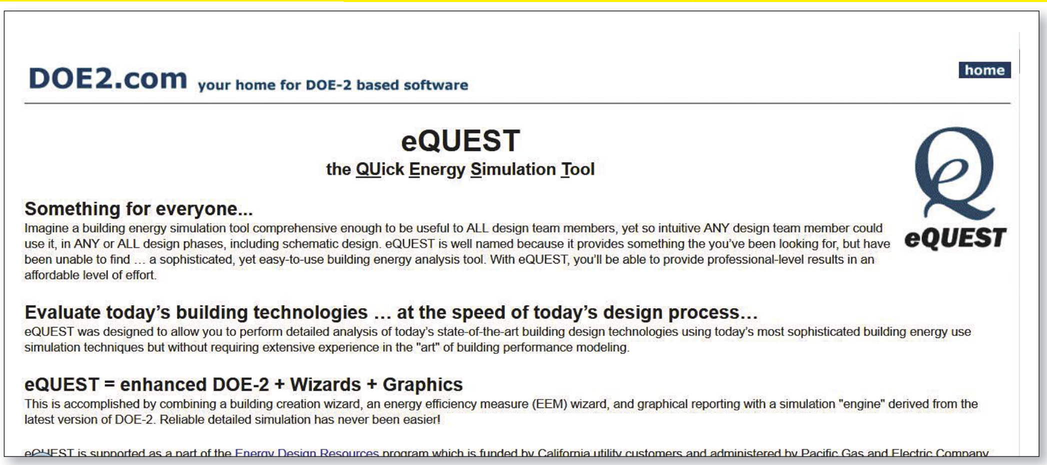
CSE: What unique requirements do hospitals and health care facilities' HVAC systems have that you wouldn't encounter on other structures?

Isherwood: Equipment redundancy is more common in health care facilities than in other structures. This is due to the failure events that may occur and endanger patients if redundant systems are not properly designed, installed, and commissioned.

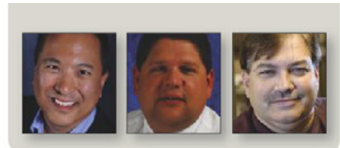
Lentz: Redundancy and reliability are the largest requirements that I see. Most health care facilities require some means of redundancy in their HVAC systems so they can still adequately serve patient and critical spaces during an equipment malfunction or failure. The amount of redundancy is always something that has to be weighed and measured against the project budget and the type of program space that is being built. For example, 100% redundancy for the HVAC system is more suitable for operating rooms and patient spaces than material holding or administrative offices. How you achieve this type of redundancy is also something that is unique to each facility. Is the redundancy a standby air handling unit, a standby supply fan, a fan wall assembly, or a manifold system that can withstand the loss of partial supply air?

CSE: What HVAC techniques or tools have you used to reduce the possibility of hospital-acquired infections (HAIs)?

Lentz: Strict pressurization requirements between different program areas within the hospital, and filtration and separation of different program areas within the hospital. For example, applying 100% exhaust to the emergency



eQUEST was designed to allow engineers to perform detailed analysis of today's state-of-the-art building design technologies using today's most sophisticated building energy use simulation techniques, but without requiring extensive experience in the "art" of building performance modeling. Courtesy: *Consulting-Specifying Engineer*



department waiting rooms. Any airborne infection isolation room exhaust is treated with high-efficiency particulate air (HEPA) filtration. All critical spaces, such as operating rooms, recovery areas, and sterile processing departments, are equipped with return or exhaust air terminal units in order to maintain correct pressurization within the program area, even if there is a loss of supply air to the space.

> "**We can see which system** will have the most energy savings, and then evaluate that system from a maintenance perspective as well as evaluate if the system is a practical application for the building."
> —*Michael Lentz*

CSE: What software or systems do you use to model the energy consumption of the building?

Lentz: The two programs that we most commonly use are Carrier Hourly Analysis Program (HAP) and the Dept. of Energy's eQUEST. These programs allow us to model the exterior of the building and evaluate several different HVAC systems throughout the building at the same time. We can see which system will have the most energy savings, and then evaluate that system from a maintenance perspective as well as evaluate if the system is a practical application for the building. This is especially helpful on existing buildings when looking to replace the existing HVAC system that is beyond its useful life. We can evaluate the existing skin and windows of the building and see if a total change in not only the HVAC system, but the type of HVAC system is warranted, cost-effective, and the correct engineering solution for the building.

CSE: ASHRAE has a goal: net-zero energy for all new buildings by 2030. What do other engineers need to know to achieve this goal on their hospital projects?

Chow: Engineers need to know that a net-zero energy hospital project should incorporate integrated project delivery (IPD). Also, extensive energy modeling analysis will need to be performed as well as integrating innovative design strategies and including both on-site and off-site renewable energy sources.

ExecutiveBiz®
We Connect Executives™

November 22, 2013 // **NEWS**

Bob Smith, VP at RMF Engineering, on Modernizing Government Buildings, Growth Plans & Energy Modeling

By David J. Barton


Bob Smith, RMF Engineering

As vice president at RMF Engineering, Bob Smith leads the Baltimore, Md.-based professional services firm's new business development efforts.

Smith has been with the company since its first year of operation in 1983 and elevated to his current position in 1991 after holding several project engineering and project management positions.

A recent chairman of the International District Energy Association, Smith has traveled around the world on behalf of the IDEA exchanging knowledge on areas such as lowering emissions and greenhouse gases.

ExecutiveBiz recently caught up with Smith to discuss RMF's work with public sector clients, the company's commissioning and growth plans, and modernizing federal buildings through tools such as energy modeling.

ExecutiveBiz: What kind of work do you provide government clients at RMF Engineering?

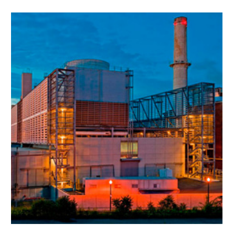
RMF Engineering

Bob Smith: There are a couple of very big parts of our business line. One focuses on buildings themselves, new and existing buildings. They can be for uses such as office, research or healthcare and we touch on a lot of different areas. One, for example, is the new medical examiner's facility at Dover Air Force Base.

We supported a design and build team on a project intended to process, identify and appropriately treat the remains of service men who come back from war, the deceased. That was a very highly specialized laboratory-type facility. Very unusual. There are not that many like it.

On the other hand, a lot of our work is in the energy sector. The other major part of our business includes campus energy plants. Some of these have been for the modernization and expansion of the U.S. Capitol Power Plant.

It serves over two dozen major buildings and millions of square feet. From the central location we provide all the heating, cooling, and in the future, a large portion of the electrical power needs from that Capitol Power Plant, which is over 100 years old now.


Capitol Power Plant

The type of project we probably get the most notoriety for is the campus energy plant and distribution systems. Those plants generate heating, cooling, and power. There is usually an associated distribution system that's underground, sometimes in tunnels, that feeds every connected building that may be at that campus.

We've always enjoyed the government and institutional type facilities because they've given us the most freedom to really employ quality-type systems design. You know, they're not necessarily in it for first cost.

Colleges, hospitals, and government facilities generally use life-cycle costing and life-cycle analysis to determine the right system and the right way to build a building, so that it's the most sustainable.

So, those areas of practice allow us to do what we consider to be our best engineering work. We're able to do things that really have a lot of meaning, a lot of substance, quality products and systems.

Redundancy is always a big deal. You've got to have that N+1, sometimes N+2 for very important type applications for the government, specifically DOD or intelligence-type facilities. We've designed a lot of redundancy, a lot of cross connects, and put in features that we wouldn't be able to do in the commercial side.

ExecutiveBiz: What is your plan to continue to grow the company? What areas are you looking to expand?

Bob Smith: Commissioning is probably the fastest growing, and there are a lot of reasons for that. One is in the building and construction industry. Owners have learned that their buildings, their facilities, and their plants don't necessarily perform the way that they were originally intended to.

Somewhere along the way, there was a disconnect. Whether it be the hand off or finishing a facility, they find that things were left incomplete.

So, we've developed a niche business in commissioning, and that means we're completely independent and objective. We don't work under the direction of the building contractor, we don't work as a designer, we work for the owner and our job is to verify, and validate that everything works.

Our guys have been doing this a lot. We've been doing this on hundreds of projects now, and it's a requirement for any building that is Leadership in Energy & Environmental Design, or LEED, certified.

If it's going to be a LEED-certified building that is silver, gold, or even platinum, part of the proof is that it has to be commissioned by a third party who has no vested interest in forcing the outcome to anybody's favor.

It really gives it a very good objective opinion that it's doing everything it's supposed to do. We can say "this power plant really is as efficient as everybody says it is, and here's the proof." So, this is something we've learned to do successfully.

We've performed commissioning domestically, and we've taken this expertise overseas at diplomatic facilities for the federal government, and we're able to do this in non-English speaking countries. It's been a challenge, but it's also been exciting.

Our president Duane Pinnix has been leading our effort and he has been doing a marvelous job of overseas building commissioning.

ExecutiveBiz: How does the amount of un- or underused buildings owned by the government affect your business?

Bob Smith: Often times, we're asked to do what is called a condition assessment of a facility, and it may be an occupied building or it might be one that hasn't been used in a long time. It's a top to bottom evaluation of the useful remaining life of the building and its potential.

Would it be smarter for me to demolish this building and replace it, or should we try to renovate and try to do everything we can to make it perform like a new building? Can an office building be repurposed for another use like multi-tenant residencies?

It's always a debate, because oftentimes, the cost to completely modernize a facility and make it like new can reach or exceed the cost of starting from scratch. It's a unique proposition every time where there may be several parties involved in determining the value and condition of a facility to determine that recommendation.

Do you tear it down or do you rebuild it? Which is the most cost effective?

We've heard both sides of the argument, and one of the biggest problems that you run into, specifically in federal facilities, is trying to renovate and modernize a facility that's occupied. When it's occupied, it gets very difficult. Schedules are very long. It gets costly, and oftentimes at the very end, you really don't end up with what you had hoped for.

There are physics involved where things like floor-to-ceiling heights and shaft space, and room for some of the infrastructure equipment, the generation equipment, just never lends itself to be adequate for you to make that building what you want it to be. So, it's always a unique debate and one that we see goes on a lot.

Assesment, hard hat, constructionSometimes we may do those condition assessments that may go for millions of square feet around an entire hospital, for example. We'll tell them which buildings are good, which buildings are bad, what equipment is going to last for 5 years, 10 years, 15 years, and how to prioritize those things. If you're developing a capital renewal plan, where do you start? What do you do first?

And how do you mitigate risk if you're relying on underground utilities that are 30 or 40 or 50 years old? How do you begin to put some type of an estimated remaining life or some type of a risk value on what's underground?

Could these things fail tomorrow, and what would we have to do to mitigate that risk, and if we had this amount of budget for capital renewal and repair, how do we use it in the smartest way so that we mitigate the risks in the most responsible way?

One of the things that has been especially useful is energy modeling. We can model a building using a variety of sophisticated computer simulation programs before anybody puts anything down on paper to design a building.

If an architect says 'I'd like to use this type of glass, I want to orient the building so it faces this way, it's going to be this many stories, I'm going to make it out of this', we can develop a model, even before anybody draws anything.

That can steer you in the direction of knowing where that building's going to go if it's objective in terms of LEED certification. It is a new tool that we didn't have years ago, and it's been very useful for decision making.

November 22, 2013 // **NEWS**

VP Bob Smith on RMF Engineering's Leadership Development Program, International Embassy Work, NIH & Johns Hopkins Projects

By Tim Watson

ExecutiveBiz: You've been with RMF since its start in 1983. How would you characterize the company's evolution over that time?

Bob Smith, RMF Engineering

Bob Smith: I think there were two major growth periods for us. One was in the early days when we'd begun to take a lot of projects for the Johns Hopkins Health System.

Johns Hopkins gave us a chance to do things in a big way, and there was a lot of growth. We did a lot of hiring, very close to Hopkins physically, and we were able to work on these world-class facilities, and do things that we probably couldn't do at most other institutions.

It was both a time of growth and learning, and we were allowed to do things that were new, innovative and novel.

The other big growth period in our company was when we began a long-term contract with the National Institutes of Health. The NIH, again, allowed us to do new and innovative designs.

RMF Engineering-designed laboratory at Johns Hopkins

The utility system at NIH is one of the largest of its kind in the nation. The campus cooling capacity, for example, is measured in tons of cooling.

They have 60,000 tons of cooling, which is just unheard of. You rarely see something like that, except maybe at a campus like the University of Texas or in the Middle East. There just aren't that many of these types of facilities out there.

At NIH we were able to design some very sophisticated laboratories. These laboratories were for developing new vaccines, for conducting some of the most advanced medical research. We were a part of several of those largest laboratories that were constructed at NIH.

Not only did that give us an opportunity to do things that no one else was doing, but it also gave us experience that we then took to other campuses that belonged to the Agriculture Department, Environmental Protection Agency, and other types of facilities, so it was good growth and learning opportunity.

USDA Infrastructure Modernization from RMF Engineering Project

We were able to then take that knowledge and apply it elsewhere.

With projects such as those, we are usually the primary designer and we will marry up with an architect. Architecture is probably the only major professional service that we don't offer ourselves.

Some architects have specialties in different areas. Some are really good at healthcare, some are really good at labs, some are really good at utility buildings, so we'll choose the one with that specialty, that key expertise, and partner with them, and we'll produce the design documents and see them through construction.

Our responsibility continues all the way to the very end throughout the complete close-out period.

We're also very proud of our young employees. We started something new in the last few years called Leadership Development

Program, or LDP, where we grab the best and brightest of a certain age group and tenure and put them through an MBA-type program, something they would never get in their college program that really talks about real-life situations.
How to run this business, how to deal with ethical challenges, how to deal with technical and business challenges, and it's something that we don't see any other firms doing.

We're so proud of it because we're grooming our next leaders, and it has just turned out better than anybody ever expected. It's something very new.

We're going to be having the graduation for our first class coming up and we're going to start a new class of these new young leaders. It's something that has gotten everybody here very excited.

Never before have we put so much time into teaching and mentoring the next group of leaders, and it appears that it is a very smart thing to do. Two of the LDP graduates were just promoted to be shareholders.

ExecutiveBiz: Tell us about some of your international work.State Department, DOS

Bob Smith: The majority of international work has come through the State Department. They have a long-term program to build new diplomatic facilities throughout the world.

Facilities that are much more safer, more resilient to physical attacks, and much more modern in terms of IT, the whole communication aspect, backup power systems, and things of that nature. So, there is a multi-year program, and our aspect of that is the commissioning.

We don't design any of those facilities. Most of them are designed domestically here, and many of the builders are U.S-based international builders in those host nations, and our job is to commission them.

It is interesting because we're dealing with different languages, a lot of this work is done in the metric system, the subcontractors oftentimes have never had to deal with such a high end facility before, so there's a lot of training that takes place.

We put these buildings through their paces and there are two aspects to that. One we call the pre-functional checklists test, making sure everything is in its place.

Then the second major step is the functional performance test where everything is turned on and off, and then demonstrated to operate correctly and efficiently. We test it to make sure it runs smoothly and meets all the intended set points and things like that.

Oftentimes these nations are not quite equipped to operate buildings like that, and you're relying on local resources.

So part of our job is to develop training programs, step-by-step procedures on how to turn on all the equipment, how to operate it safely and efficiently, how to do preventive maintenance, and how to operate it in an emergency mode or standby mode. There's a great deal of training of the local operating staff before the keys are handed over.

ExecutiveBiz: What are you most excited about moving forward?
Bob Smith: Well, we believe that we have seen the corner turn in terms of work load. We went through a period where it was very discouraging. You know, we just didn't see the kinds of projects that we had seen year after year after year.

We certainly kept our business practice solid, that wasn't a problem, but in terms of being able to do the kind of work that we really get excited about, those projects weren't there. They hadn't been there for several years, but we're seeing them now.

NIH Building from RMF Engineering Project

We're starting to see large projects again and ones that we can really apply some neat ideas. They're not just fix, repair, replace. It's, Hey, what can we do to make this exceptional?

What can we do now to make this the best in its class in terms of an energy plant or a laboratory or a research facility or a hospital? On the economical side, we're seeing owners of facilities now seeking and requesting those really original thoughts and the opportunity to apply neat ideas that we wanted to do for so long.

For the past few years, we haven't been able to do it, because there was no financial means to do those things.

THE SOURCE FOR FACILITY SOLUTIONS
Today's FACILITY MANAGER

November 7, 2013 // **NEWS**

The HVAC Factor: Keeping Steady With Geothermal

By Avery L. Monroe, P.E., LEED AP and Paul Harry

The geothermal system was engineered to deliver 40% HVAC system energy savings over typical energy code compliant systems.


The geothermal system was engineered to deliver 40% HVAC system energy savings over typical energy code compliant systems. (Photo: RMF Engineering)

Completed in December 2012, the University of North Carolina Coastal Studies Institute (UNC CSI) is a 52,000 square foot research facility located on a 200 acre site on Roanoke Island along the Croatan Sound on the Outer Banks near the Town of Manteo. The facility includes research labs for marine archeology, coastal processes, estuarine ecology, public policy, and engineering. The new building also comes equipped with teaching classrooms and labs as well as marine operations, administration, and research offices.

One of the goals for UNC CSI is to be a model for sustainability in the local and regional communities. As such, the facility was designed and constructed to achieve LEED Gold certification (pending), with a particular focus on low energy use and water conservation. The crux of the project, however, was temperature control. Since multiple functions would be performed in the facility, it was important to maintain the same level of space temperature control as would be achieved using conventional VAV systems. A geothermal heating and cooling system was designed and installed in an effort to achieve the greatest energy savings for the HVAC system.

The building is heated and cooled with a geothermal system in conjunction with a heat pump chiller/heater, pumps, and central VAV air handling units. The chiller/heater is modular, capable of simultaneously producing chilled water and heated water from a single source of condenser water. The heat pump chiller/heater automatically assigns modules for heating and cooling depending on space conditioning requirements.

Key to the success of the project was determining the most appropriate geothermal source for use as a heat sink. Initially, closed loop geothermal wells were considered and would have included over 180 wells, each 300′ deep, supplemented by a closed circuit cooling tower. This option had the greatest potential for energy savings; however wells at this depth would penetrate three aquifers, one of which supplies water to the county's public water distribution system. The other two aquifers contain brackish water; therefore the geothermal wells may have compromised the water supply system, as the county's water treatment plant is not capable of treating salt or brackish water.

An additional consideration was that based on the geothermal model, the ground temperature could potentially increase 10°F over the next 20 years. This would have reduced the overall efficiency of the system and required more wells in the future.

The good news was that the water supply aquifer had plenty of water available for use and the local and state authorities were willing to allow the use of an open loop geothermal (groundwater source) system if the wells were constructed to water supply well standards. The groundwater temperature at the site is typically 64°F year round, providing a consistent heat source/sink.

Three different open loop solutions were considered: a one pass system with water supply wells, with return water discharged into the Croatan Sound; injection wells used in conjunction with water supply wells; and using one of the county's water supply wells as the geothermal source.

Ultimately, the third option was implemented—an open loop system using raw water from an existing county water supply well. Coincidentally, the project site is located within a quarter mile of the municipal water treatment plant and the raw water main passes by the site en route to the treatment plant, thereby making this solution the most feasible and efficient. The raw water is intercepted, passed through a heat exchanger and returned to the distribution system. Condenser water is then circulated through the condensers of the modular heat pump chiller/heater. The heat pump chiller/heater simultaneously produces 42°F chilled water and 120°F heating water.

1310 HVAC a 300x156 The HVAC Factor: Keeping Steady With Geothermal
Monroe (left) and Harry (right)
Future plans for UNC CSI include dorms, an auditorium, and additional boat and research equipment storage.

Monroe, project manager at Baltimore, MD based RMF Engineering, served as the project manager for this CSI project. Harry is a project manager at RMF Engineering, serving as principal in charge and mechanical engineer on this project.

the construction specifier
The Official Magazine of CSI

November 1, 2013 // **NEWS**

Preserving 10 Light Street's Exterior Façade with Restoration

by John Hovermale, PE

Photos courtesy RMF Engineering

ONE OF BALTIMORE'S MOST VISIBLE AND RECOGNIZABLE BUILDINGS IS LOCATED AT 10 LIGHT STREET, CLOSE TO THE WATERFRONT. THE 34-STORY STRUCTURE IS CONSIDERED TO BE THE FIRST SKYSCRAPER IN THE CITY; IT HAS REMAINED ITS TALLEST BUILDING FOR NEARLY 50 YEARS.

The construction of the tower started in July 1928 and was completed in 15 months. This is a remarkable feat given its magnitude—approximately 46,450 m^2 (500,000 sf) and standing taller than 152 m (500 ft). The building also showcases a high level of architectural detail on its interior and exterior design. It is one of the historic gems of the Maryland Historic Trust, the City of Baltimore's

One of the several limestone medallions at the entrance—each medallion has a unique carving.

Commission for Historic Architectural Preservation (CHAP), and Preservation Maryland.

While the designer, Taylor & Fisher-Smith & May, and the builder, J. Henry Miller, created the iconic tower to last forever, age and natural elements necessitated efforts to reinforce and renew the exterior features so it could remain a prominent fixture in the commercial real estate market.

Baltimore's skyscraper

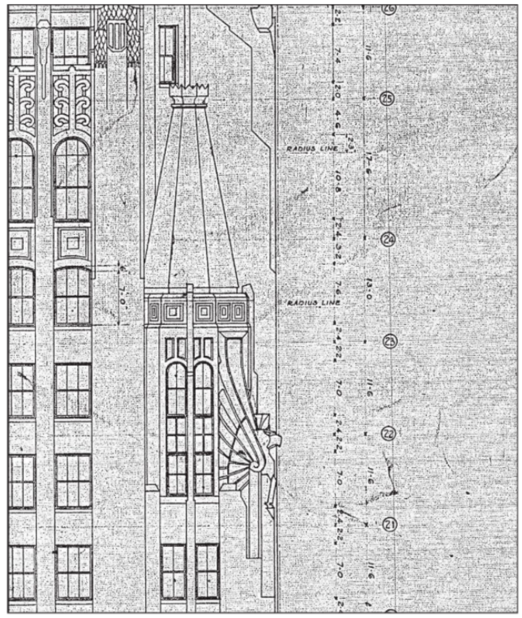
The 10 Light Street structure has a steel skeleton frame with masonry wall construction comprising terra cotta backup faced with brick and limestone. The floor slabs consist of a terra cotta flat arch system common to the period. The structure type is known as a 'transitional façade,' which was often seen in the United States from the 1890s to the mid-1950s.

When structural steel became a common building material in the early 1900s, it allowed building structures to reach new heights. Transitional structures bridged the gap between those with load-bearing masonry barrier walls that preceded them, and the curtain walls common today. In transitional façades, the floor slabs and masonry walls encase the structural steel at the building's perimeter. Generally, structural steel buildings, particularly buildings of several stories, tend to be flexible and move when subjected to lateral loading. The steel frame and masonry were not detailed to accommodate the differential movement. Additionally, traditional façades were not always properly designed to resist moisture infiltration.

The owner of 10 Light Street noticed cracks and dislocated masonry in the façade and knew if those issues were not addressed, they could progress, presenting a higher risk to public safety and resulting in expensive future repairs.

Assessing the damage

Baltimore-based RMF Engineering completed a detailed study of the façade to assess the project's magnitude and set budgets.



Detail from the original architectural drawings.
Image courtesy Taylor & Fisher-Smith & May

[Generally, structural steel buildings, particularly buildings of several stories, tend to be flexible and move when subjected to lateral loading.]

A before and after photo of the repair performed at a steel spandrel beam. The moment splice plate behind the screw jacks is needed for the new steel member installation.

Photos courtesy RMF Engineering

The condition assessment employed 29 swing stage drops providing close access to the façade for inspection. (Given the vertical nature of the work, 'drop' is the term used to describe the wall area accessible from a mast climber or swing stage.)

Not every square foot of the façade was inspected during the study; however, enough drops were completed to provide an assessment at each unique structural and architectural building detail, enabling reliable extrapolation of the data for those areas not inspected during the study.

RMF provided construction documents for the restoration work and followed through project completion as the construction inspector. More than 325 m^2 (3500 sf) of the original Italian marble was replaced. Approximately 122 m (400 ft) of helical joint reinforcement was installed at vertical cracks in the brick, and 6800 helical pins were used to restore the limestone. Further, more than 4645 m^2 (50,000 sf) of spot tuck pointing was completed, in addition to brick replacement, relief angle replacement, and structural steel reinforcement. The restoration was successfully completed with more than 35,000 hours of labor and no injuries.

The construction budget was set by the owner based on the condition assessment report. The delivery method was guaranteed maximum price (GMP). Although there was a detailed study, the inherent risks and unknowns related to façade restoration work remained. The GMP approach provided for better cost management where funds can be focused on the most critical repairs, as well as shifting funds from low-to high-priority repairs to address unforeseen conditions. Funds can also be shifted from repairs that were conservatively estimated in the design to other areas. Moreover, the GMP process allows the owner, engineer, and contractor to evaluate the approach to each repair and determine a solution addressing design and constructability.

Throughout the construction of 10 Light Street, RMF inspected each drop with the contractor and reviewed the remedial work required, providing an opportunity to verify what was illustrated on the construction documents and make adjustments where necessary. If conditions varied from the construction documents, the owner was immediately notified and a discussion about costs and procedure followed. After the contractor completed the work on the drop, RMF would punch out the drop and document the findings. Although a final walk-through was performed for the entire project, most of the project was punched out on a drop-per-drop basis as the façade access migrated along the building.

Logistics

Access to perform the repairs was one of the project's most challenging aspects. The building has a straight vertical face for the bottom 22 floors, accommodating the use of mast-climbers. However, the floor plate diminishes and steps back several times between Floor 22 and the top of the building with a number of small roof levels in the upper section making mast-climbers impossible to use. Individual swing stages of various lengths, including small, single-cable stages called 'buckets,' were used. In a few isolated areas, bosun chairs were the only solution. More than 60 drops in all were required.

The building is located in a busy area of the city with a bus stop on one side of the structure and a service entrance on the other—both had to be maintained throughout the construction. Scaffolding with overhead protection was erected over all the sidewalk areas from the face of the building to the curb line of the streets; this also provided a landing level for the mast climbers and swing stages above the sidewalk level.

The design was completed in a phased approach, and the construction documents were separated into three distinct packages:

- Package 1–Marble Replacement;
- Package 2–Phase 1, General Repairs; and
- Package 3–Phase 2, General Repairs.

The Marble Replacement Package was completed first given the replacement stone had a long lead-time. The team determined the stone thickness and the overall quantity the contractor needed to order. While the stone was being quarried, cut into 30-mm (1.18-in.) thick slabs and shipped, the initial mast-climber was being erected at the first drop. This marble removal provided valuable information on the conditions of the existing backup, and also provided insight on the appropriate stone anchorage details subsequently added to the Marble Replacement Package.

Repair plans

The original stone was an Italian marble containing intermixed serpentine, and classified as Soundness Group D by the Marble Institute of America (MIA). Soundness Group D stone is often the most attractive but, it is the least durable of the Groups A through D and contains large portions of natural faults, as well as variations.

Although prized for its rich burgundy color and decorative veining, it is not suitable for exterior exposure in this climate. As a result, all the exterior marble was replaced. This same marble, used extensively inside the building and a few well-protected exterior areas, was in good condition. It maintains its polish and gives credence to the deleterious effects on the marble when exposed to

This is the original marble in the framed opening. Not only is there a crack in the panel to the right along one of the natural soft veins in the stone, but the marble had also lost its luster and burgundy color.

New granite quartzite in framed spandrel panel.

This existing marble at the main entrance was replaced in the ornamental brass framing.

the elements over time. The replacement stone used on the project is not a marble product, but rather a granite quartzite stone from a Brazilian quarry. The granite quartzite is highly durable and an excellent visual match to the original marble.

The stone was mounted in two distinct conditions:

- recessed into the wall with a limestone surround; and
- mounted in a steel frame integrated into the window system as a spandrel panel.

The primary methods of attachment for the recessed stone were stainless steel drop pins in the surrounding limestone at the upper section, epoxy-set stainless steel pins at the bottom section, and blind stainless steel Type 31 anchors in the brick backup.

The pin locations had to be carefully placed to logistically allow the stones to be set onto the epoxy pins at the bottom and tilted into place with tight tolerance all around. The recessed stones have unique shapes; this required the stone supplier to field measure and make templates of each individual piece given the tight tolerances. The stone fabrication rate was largely driven by the accessibility to the façade to allow for field measurements and template-making.

Additionally, the stone fabrication had to be closely coordinated with the mast-climber and swing-stage sequence. At the spandrel panel installation, the external steel components that held the stone in place were re-installed or replaced with new steel components matching the existing profile to maintain architectural integrity. All steel components were cleaned and painted with a high-performance direct-to-metal acrylic coating. Missing from the original design, a weep system was added directly above the sill frame to prevent water buildup behind the stone. A fluid-applied air barrier membrane was installed on the brick backup in all cases.

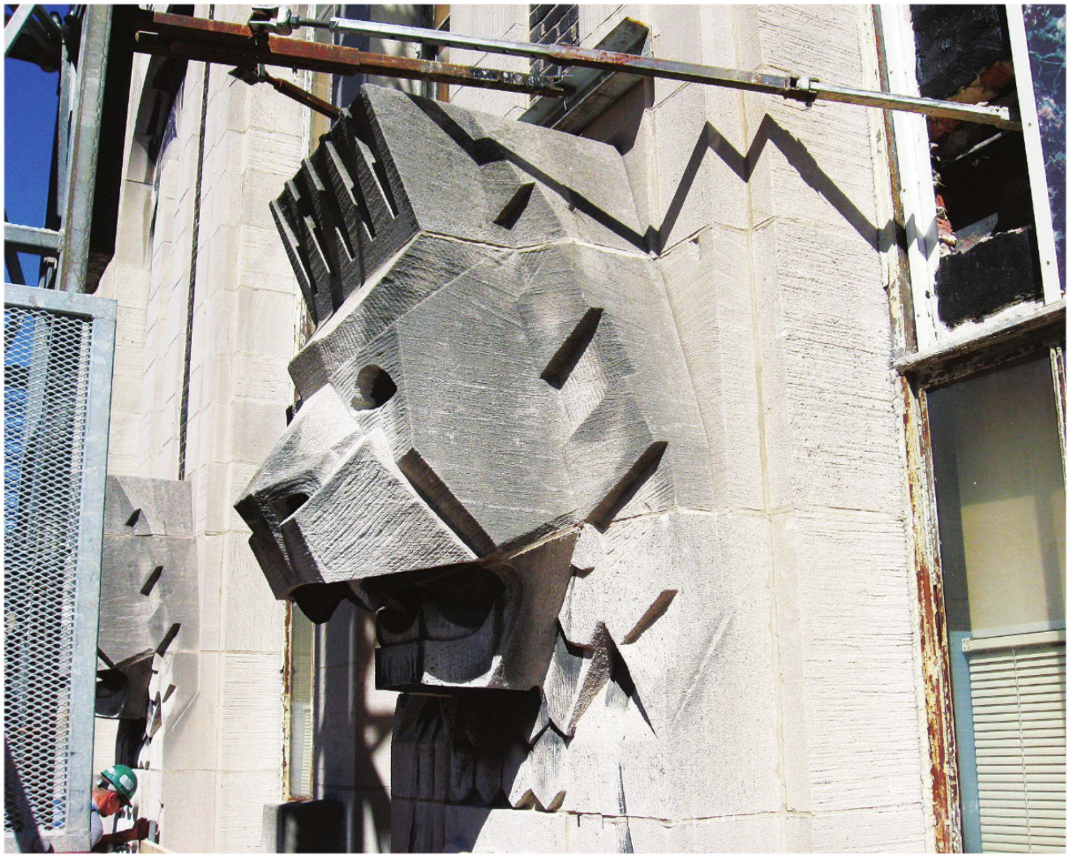
The Phase 1 and 2, General Repair Packages included repairs to the limestone and brick with the Phase 1 Package including higher priority repairs. Funds left over after completion of Phase 1 were attributed to the Phase 2 scope of work.

The limestone was on the bottom five floors and the building's upper portion between Floors 19 and the top of the building. Less than one percent of the ornamental limestone pieces (*e.g.* medallions, rosettes, and carved lion heads) required patching. The limestone pieces not mechanically anchored to the backup or keyed into the backup or other limestone proved to be an issue—a few of the stones had shifted out of place. After removing the stone for inspection during the report phase, the joint mortar and mortar buttered on the stone's back were found to be the only mechanisms holding it in place.

Although this performed well for numerous years, the mortar joints were deteriorated and allowed moisture to migrate behind the stone, slowly loosening them. While consideration was given to removing and re-anchoring without impacting the face of the stone, the risk of removing stones of this size on a swing stage, particularly with heights upward of 122 m (400 ft), was too great.

The decision was made to keep the stones in place, re-align if necessary, and anchor with helical pins through the stone's face. The small circular recess left in the face of the stone from the drill at each pin was patched with a mortar specifically designed for a natural stone substrate. The patching product was also tinted to match the limestone color. In addition to the pinning, all of the limestone joints were raked out and repointed. The new mortar was made compatible based on petrographic examinations and chemical analysis on the existing mortar—a critical step in any façade restoration work. The results yielded ASTM C270, *Standard Specification for Mortar for Unit Masonry*, Type M or S to be suitable. The existing brick mortar was also tested resulting in ASTM C270 Type S.

Given its age, the original brick's condition and mortar between Floors Five and 22 was good—there were only a few areas where the brick was repaired and re-pointed. The steel lintels at the window openings were also in good condition. In the upper elevations of the building, where the building geometry becomes more complex with the extensive use of limestone, the brick and mortar was more distressed. The abrupt change in the façade condition would suggest the several building setbacks, roof levels, and parapets allowed the building envelope to take on more moisture in the upper elevations which also experienced rust-jacking in some of the steel columns and lintels.[1]



This is one of many limestone lion heads on the 22nd floor.

The façade damage caused by rust-jacking areas was addressed, including remediation of the structural steel. The brick was removed in front of the steel where the rust-jacking occurred to expose the steel for inspection. Although the column steel experienced some section loss, it remained structurally adequate. However, some lintels and spandrel beams needed to be replaced. Switching out the short lintels was straightforward, but the spandrel beam replacement presented challenges in providing temporary support of the wall and roof structure during the beam remediation.

Ultimately, the existing beam stayed in place and a portion of the outboard flanges of the existing beam was removed. A new steel member was installed with a similar depth and narrow profile allowing one wythe of brick to bypass the new steel. Given the existing beam's condition and selective removal of the flanges, structural calculations were performed at each phase of the construction to verify adequate support of the wall and roof structure throughout the process. The vertical cracks in the brick caused by rust-jacking of the steel columns were repaired using L-shaped helical joint reinforcement recessed into the horizontal mortar joints. The reinforcement was spaced vertically at 0.6 to 1.2 m (2 to 4 ft) on center (oc), and wrapped around the corner to stabilize the brick. The cracked brick was replaced and the area repointed. The limestone integrated into the corner masonry was pinned to the backup.

Conclusion

Façade issues are frequently left unaddressed until a major disaster occurs, or until the

The 10 Light Street façade restoration project is an example of proactive façade inspection followed up with repairs in order to successfully preserve an historic structure.

damage is so extensive it becomes cost-prohibitive to repair. The 10 Light Street façade restoration project is an excellent example of proactive façade inspection followed up with repairs in order to successfully preserve an historic structure.

For its first 84 years, the building served primarily as a banking center, and provided retail and office space for thousands of employees, customers, and visitors every day. It is currently under renovation to be repurposed as a residential complex with tenant fit-out and building support functions on the lower three floors. Approximately 460 living spaces will be integrated into 31 floors of the building, ranging in size of approximately 42 m^2 (450 sf) for the studio units to 186 m^2 (2000 sf) for the multiple bedroom and loft units. These apartments are primarily designed for the student population attending nearby teaching hospitals and universities, and are expected to be ready for occupancy in 2015. **CS**

A limestone falcon head, mounted on the 29th floor.

Notes

1 Rust-jacking is the process where steel, in contact with masonry, corrodes then expands pushing the masonry outward to the point where the masonry cracks and can eventually become dislocated.

ADDITIONAL **INFORMATION**

Author
John Hovermale, PE, is a partner in the structural engineering department at the Baltimore branch of RMF Engineering Inc. He has been with RMF for 20 years, and has been involved in façade restoration projects for a decade. Hovermale has a bachelor's degree in civilstructural engineering from the University of Maryland, College Park. He can be reached via e-mail at john.hovermale@rmf.com.

Abstract
Built in the late 1920s, the Art Deco 10 Light Street is the first skyscraper in Baltimore. A detailed façade inspection was recently completed using 29 swing stage drops for close access—this led to a restoration project for the more than 325 m^2 (3500 sf) of Italian marble, replacing it with a durable quartzite from Brazil. This article examines what occurred during the reconstruction.

MasterFormat No.
01 35 91–Historic Treatment Procedures
04 42 00–Exterior Stone Cladding

UniFormat No.
B20–Exterior Vertical Enclosures

Key Words
Division 01, 04
10 Light Street
Façade restoration
Limestone
Masonry
Rust-jacking

ENGINEERED SYSTEMS

November 1, 2013 // **NEWS**

Chiller Retrofit: The Attraction Of Magnetic Bearings

With multiple expansions and projects, a DC-area hospital also had to plan for cooling that could keep up with developing demands and spaces.

By Richard M. Heim, P.E., LEED AP and Paul J. Orzewicz, P.E.

When the facilities management staff of Mount Vernon Hospital completed an assessment of its central chilled water plant, it became evident that while the original chillers had served the hospital well since its opening in 1975, they were ready for replacement. The hospital used this opportunity to install three state-of-the-art chiller systems; the largest of their type.

The energy required to cool a hospital in the mid-Atlantic region of the U.S. can represent 20% or more of the annual energy consumed, so efficiency upgrades in the cooling system can have a significant impact on total energy use. With the many advances that have occurred in chiller technology since the original units were installed, replacing the chillers with new equipment was seen as an ideal approach for improving operating efficiency.

Improvements in compressors, controls, and heat exchangers have occurred over the past few decades that make even the most basic modern chiller much more efficient than those produced in the 1960s and 1970s.

Today, the use of VSDs on chillers coupled with reduced condenser water temperatures (where feasible) has allowed many manufacturers to offer chillers with very attractive efficiency ratings, especially Integrated Part-Load Value and Non-Standard Part-Load Values (IPLV/NPLV). These values are used throughout the industry to describe the realistic performance of the chiller over the life of the machine and make the investment of a chiller replacement much easier to justify through a lifecycle cost analysis.

For several chiller manufacturers, the use of magnetic bearings in a variable-speed, oil-free compressor is the most recent chiller innovation with both measureable maintenance and efficiency benefits, but until recently was limited in capacity to applications of only a few hundred tons.

The magnetic bearings technology actually provides a magnetic electrical field that levitates the shaft of the compressor so it is essentially “riding on air.” The shaft speed of revolutions reaches as high as 20,000 rpm with very little friction due to the elimination of oil lubricated bearings.

For Mount Vernon Hospital’s project team, the final piece fell into place for a very modern, very efficient chilled water system when Daikin McQuay extended the product range of its magnetic bearing compressor chiller offering to 700 tons.

Hosptial Background

Mount Vernon Hospital is part of the INOVA Health System, which has five nationally ranked hospitals located within the northern Virginia area. Mount Vernon Hospital located in Alexandria, VA, is a 237-bed facility specializing in orthopedic joint replacement and patient rehabilitation.

Although several building additions have been completed since its original 315,000-sq-ft construction in 1975, the largest construction project in the hospital’s 38 years of operation began in 2013 and is currently under construction. This latest project involves the addition of a 55,000-sq-ft patient tower along with a 15,000-sq-ft operating suite addition. The project is scheduled for completion in 2015. Also, a 14,000-sq-ft addition to the hospital’s emergency department is slated to start next year.

The hospital’s heating, cooling, and electrical utilities are served by a dedicated central energy plant (CEP) in a separate building located behind the hospital. The CEP houses high-pressure boilers (125 psig) and water-cooled chillers for the hospital’s heating and cooling demands and is manned 24 hours/day.

Hospital Operations

The hospital utilizes central station air handling units (AHUs) for space pressurization and comfort control. Under normal operation, the AHUs have an outdoor air (ventilation) demand of approximately 45% and all of the AHU's are equipped with economizer controls for 100% OA capability.

At Mount Vernon and other healthcare institutions, it is common to maintain the operating room space temperature at 62°F because of the physical nature of the surgical procedures performed in the orthopedic operating rooms. During a joint replacement surgery it is not uncommon for the surgeon to use tools such as hammers, saws, and chisels to complete the procedure, resulting in increased internal heat gains inside the operating room. Chilled water from the hospital's CEP is required year-round to maintain proper temperature and humidity control within the operating rooms. Therefore, to achieve a stable 62°F temperature and 50% relative humidity, even though the AHUs are equipped with 100% outside capability, supplemental mechanical cooling may still be required during days when outside air conditions are suitable for economizer control.

Randy Cole, chief plant operator of the CEP, stays in constant communication with the surgical staff. On any given day based on the surgery caseload, Cole may receive a call from the surgical unit requesting additional cooling for the OR suites. At Mount Vernon, the operating rooms are active 10 hours a day, 5 days per week.

Another challenge the chilled water equipment must handle is the considerable swings in cooling load the hospital experiences throughout the year. The CEP chilled water equipment must be capable of meeting the peak summer cooling load of 1,400 tons while able to turn down to as low as 150 tons of cooling during the winter months of operation.

The Project

The chiller replacement project originated from a condition assessment report, which detailed all of the age related deficiencies at each of the INOVA facilities. Pete Shannon, a project manager for INOVA, was responsible for the projects, which came from this report. System deficiencies were listed for each facility and grouped by level of urgency. One of the major priorities at INOVA Mount Vernon Hospital was the replacement of aging chillers at the CEP.

The original CEP consisted of four chillers: two 700-ton centrifugal electric chillers, one 500-ton high-pressure steam absorption chiller, and one 300-ton high-pressure steam absorption chiller. From a condition assessment investigation, the two 700-ton chillers were listed as beyond their useful remaining life and were identified for immediate replacement due to their age, which exceeded 35 years. These chillers operated below their nameplate capacity, typically at 600 tons, and performed at efficiencies greater than 1.0 kilowatt of electricity per ton of cooling. In addition, the 500-ton steam absorption chiller was listed for immediate replacement due to the lack of reliability and constant maintenance requirements. The condition assessment report also recommended replacing the four condenser water pumps as they were in "fair" condition and approaching the end of their useful lives.

Shortly after the chiller replacement engineering project kicked off, it began to evolve with a greater purpose. Mount Vernon Hospital was growing rapidly — and with growth, comes building expansion. With the addition of the hospital patient tower and the operating suite it was necessary not only to improve the chiller operating performance, but also to increase the central energy plant cooling capacity to account for this additional load. This ultimately led to the decision to replace the chillers each with a 700-ton capacity chiller, adding an additional 400 tons of capacity over the two underperforming centrifugal electric chillers and a 500-ton steam absorption chiller.

It was determined the new chillers would be capable of variable flow through the evaporator barrel. Therefore, the decision was made to include replacement of the chiller's associated constant speed primary chilled water pumps and provide variable speed capability. Shortly thereafter, Cole brought to the design team's attention the lack of winter cooling capability. The existing cooling towers did not have a means of winter time operation without having to drain a tower each time it was idle to prevent freezing and refilling when there was a call for cooling. Since the condition assessment report indicated one of the three cooling towers was near the end of its useful life, its replacement was added into the project, with the ability to provide on-call winter time operation with basin heaters included to prevent freezing.

As the design moved forward, multiple chiller manufacturers and types were investigated to determine the optimal plant design, but kept within budget. After meeting with manufacturers' representatives, attending factory plant tours, and visiting nearby sites where these machines were installed and operating, a decision was made to design the replacement around the new Daikin McQuay Magnetic Bearing chiller. Standard variable speed centrifugal chillers were included as an alternate during the bid process in order to provide INOVA with multiple options.

Mike Ruby, sales engineer for Havtech, said, "When RMF and INOVA asked me if Daikin (McQuay) had a magnetic bearing chiller around 700 tons, I was very pleased to say 'yes.' Daikin is a leader in innovation and design of oil-less magnetic bearing and inverter compressor technologies. They are constantly improving the technology and increasing their chiller product offering. Havtech is pleased to represent Daikin as it gives us the opportunity to offer owners the ability to reduce their total cost of operating and maintaining their machines as compared to traditional oil machines."

The existing CEP was previously operated manually and as part of the optimization effort, the project included providing automatic controls to stage chillers on and off to maximize their efficiencies at part load conditions. Ultimately, this was one of the major reasons for use of the magnetic bearing chillers, which demonstrated outstanding efficiency between 40% and 80% load. Figure 1 demonstrates the chillers efficiencies at part load conditions, which includes 0.310 kW/ton at 25% load, 0.268 kW/ton at 50% load, and 0.564 kW/ton at full load.

Redundancy

Since INOVA Mount Vernon Hospital provides a full continuum of patient care, it seemed prudent to provide the ability to operate these chillers during an unplanned outage of normal power. However, the existing generator capacity was not able to account for all three magnetic bearing chillers. Instead, all three were designed to be capable to run, but only two are ever able to run at the same time. This provided a new level of redundancy under an emergency situation.

The Results

The project was competitively bid among several INOVA-proven mechanical contractors with the bidders required to submit both cost and guaranteed operating efficiency data so that a lifecycle cost analysis could be performed based on reliable data. Mechanical contractor BION Inc., was selected to furnish and install the three 700-ton chillers in a phased replacement that would allow the plant to maintain reliability throughout the planned construction period.

The chillers, which were the basis of design, were ultimately selected based on the results of the annual operating cost analysis. In addition, the contractor later reported that the magnetic-bearing chillers were no harder to install than conventional chillers, while delivering advantages of a smaller footprint and less maintenance.

The installation of the final chiller was completed in June 2013, with the new chillers serving the hospital throughout the summer of 2013. The application of magnetic bearing technology in this size range was new enough that field retrofits of standard product features were necessary in order to meet the project required chiller production schedule.

As Greg Foor, project manager for the Inova Facilities Management Department (IFMD) explained, "…we are already seeing a significant savings in power consumption and have found the new chillers more than capable of meeting the hospital's demand needs."

Richard M. Heim, P.E., LEED AP, is a mechanical engineer at RMF Engineering, with experience in the design and analysis of plumbing and HVAC systems serv-ing healthcare facilities. He performs building condition assessments, conceptual design studies, and subsequent designs. He has extensive experience in evaluation and optimization of HVAC systems and their applications to various building types and functions.

Paul Orzewicz, P.E., is a mechanical engineer and project manager at RMF Engineering. He has extensive experience in the design of healthcare related projects. Orzewicz is routinely responsible for the detailed design of HVAC, plumbing, and fire protection systems, and performs the detailed coordination between mechanical systems and other disciplines. troubleshooting the problem down the road.

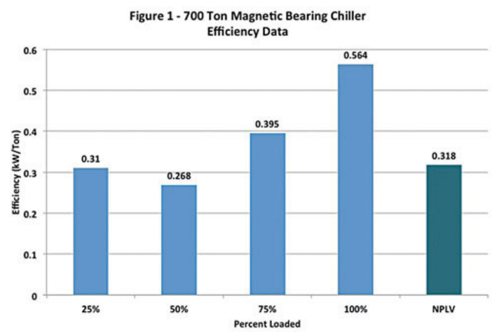


FIGURE 1. Efficiency and percent loaded for a 700-ton magnetic bearing chiller.

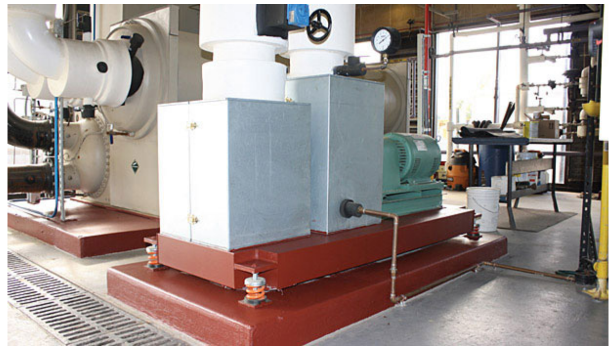


FIGURE 2. New variable speed primary pumps were installed for a variable primary/variable secondary chilled water distribution for reduced pumping energy.

FIGURE 3. This new 700-ton (oil free) chiller utilizes magnetic bearing technology which eliminates bearing surface wear for high-efficiency operation and extended life of the machine.

FIGURE 4. Magnetic bearing technology when applied to the design of the conventional centrifugal compressor gives way to a smaller, quieter compressor as seen here in the magnetic bearing compressor installed at Mount Vernon Hospital

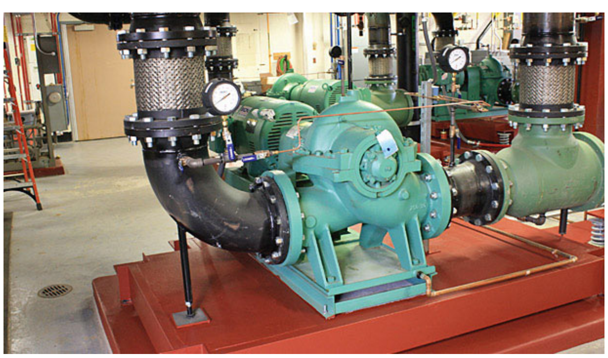


FIGURE 5. As part of the chilled water system improvements, the original condenser water pumps were also replaced to increase the central energy plant's overall operating efficiency and energy.

FIGURE 6. On board microprocessor controller and unit-mounted touchscreen panel with full system graphics provides the plant operators with a view of the chiller parameters and design set points at a glance.

October 31, 2013 // **NEWS**

Executive Profile: Bob Smith, RMF Engineering VP of BD

Bob Smith serves as vice president of business development at RMF Engineering.

He has focused his entire career on the development and improvement of central heating, cooling, and power systems serving campuses, such as colleges, hospitals, research centers and government agencies.

Smith has also served as the chairman of the board of the International District Energy Association and has traveled to Europe, China and the Middle East as IDEA's representative to exchange information on best practices to maximize efficiency and lower air emissions including greenhouse gases.

Smith has authored numerous magazine articles and has presented many technical papers at energy industry conferences. His main mission at RMF Engineering is to review emerging new technologies such as renewable fuels, green power production and energy conservation and identify practical applications for commercial use.

He is currently a member of the "Integrating Renewable Energy and Waste Heat" team on behalf of theInternational Energy Agency headquartered in Paris, France.

This group of industry experts from North America, Asia, and Europe is developing a guide for overcoming technical challenges and successfully integrating renewable energy and waste heat into district energy systems worldwide.

Smith earned a bachelor of science in mechanical engineering from the University of Delaware.

October 29, 2013 // **NEWS**

Chilled Beams in Health-Care Patient Rooms

Revision of standard opens door to more progressive, lower-energy solution

By Craig R. Buck, PE, LEED AP, HFDP, RMF Engineering Inc., Baltimore, Md., *HPAC Engineering*

Health-care patient-room design is dictated by rigid environmental and safety requirements, which severely limit the types of systems deemed suitable for HVAC. These requirements are evaluated continually, which, on occasion, opens the door to more progressive and lower-energy technologies.

A patient room with chilled-beam technology.

Such a time was 2011, when ASHRAE revised ANSI/ASHRAE/ASHE Standard 170-2008, Ventilation of Health Care Facilities, with the publication of Addendum h, allowing the use of recirculating-type heating and cooling units within non-invasive areas of hospitals, including patient rooms. The revision includes language indicating "induced" recirculation air qualifies as an "air exchange" for the purpose of compliance with room air-change-rate requirements of the standard. Additionally, the revision clarifies additional filtration is not required within recirculating room units designed to operate without condensing water on their surfaces, provided the primary ventilation air to the units is filtered in accordance with the standard.

Addendum h provided another option for energy-efficient heating and cooling of non-invasive areas of hospitals, particularly existing facilities with limited ceiling cavities. This was a huge step toward discussion of more progressive, more innovative, and lower-energy HVAC systems, such as active chilled beams, within the boundaries of regulatory requirements.

With patient-room design driven by fixed continuous ventilation rates and accurate control of those rates, chilled-beam systems are ideal, as their hydronic sensible cooling regulates space temperature while allowing constant-volume delivery of supply and ventilation air.

Used successfully in Europe for more than 20 years, chilled-beam systems have gained wide acceptance in North America as an alternative to traditional variable-air-volume (VAV) systems. This interest is fueled largely by chilled beams' energy-saving potential, ease of use, low maintenance, and minimal space requirements. While all are important, the primary concern of health-care cooling/heating-system designers needs to be maintaining good indoor-air quality (IAQ) and mitigating airborne transmission of disease.

How Chilled Beams Work

Chilled beams are cooling (and optionally heating) units located in or above a conditioned space that utilize a ventilation-only primary air stream from a remote air handler to induce larger recirculating room flows, effectively heating, cooling, and ventilating the space without the use of an in-room fan and with reduced overall airflow from the central air-handling unit (AHU).

The cooling capacity of active chilled beams is much greater than that of passive chilled beams. While passive chilled beams rely on natural convection for cooling, active chilled beams have a duct connection through which primary air is introduced and strategically positioned slots through which room air is induced through the cooling coil. With an adjustment of the width of the slots, the ratio of induction air to primary air can be varied from about 1:1 to about 4:1, and the amount of cooling capacity achieved, outdoor air provided, and supply air delivered can be modified to meet the air-change and sensible-cooling/heating needs of a patient room.

Benefits of Active Chilled Beams in Health Care

Facilitywide benefits of implementing active chilled beams include downsized ductwork/equipment, energy reductions of up to 50 percent (dependent on system design, building details, and climate zone), and decreased maintenance. Benefits specific to health care and patient rooms include:

- Optimum comfort and IAQ. An active-chilled-beam system controls both temperature and humidity in an occupied space. With a constant supply of primary air, minimum outdoor-air ventilation requirements are met at all conditions and in all spaces. ANSI/ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality, requires a chilled-beam system to process less outdoor air than a recirculating VAV system. Air from beams is distributed evenly throughout a space, reducing the risk of drafts and cold-air "dumping" while supplying a greater flow of air (because of induced room air) than a VAV system at peak conditions. Testing has shown not only improvement in overall thermal comfort with chilled beams, but greater comfort and temperatures more consistent with the room thermostat around patient beds.
- Reduced risk of cross-contamination. Mechanical filtration has proven effective in producing virtually bacteria-free return air in hospitals. Viruses and many gases, however, cannot be filtered. Introducing 100 percent outdoor air to a patient room reduces the risk of airborne infection by eliminating room-to-room air transfer. Additionally, when chilled beams are designed properly, there is no condensation on the coil to collect dust and dirt, and because inspection and cleaning of the coil and induction grille can be performed from the face of the unit, ceiling tiles do not have to be disturbed.
- Quiet operation. High ambient-noise levels in patient rooms can have serious impacts on patients, ranging from sleep loss and elevated blood pressure to extended recovery times. Properly designed active-chilled-beam systems contribute virtually no detectable noise to occupied spaces, with sound-power levels at or below 25 db.
- Eliminated or reduced reheat. Compared with a conventional overhead mixed-air constant-volume or VAV system, an active-chilled-beam system can reduce the volume of primary air it supplies by 30 to 60 percent. The lesser the amount of primary air, the lesser the amount of terminal reheat required, which can result in significant operational-cost savings. This particularly is the case with patient rooms, in which the air system typically is constant volume to meet minimum-total-air-change requirements.

Challenges

Challenges associated with the use of active chilled beams in health-care settings include:

- Condensation prevention. Avoiding condensation on ceiling-mounted "cooled" coils (active beams) requires accurate estimation of internal latent loads and effective control of indoor humidity. As long as indoor humidity is controlled and beam supply-water temperature is maintained above the dew point of the space, condensation is of no greater concern than it is with a conventional all-air system.
- Industry perception. Chilled beams are fairly new to the United States and even newer to the health-care industry. Owners and engineers with little or no familiarity with the technology either shy away from its use or apply it improperly.
- Cleanliness. Large amounts of bedding are used in patient-care areas of hospitals. Lint from this bedding becomes airborne and can accumulate in HVAC duct-work. Although chilled beams do not usually attract large amounts of lint—the velocity of the air moving over them is too low—it still is a good idea to perform routine maintenance on them. Chilled-beam manufacturers offer removable faces for first-stage cleaning, removable coils for second-stage cleaning, and, in some cases, lint screens.
- Building envelope. Chilled beams require a tight building envelope to prevent moisture infiltration from the outside and the loss of room humidity control. The dew point of the air in the space must remain above the temperature of the beams.

Approach

Depending on the size, orientation, and layout of a patient room, chilled beams can be installed perpendicular or parallel to the perimeter wall. Perpendicular is recommended. Parallel installation can result in drafts and patient discomfort, as during intermediate seasons, when internal cooling is required and window surfaces are cool, an increase in air velocity can occur.

In patient rooms, two-way or one-way beams typically are used. With multiple sizes and nozzle configurations available, two-way beams offer a flexibility allowing them to be applied in most applications. One-way beams typically are used in perimeter zones and/or smaller rooms, usually above the patient bed, along the side wall.

Flow-pattern control allows testing, adjusting, and balancing contractors and facilities engineers to direct supply air from a beam as needed to fit a space configuration, compensate for heat gain through windows, and accommodate comfort needs of patients. Optimal orientation and design target values can be verified with a full-scale mock-up or computational fluid dynamics.

For a typical 220-sq-ft patient room with 9-ft ceiling and 4,500-Btuh sensible load, the minimum total air required (6 air changes per hour [ACH]) is 200 cfm, and the minimum outdoor air (2 ACH) is 70 cfm. Rather than supply 245 cfm of 55ºF air from a mixed-zone recirculation AHU to satisfy a sensible load, a 6-ft chilled beam served by 57ºF chilled water and 70 cfm of 55ºF primary outdoor air will deliver approximately 4,500 Btuh of sensible cooling at an effective 275-cfm supply airflow and very low sound level (20 db). That is a 70-percent reduction in required airflow.

Conclusion

Health-care providers are under increasing pressure to deliver more efficient and effective services using limited resources. Mechanical designers need to take this into account and provide HVAC solutions that are current with technological advances. By capitalizing on new and improved technologies such as active chilled beams, owners can see an improved bottom line, a more productive work environment, and healthier patients.

A mechanical engineer and project manager for RMF Engineering Inc., Craig R. Buck, PE, LEED AP, HFDP, has extensive experience in HVAC-, plumbing-, and medical-gas-system design for health-care facilities. He is well-versed in design standards and code requirements associated with health-care facilities, having designed systems successfully serving a wide variety of specialized-care areas.

HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING

October 29, 2013 // **NEWS**

Craig Buck's article on chilled beams in healthcare patient rooms was also featured in HPAC's email blast.

View Web Version | Add to Safe Sender List

HPAC Fastrack
Engineering resources at your fingertips

HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING

November 13, 2013

FASTRACK Features

Chilled Beams in Health-Care Patient Rooms

By CRAIG R. BUCK, PE, LEED AP, HFDP; RMF Engineering Inc.; Baltimore, Md.

Health-care patient-room design is dictated by rigid environmental and safety requirements, which severely limit the types of systems deemed suitable for HVAC. These requirements are evaluated continually, which, on occasion, opens the door to more progressive and lower-energy technologies. Such a time was 2011, when ASHRAE revised ANSI/ASHRAE/ASHE Standard 170-2008, *Ventilation of Health Care Facilities*,

FULL ARTICLE

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

October 24, 2013 // **NEWS**

DEPARTMENTS | **LEED + DISTRICT ENERGY**

LEED Politics:

Peeking behind the curtain

Tim Griffin, PE, LEED AP, IDEA USGBC Liaison

Editor's Note: *"LEED + District Energy" is a quarterly column providing information about the U.S. Green Building Council's LEED rating system and how it applies to buildings served by district energy systems.*

Politics. Don't you love them? Every organization, whether for profit or not, has them. Heck, every family has them. The U.S. Green Building Council (USGBC) is certainly not exempt, and because of its potential ability to impact not only the construction industry but also many Fortune 500 companies that manufacture construction products, the council often kicks the proverbial beehive. Just follow the money. Primarily as a result of the USGBC's LEED (Leadership in Energy and Environmental Design) rating system, the green construction industry has grown from just $3 billion in 2005 to $58 billion in 2011. Current projections have it reaching $122 billion by 2015! That's a lot of money flowing to a lot of organizations whose executives are keenly aware what is at stake. In fact, business interests make up 89 percent of the USGBC's voting membership, according to a *USA Today* analysis of council records, and 91 Fortune 500 companies belong to the organization. Ninety percent of the voting members of the USGBC board of directors are also officials at for-profit firms. Business, through dues and donations, has given the council many millions of dollars. Does this mean the USGBC's goals of putting the building industry on a more sustainable path are a red herring? Not really. Overall, the council's actions support its stated goals. However, it is clear that for-profit businesses are well-entrenched within the council in an effort to protect and promote their own organizations' goals as well.

THE USGBC'S ACTIONS SUPPORT ITS STATED GOALS. HOWEVER, FOR-PROFIT BUSINESSES ARE WELL-ENTRENCHED WITHIN THE COUNCIL TO PROTECT THEIR OWN GOALS AS WELL.

EARLY BATTLES

If you have been following the LEED rating system for a while, you are probably aware of the changes in the guidelines pertaining to refrigerant use. From the beginning, the use of refrigerants such as R-11 and R-12 has been disallowed in any of a building's cooling systems. However, the early LEED rating system versions also provided points for cooling systems that used refrigerants without HCFCs. This had a direct impact on only one major equipment supplier, Trane, which makes chiller equipment exclusively using R-123, an HCFC. Interestingly enough, a couple of versions later, the whole process for additional points related to refrigerants was changed. No longer could you receive points by avoiding HCFCs. Instead, you had to determine the ozone depletion and global warming potential of all of your refrigerants together to qualify for points.

Why the change? Why the no-HCFC policy in the first place? Although no direct connection can be made, it was interesting to discover that the first CEO of the USGBC was a gentleman by the name of Rick Fedrizzi. Mr. Fedrizzi was also employed as head of environmental marketing for Carrier, a company well-positioned to benefit from LEED credits being unavailable if a building installed one of its main competitors' chillers. Trane President Craig Kissel protested, writing a letter to the USGBC that has been described as "blistering," stating the guidelines required a building owner to pick a less-efficient chiller. In reality, the guidelines did not require anything, as eliminating HCFCs was not a prerequisite. The USGBC was just encouraging building owners not to use HCFCs. At any rate, through a lengthy process, Trane eventually convinced the council of the merits of its argument, and today the additional points can be achieved with chillers containing R-123. Although this was one of the first hornet's nests to be kicked, it has certainly not been the last.

THE MIGHTY ACC

We often talk sports at our conferences, and many of our members represent schools that battle each other on the sports fields within the Atlantic Coast Conference. Today, one of the USGBC's biggest battles is with another ACC, the American Chemistry Council, a trade organization whose members include firms such as DuPont, Dow and others that produce chemicals and materials used in building projects.

From its foundation in the 1990s, the USGBC has wanted to encourage the use of more environmentally friendly materials in building construction. However, early on it encountered resistance from manufacturers that threatened to pull both membership and financial support. The result of these actions could have imperiled the very creation and survival of the USGBC. As a result, the USGBC backed off on the issue.

The issue appears to have lain dormant until the USGBC began work on the latest version of the LEED guidelines, version 4, early last year. The first draft added points for buildings that avoided harmful chemicals or materials; it also included a list of chemicals that were considered harmful. The response from the ACC was immediate. Its primary attack has been to claim the USGBC is requiring building owners to use less energy-efficient materials for building insulation and other applications that will lower the efficiency of the building. This claim, in itself, is misleading. The USGBC again has not made avoidance of harmful chemicals or materials a prerequisite. It is only encouraged through the opportunity to achieve up to two points toward a LEED certification level. On the other hand, building energy efficiency can earn much more than two points. Therefore, it is unlikely a building owner pursuing LEED certification would strive to earn points by ignoring materials only to lose points because he sacrificed building energy efficiency. In contrast, if the same building energy efficiency can be achieved with acceptable materials at the same cost, the owner will likely elect to do so.

The ACC's message, however, has had an impact. When Congress members hear that the changes to the LEED rating system will reduce energy efficiency in federal buildings that achieve certification, they pay attention. There have been bills since proposed before Congress to outlaw and/or limit the LEED certification of federally funded buildings. This is a significant issue for the USGBC as a good proportion of LEED-certified facilities, as well as those currently pursuing LEED certification, fall into this category.

Just when you think the ACC has gained the upper hand, another unusual combatant joins the mix. At last fall's Greenbuild conference, Google announced it was donating $3 million to the USGBC specifically to support research and develop guidelines for healthier building materials. What's Google's angle? While it is not in the materials business, it has been reported that the company has already been a pioneer in keeping toxic chemicals out of its facilities. The battle continues …

AT THE STATE LEVEL

The battle over influencing the LEED guidelines is occurring at the state level across the country as well. In my home state of North Carolina, for example, an issue has arisen as a result of the most recent requirements in the area of sustainable wood products and forest management. While in the past, several different forest certification standards have been accepted as a basis for LEED credit, it appears the new rating system will require forests to meet standards outlined by the Forest Stewardship Council, which are stricter than other guidelines relative to clear-cutting, herbicides and pesticides. North Carolina is a leader in the forestry industry, but more than 98 percent of its timberland would not meet this new requirement. In response to the USGBC's proposed change, the Weyerhaeuser Co. and the North Carolina Forestry Association pushed a bill through the North Carolina House Agriculture Committee to eliminate the ability of any state-funded project to pursue LEED certification.

Interestingly enough, another Fortune 500 company headquartered in North Carolina, Nucor Corp., would have been penalized by the bill. Nucor makes beams and girders for building construction that are more than 90 percent recycled content. The sustainability movement in construction has been a boon for the company's business. Someone always wins; someone always loses.

Eventually, the state overhauled the proposal and passed the Protect/Promote Locally Sourced Building Materials bill, which allows for the use of LEED or another rating system as long as it does not disadvantage "building materials or furnishings … that are manufactured or produced in North Carolina." So, we're green as long as we can buy local.

CONCLUSION

The USGBC is about driving change in the building construction industry. With any change, there are winners and losers. It seems oftentimes that companies spend tremendous resources fighting inevitable change, when the same money could be invested in positioning the organization to be one of the beneficiaries of that change. However, that's politics.

The question for your organization is, How are you responding to the challenges and opportunities created by the green building movement?

Tim Griffin, PE, LEED AP, is IDEA's liaison with the U.S. Green Building Council and serves on IDEA's board of directors. He is a principal and branch manager with RMF Engineering Inc., a firm specializing in district energy system planning, design and commissioning. A registered engineer and a LEED Accredited Professional, Griffin has a Bachelor of Science degree in mechanical engineering from North Carolina State University and a Master of Business Administration degree from Colorado State University. He authored the book *Winning With Millennials: How to Attract, Retain, and Empower Today's Generation of Design Professionals.* He may be reached at tgriffin@rmf.com.

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

October 16, 2013 // **NEWS**

Commissioning Beyond the Documents

Using commissioning as the basis for innovation and improved performance

By James I. Givens, CxA, EMP, RMF Engineering Inc., Baltimore, Md., *HPAC Engineering*

Building commissioning is a quality-based process, the fundamental purpose of which is to provide documented confirmation that building systems are planned, designed, installed, tested, operated, and maintained in accordance with the owner's project requirements. Commissioning often is seen primarily as an added cost, which, admittedly, it is. This, however, should not overshadow the benefits commissioning can yield by lowering operational costs, increasing efficiency, reducing callbacks and occupant complaints, improving indoor-air quality and thermal comfort, and lessening the potential for premature equipment failure. Rather than an added cost, commissioning should be viewed as an investment. Studies by the U.S. General Services Administration, the U.S. Green Building Council (USGBC), ASHRAE, PECI, and the Building Commissioning Association indicate commissioning easily pays for itself over the life of a facility and, in many cases, within just a few years.

Over the last decade, commissioning has become an integral and accepted part of the design and construction process. It is becoming increasingly prevalent and, in some cases, even mandated. This can be attributed largely to the USGBC, which requires the incorporation of commissioning into facility design and construction for consideration and accreditation through its LEED, or Leadership in Energy & Environmental Design, program.

With commissioning becoming more common and new providers appearing every day, facility owners and operators are having an increasingly difficult time separating the wheat from the chaff. At the same time, commissioning providers are finding it harder to demonstrate the value they bring to the table.

In the commissioning industry, there has been a trend toward standardization, as a prescribed process using relatively uniform checklists, forms, and documentation procedures has developed over time. Unfortunately, there also seems to be a trend toward sole reliance on the basic recommendations of published commissioning guidelines and standardized reporting mechanisms. Anyone can understand and implement a prescribed process, but not everyone can see past the documents and associated requirements to carry out standard activities while maintaining focus on the quality of the end result.

Realizing the fundamental intent of commissioning requires an inherent understanding of a facility, the procedures/operations, and the integration of building systems. This reaches far beyond documents and is where the value in commissioning is found.

For example, consider an enthalpy-control scenario for outside-air-economizer operation for air-handling systems serving a humidity-sensitive health-care facility. Pre-functional checklists were completed, and device installation and calibration and point-to-point communications were verified. Functional performance testing demonstrated effective sequence-of-operation programming and control logic. Also, automated control-system graphics were reviewed for applicability and representation of control points. The commissioning process was applied in accordance with the documents and standard industry practices. The result was a HVAC system applying accurate temperature and relative-humidity values to a tested enthalpy-controlled economizer sequence.

Had that been the end of the story, the system would have had no hope of operating according to the design intent. A technical understanding of enthalpy controls and the applied psychrometrics, together with an in-depth analysis of system operations—beyond what was identified and spelled out in the documents—revealed the equations embedded in the automated-control programming were calculating enthalpy incorrectly. This problem, which was relatively quick and painless to rectify, would have gone unnoticed through the "standard" commissioning process. As the result of a small investment in focus and quality, far-reaching seasonal operations and temperature-control problems that would have plagued the facility over time were avoided. Think about the money and labor that otherwise would have been spent investigating and troubleshooting the problem down the road.

Another suitable illustration is airflow validation. Typically, whether as part of contract documents or the commissioning process, demonstration of a certain percentage of airflow readings within prescribed tolerances is required. Normally, actual measured airflow must be within ±5 to 10 percent of specified design values.

Consider a room in which supply airflow is 5 percent below the design quantity, and exhaust airflow is 5 percent above the design quantity. This would pass a common document-driven commissioning process. Now, imagine there is no clear statement in the documents that a specific pressure relative to adjacent spaces must be maintained. This, however, is an operating room that must be positively pressurized for sterile conditions to be maintained. Understanding this requirement and the use of the space, could you walk away from the room with confidence the implied design intent was realized? What is the chance the room could exhibit a neutral or even negative pressure, and how important is that? Though not expressly required, validation of room-pressure relationships for critical areas as part of commissioning adds value.

As automated control systems become more sophisticated and tolerances and sensitivities for energy management tighten, verification beyond documents and control graphics is becoming increasingly important. All too often, information is taken at face value and not substantiated, justified, or proven through testing. Design professionals rely on computer load-calculation programs and vendor-provided equipment-capacity selections. Controls vendors install factory-calibrated devices and implement canned control-sequence programming. Device values, component positions, and equipment statuses reported on computer screens commonly are accepted without a second thought.

Project documents often include general requirements for system operating sequences and control strategies, leaving equipment/system providers and controls vendors to determine the details. While operating parameters and setpoints often are spelled out in documents, the processes by which requirements are satisfied routinely are undefined and, thus, left open to interpretation. Examples include system interaction and interlocks, interfaces between packaged controls and building-automation systems (BAS), control sequences and capacity-staging requirements for packaged equipment, and modes of operation, such as startup, shutdown, normal, and emergency. Commissioning providers have the advantages of objective involvement and experience to draw attention to voids in project documents.

Calling attention to such details as part of a commissioning design or submittal review early in a project can drive action and head off potential delays and expenses. Having manufacturers, equipment vendors, and design professionals confirm details, capabilities, and compatibilities of packaged and central control systems prior to or at least during the selection process is extremely beneficial, although it may not be expressly required in documents. How many times have you encountered a scenario in which an aspect or feature of equipment control cannot be implemented or must be manipulated because of incompatible packaged controls or because a specific piece of equipment is required to satisfy an owner's needs? Perhaps the owner invested a significant amount of time and money into a sophisticated BAS, which is able to inform the owner only of on/off status and general alarm condition for specialized equipment because the BAS is not compatible with the packaged control system. Would the recommendation of a controls gateway or added device enabling a full controls interface be considered beneficial by the owner? How about the ability to seamlessly view and integrate the control functions of all equipment and components for the life of the facility?

While it is common for system sequences to be outlined in great detail in project documents, it also is common to see, "On the reverse, the opposite shall occur," or something similar. This clouds the intent and, when commissioning is performed strictly to the requirements of documents, may not yield all of the desired results. Requesting clarification and details serves not only to spell out testing requirements, it sheds light on criteria that may not have been considered by the design and operations team. For instance, is the manual, or "hand," mode of system operation required to be the same as the fully automatic mode? What about bypass operation of variable-frequency drives? For critical systems and applications, when and how do system-control safeties come into play? Should a temperature-control safety device de-energize an air-handling system serving a critical health-care or laboratory facility? Clarification and understanding of unstated or otherwise implied expectations can be valuable to an entire team.

Conclusion

With project schedules continuously being compressed, there is a trend toward simplification and streamlining of design and construction processes and documentation. At the same time, building systems are becoming increasingly complex, and the bar for performance is being raised. Bridging this gap is where commissioning providers can bring the most value to clients. If you commission beyond the documents, the question of whether commissioning services are worth the investment is easily answered.

Whether you are a facility owner/operator trying to distinguish between quality- and commodity-based commissioning providers or a commissioning provider looking to increase the value you bring to a project, look for opportunities for commissioning beyond the documents. More often than not, "hidden" and overlooked items are the most valuable and rewarding, no matter your role. These items serve to "connect the dots," streamline the process, and maintain overall quality.

When you work out solutions, rather than merely document deficiencies, real commissioning value is realized—by all parties. It is the quality of the end result that matters most and remains with us for a long time to come.

James I. Givens, CxA, EMP, has been providing commissioning services through RMF Engineering Inc.'s Field Services division for more than 15 years. He serves on the board of the National Capital Chapter of the Building Commissioning Association. He can be reached at jim.givens@rmf.com.

HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING

October 16, 2013 // **NEWS**

Jimmy Givens' article was also featured in HPAC's "Engineering Green Buildings" email newsletter.

View Web Version | Add to Safe Sender List

Engineering Green Buildings

HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING

November 20, 2013

- Commissioning Beyond the Documents
- Urine Power: The Wave of the Future?
- LEED v4 Launches
- Berkeley Lab Models Greenhouse-Gas Emissions in California
- Taco University Session 3 Set for Nov. 26

EGB Features

Commissioning Beyond the Documents

By JAMES I. GIVENS, CxA, EMP; RMF Engineering Inc.; Baltimore, Md.

Realizing the fundamental intent of commissioning requires an inherent understanding of a facility, the procedures/operations, and the integration of building systems. This reaches far beyond documents and is where the value in commissioning is found.

FULL ARTICLE

EGB Blogs

Urine Power: The Wave of the Future?

By SCOTT ARNOLD, Executive Editor, HPAC Engineering

When it comes to sustainable energy sources, I have heard of wind, I have heard of solar, and I have heard of geothermal. But *urine*?

FULL ARTICLE

September 30, 2013 // **NEWS**

RMF Presents Water, Engineering Design Paper at Science Conference

RMF Engineering
Reliability. Efficiency. Integrity.

RMF Engineering presented a paper on the role of water in engineering sustainability efforts at a gathering of engineers and scientists from the academic, government, industry and nonprofit sectors.

The presentation was based on a paper written by Don Kranbuehl of Clark Nexsen and Nancy White, UNC Coastal Studies Institute executive director, on natural waters and water systems in North Carolina's Outer Banks, RMF said April 25.

Kranbuehl and Avery Monroe, RMF project manager, presented "The Science of Water and How it Can Inform Design" at Engineering Sustainability 2013

The conference was hosted by the University of Pittsburg's Mascaro Center for Sustainable Innovation and Carnegie Mellon's Steinbrenner Institute for Environmental Education and Research.

Air Conditioning | Heating | Refrigeration
the NEWS

August 22, 2013 // **NEWS**

Sept. 11, 2013: RMF Engineering Opens New Office in Charlotte

Firm Offers MEP Engineering Services

BALTIMORE — RMF Engineering has announced the opening of a new full-service office in Charlotte, N.C. The new office enables RMF to offer local mechanical, electrical, and plumbing (MEP) engineering services for health care, higher education, and local and federal government projects in the greater Charlotte area. Additional services, including commissioning engineering, will continue to be provided from RMF's Raleigh office.

The new office is being led by Avery Monroe, P.E., LEED AP, a mechanical engineer and project manager who was appointed branch manager for the Charlotte office. Monroe has been with RMF for 12 years. He has more than 25 years of experience in design, analysis, and construction administration of HVAC, plumbing, and fire protection systems serving educational, health care, laboratory, military, and commercial facilities.

Teresa White, an electrical engineer who has been with RMF for more than 15 years, is now working with Monroe in the new office. Mechanical designer, Scott Broadfield, was recently hired and has joined the Charlotte team as well.

RMF brings experience in energy modeling and building information modeling (BIM) to the Charlotte market.

For more information, visit www.rmf.com.

CONSULTING - SPECIFYING
engineer

August 23, 2013 // **NEWS**

MEP Roundtable

Tips and tricks for commissioning, balancing buildings

Building commissioning is one of the most important (and complex) types of projects an engineer can be tasked with. Engineers give advice here and online, and manufacturers provide advice at **www.csemag.com/archives.**

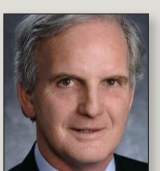
CSE: What tips can you offer engineers working on commissioning projects?

Michael P. Feyler: During the design phase, a meeting should be held for the commissioning engineer and the design engineer to review the systems chosen and the sequences of operations, plus a controls integration meeting to share experiences on similar systems and the results from previous projects with similar systems and building types for the systems being included within the design. During the submittal phase, on complicated projects, it is beneficial for the design engineer, commissioning agent (CxA), and controls contractor to meet prior to the final approval of the control scheme to ensure that all are in agreement on the control mythologies and sequences. During the construction phase, after the control submittal is approved, the commissioning engineer drafts the functional testing documents. Sharing the draft functional testing documents with the design team and contractors for their review and input will ensure that prior to the release of the final testing documentation, all parties have reviewed and provided input on the documents, and all parties have a though understanding of the design intent. A beneficial procedure our team has incorporated into the commissioning specification is for the contractors to "dry run" the system prior to commissioning. This requires the contractors to test the systems using the functional performance tests, to debug and check programming and operation. RDK requires a sign-off of the dry run prior to site commissioning. All of the above ensure that the contractor has a full understanding of the system operation prior to commissioning.

Jerry Bauers: Effective execution of any field testing effort is almost entirely dependent on preparation prior to arrival at a project site. While a test procedure can be a long, complex process, its component parts should be quite simple and clear. Each step in a test procedure should be specifically designed to demonstrate an element of performance clearly and without confusion. And the purpose of that step (or series of related steps) should be clear to the execution team. In the end, testing is only valuable if it either demonstrates success or points clearly to corrective actions that lead to success. Preparation prior to going to the field, understanding the systems to be tested, the objectives of each step of the test, and strategies to deal with the unexpected are essential to effective field execution.

Geremy Wolff: There are a number of tips:

- Break it down into manageable steps; you can't eat an elephant in one bite.
- Take the time to review and play devil's advocate with the sequence of operation. Make sure that the sequence covers all aspects of operation including what happens during a loss of power and return to normal power after an emergency (often ignored). And, if an engineer is going to "borrow" a sequence from a previous (similar) project, take the time to go through the sequence and make sure all the changes are made to make this one applicable to the project (often ignored).
- Have the installers pretest the systems before you attempt to "commission"



Jerry Bauers
National director of commissioning
Sebesta Blomberg
Kansas City, Mo.

Michael P. Feyler
Co-director, building solutions group
RDK Engineers
Andover, Mass.

Robert J. Linder, PE
Senior project manager
Karges-Faulconbridge Inc.
St. Paul, Minn.

them. There is no greater waste of time than organizing a test and getting everyone out to the site and in place only to find out the contractor running the test is not ready, the system is not ready, or the contractors don't understand their role and responsibility.

■ Change the way people view "functional testing." It should not be viewed as "well, let's flip the switch as see what happens." Functional testing should be viewed as "functional demonstration." We are not testing to see if it works, but rather demonstrating that it works in accordance with the designer's expectations and the owner's project requirements.

■ Start from the basic concept of "How does it (the piece of equipment/system) turn on and turn off?" If you can't prove those basic functions, then the rest is meaningless.

■ Test from the approved as-programmed sequence of operation, not the engineer's operating "intent." The intent is usually vague and is not detailed enough to create a test from.

■ Ensure there is time in the schedule for the building automation system (BAS) provider and engineer to review the test scripts and provide comments weeks before the test is executed. You might find how you are planning to test the system can't be done, or that the sequence used to create the test is out of date and no longer applicable.

■ Be flexible; know the test procedure you spent all that time on will have to be modified in the field while performing the test.

Barney York: The best tip for engineers working on commissioning projects is to become proactively involved early with the owner and design team and remain involved with both throughout the project. The CxA is there to assist the design team professionals and as such can help designers avoid problematic and costly errors that would otherwise be discovered during construction or occupancy. Early designer involvement helps the CxA better understand the design intent, and together the CxA and design team can incorporate the devices and sequences needed to successfully test and validate the systems operation. Continued involvement and communication with designers during construction and commissioning helps the project team make minor adjustments to system performance as well as helps the designers further their professional development.

Figure 1: At the Carolinas Medical Center Pineville near Charlotte, N.C., RDK Engineers' commissioning work included an energy plant, providing critical utility systems to the hospital. Courtesy: RDK Engineers

Robert J. Linder: A few tips we press upon our staff include:

■ Do your homework; understand the owner's functional requirements that were to be met.

■ There is no substitute for getting dirty on a project; don't just sit at the direct digital control (DDC) front end observing operations.

■ Develop detailed testing procedures and don't skip steps.

■ Validate functionality and DDC reporting of all components before you test equipment; don't just trust the controls contractor.

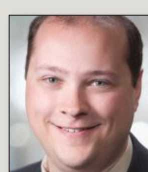
■ Functional verification is not complete until all integrated systems testing is finished and conformance to the design intent was observed and documented.

James Szel: Understanding the sequence of operation is key. Review the operations and maintenance (O&M) manuals for information on how the equipment operates. If the sequences don't make sense, don't be shy about making that phone call to the engineer of record. If it still doesn't make sense, engage the vendor's technical group. I recently went to a factory witness test at a major chiller vendor. We had some very detailed technical questions. The vendor brought in its lead installation technician to speak with us. He was a great resource. It is important to remind the team that the end goal of commissioning is to hand over a quality, operational building to the owner.

CSE: What aspect of the BAS is most overlooked when initially designed?

James Szel
Senior vice president
Syska Hennessy Group
New York City

Geremy Wolff
Commissioning manager
McKinstry
Bellingham, Wash.



Barney York
Project manager
RMF Engineering
Baltimore

MEP Roundtable

York: A significant number of design firms do not have design engineers that fully understand BAS. As a result, the mentality is that the BAS contractor will "make it work." When this occurs, drawings and specifications lack the technical detail required to transfer the owner's project requirements to the systems within the building. Unless the CxA for the project reviewing the project documents is knowledgeable in the design and functionality of the BAS, owners can be left at the mercy of the BAS contractor for numerous costly change orders and project schedule delays. We have assisted clients with developing project requirements they can present to the design team before design begins for a project. When reviewing the project documents, we are already quite familiar with the design standards and are able to provide comments that ensure the documents are matching the client's requirements for the project. We have also assisted clients by having the BAS contractor demonstrate its programming for the project in a simulator prior to downloading the programming into BAS controllers on-site. This allows "bugs" to be worked out in advance, minimizing start-up and schedule delays.

Bauers: The two most often under-specified items in control systems are the sequences of control and the alarming and reporting strategies to be implemented by the control vendor. With regard to sequences, we will also spend a disproportionate effort in understanding and clarifying the sequence of control to make its translation into control code as seamless as possible. We also work closely with the operating teams and the designer to define the graphics interface and an effective alarming and reporting strategy for the completed system. We replace the time honored control vendor tradition of working these things out with the operators at the end of the job.

Feyler: What is often overlooked is the skill-set of the building facility personnel that is left behind when the project team leaves. In some cases, the BAS if often over-sophisticated for the type of building it is operating, and the training is often not long enough to ensure a successful turnover. We offer the client additional system education via having the facility team join the CxA during the testing of the systems to observe how the system operates and how the BAS interacts with each system. In most cases, training put into a specification is classroom-style training and not field training or hands-on training that RDK offers during the testing phase and warranty phases of the project. In addition, trending reporting should be included in the specification that would allow a continuous commissioning of the building. This is not always the case; the CxA will always request trending reports prior to the testing of the systems.

Figure 2: RMF Engineering's commissioning projects include a criminal forensic laboratory at a North Carolina detention center. Courtesy: RMF Engineering, HDR Architecture

Linder: Owner preferences are commonly overlooked by the design team. Simple things like a fan status can end up being a thorn in the side of the building operator. Do you use a current switch, a pressure sensor, or a status command? These are all acceptable methods, but which is preferred? Communicate with your owner and don't overlook the details. A controls shop drawing review meeting is a great way to cover these details. We invite the controls contractor, engineer, and the owner's operations staff to a meeting where we dissect the controls shop drawing. All decisions are made at this meeting and the controls contractor leaves with an approved shop drawing to start their work. Everyone understands the decisions that were made, and why they were made.

Szel: Again, how the client intends to use the final configuration of the BAS is the most overlooked aspect. The initial design is usually good, choosing the points and describing the sequences of operation, but doesn't always take into account how the client is going to use its system. Getting the BAS contractor and the owner (or facility engineers who will be operating the building) into the same room early in the process helps the client get what it needs in the system without the contractor having to redesign a system at the end of the project when there is almost always a time crunch. Another overlooked aspect is often the integration between multiple control systems, such as multiple BAS systems. To provide optimum efficiency in operating the facility, it is important for there to integration between control systems, so the operating team does not have multiple consoles, etc., to operate.

CSE: Describe a sequence of operations challenge you solved in a building automation/control system.

Wolff: This happens every day. One of the most common is how to control pressure within a building. The sequence to operate systems with combination return/relief fans and dedicated exhaust dampers is one we typically provide significant input on. One of the most common challenges we face related to sequences of operation is that often the designers and controls technicians focus on each individual piece of equipment and lose sight of the overall function of the building as a whole. Through our process of looking at the building holistically, we can easily identify where an action of one system will strongly affect the actions or performance

MEP Roundtable

of another system. This is often overlooked in the implementation of the sequence.

Bauers: In the process of commissioning containment laboratories, we are tasked with complying with National Institutes of Health/U.S. Centers for Disease Control and Prevention standards for pressurization of laboratories. In these standards, laboratories must remain under a negative pressure at all times, including through transient failure conditions. Working closely with the operations team and the control contractor at a Texas university, we were able to use the stack effect of the exhaust system to eliminate transient pressure reversals that are inherent to systems that respond to supply or exhaust failures with fully closed dampers. While the concept is novel, the success of our efforts was driven by our patient adjustment of control loop tuning and the timing of control responses to failures.

Figure 3: RDK Engineers' Building Solutions Group recently provided LEED commissioning for a new 183,000-sq-ft academic building at Boston College. Courtesy: RDK Engineers

York: A science building had an issue with its laboratory exhaust fan system that consisted of three fans. When an additional fan was called to operate, the fan that was coming online would begin to freewheel backwards as soon as the isolation damper for the fan was fully open. Once the damper fully opened, an end-switch was made and the fan would attempt to turn in the correct direction. The fan could not overcome the backwards momentum and, as a result, the fan's associated variable frequency drive (VFD) would trip on an overcurrent situation. We recommended adding a time-delay relay in series with the end-switch safety circuit and starting the fan at minimum speed prior to opening the isolation damper. As a result, the fan was able to start in the correct direction prior to the isolation damper opening. Once the time-delay relay contact dropped out, the end-switch was made on the damper, keeping the safety circuit intact. Another project had a static pressure reset sequence for an air-handling unit (AHU) and associated terminal units based on terminal unit damper positions. We discovered that often a terminal unit with a mechanical or damper actuator issue would drive the AHU static pressure setpoint to the maximum value, thus wasting energy. We recommended additional programming that would identify terminal units responsible for this issue, temporarily remove them from the sequence, and send an alarm to alert the appropriate personnel to investigate the issue. As a result of the energy savings achieved from this change, the owner elected to implement the same change in other buildings on its campus as well.

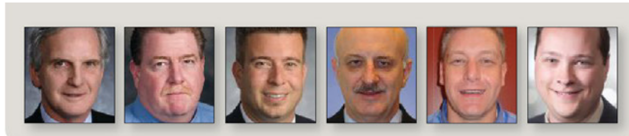
CSE: How have changing HVAC, fire protection, life safety, and/or electrical codes and standards affected your work in commissioning?

Wolff: NFPA requirements have changed the way we handle measurement on mechanical systems. It used to be pretty common for one of our engineers to open up the electrical panel on a rooftop unit to take amp/volt readings or install a data logger without thinking twice. Arc flash training has taught us this is something to be very careful with and there is a proper procedure to follow and personal protective equipment (PPE) that must be used. In Washington state, commissioning has been a requirement under the energy code since 1997. However, this code has been tough to enforce. The most recent version provides some additional compliance requirements with a compliance checklist that indicates the commissioning has been completed. We are now seeing inspectors looking for this document before they sign off on the final permits. One of the biggest challenges we face with regard to commissioning codes is one of education. There are a fair number of code officials that admittedly do not fully understand commissioning.

Figure 4: A BSL-3 laboratory, with a hazardous waste decontamination system, was one of the systems involved at a recent Sebesta Blomberg commissioning project, conducted for a university in the northeastern U.S. Courtesy: Sebesta Blomberg

We, the commissioning industry, have recently started to work closely with the International Code Council to provide educational programs to the authority having jurisdiction (AHJ) on what commissioning is and, more importantly, what it is not.

Feyler: Building, mechanical, fire protection, life safety, and electrical codes change on a cycle, allowing for designers and CxAs to keep informed of changes as the codes update. Projects to be permitted after a code cycle change are the most difficult to perform design reviews of, so the CxA needs to become familiar with the adopted changes prior to the issuance of the new code. The CxA also needs to be familiar with the state the project is to be commissioned in, and be aware of what the adopted code is for that state and if the state has amendments to the adopted code. The CxA also needs to verify if the jurisdiction, city, town or county he or she is working in has the right to amend state adopted code or choose not to adopt portions or parts of state code. An example of this is Massachusetts; the state has the



Stretch Energy Code, an addition to the building code. It provides a more energy efficient alternative to the standard energy provisions of the code. A municipality may choose to or chose not to adopt the addition.

York: I find more and more codes are now beginning to require that systems be commissioned as part of the acceptance process. The end result for CxAs is our scope of services has expanded, and we must find talented and highly skilled individuals to oversee and validate these systems. Building envelope, special inspections, and electrical testing are now becoming common request in requests for proposals (RFPs).

Szel: The changing codes are taken into consideration during the design process. We stay abreast of these codes to ensure the field installation is in compliance with the appropriate codes and standards. It is important for the design and commissioning teams to have full knowledge of all local codes and requirements, by the AHJ. The design and commissioning must be in compliance with those requirements.

CSE: What systems or best practices do you suggest to test the building envelope?

Feyler: RDK works with clients that require the CxA carry the building envelope contractor. The practice of the building envelope team inserting requirements into the commissioning specification, implementing two design reviews of the architectural drawings with tracking of those comments prior to construction commencement, is one of the best practices. Basic building envelope commissioning includes window testing, infrared scans, and moisture scanning of the roof.

Szel: Common building envelope testing practices include:

- Air leakage testing
- Water penetration testing
- Thermal bridge testing.

The air-leakage testing uses a "blower door test"—for example, using the protocol of ASTM E779–10. The PassivHaus Standard has stringent air-leakage requirements and is driving this discussion with many clients. The simplest water penetration test sprays the façade using a calibrated nozzle, for example, following ASTM E1105. This helps identify possible problems for indoor environmental quality (IEQ) and durability, as well as thermal issues. To look for thermal bridges we use infrared scanning. There are also standards like ASTM C1060-11a to look at insulation in façade cavities. cse

Read the longer version of this online at: www.csemag.com/archives.

CONSULTING - SPECIFYING engineer

August 23, 2013 // **NEWS**

MEP GIANTS 2013

MEP Giants make nearly $1 billion more in 2013

Even in a down economy, the 2013 MEP Giants firms continue to show increased billings.

BY **AMARA ROZGUS,** *Editor in Chief, and* **AMANDA McLEMAN,** *Project Manager, Consulting-Specifying Engineer, Oak Brook, Ill.*

The 2013 MEP Giants generated $39.5 billion in total revenue during the previous fiscal year and slightly more than $6 billion in mechanical, electrical, plumbing (MEP), and fire protection engineering design revenue. The jump is due to a host of new firms on the 2013 MEP Giants list, namely Jacobs Engineering Group, which came in at the No. 1 spot, pushing out the perennial top-position holders Black & Veatch and URS Corp. Other newcomers to the list include Mesa Assocs. (No. 21), Highland Assocs. (No. 55), Coffman Engineers (No. 58), Wood Harbinger (No. 67), Morrison Hershfield (No. 92), Global Engineering Solutions (No. 94), Advanced Engineering Consultants (No. 98), and Kohler Ronan LLC Consulting Engineers (No. 100). These additions, plus several firms that returned to the MEP Giants list after a year (or two) off, increased the revenue numbers.

Table 1 shows the top 10 firms based on MEP design revenue, which is how the MEP Giants are ranked. Table 2 shows the top 10 MEP Giants firms based on total gross revenue. The complete table of rankings is provided at www.csemag.com/giants. Total revenue rose from $33.8 billion in 2012; MEP design revenue totaled $5.3 billion in 2012. As seen last year, two-thirds (66%) of all firms' revenue is generated from MEP design, with average MEP design revenue at $60.6 million per firm.

While total revenue increased over 2012 revenue, participants again indicated that "the economy's impact on the construction market" was the greatest challenge (71%). According to Q2 2013 data, the research firm FMI reduced annual construction-put-in-place (CPIP) predictions to $913 billion, a 7% growth from 2012, due to shifting markets. This is down nearly $6 billion from the $918,897 million, 8% growth estimated in the Q1's outlook. However, FMI does expect growth to return to 8% growth in 2014 with annual CPIP reaching $989 billion. All markets reported by FMI were down; those with the smallest decrease are commercial construction (-0.8%) and amusement and recreation (-2.0%).

Table 1: Top 10 firms by MEP design revenue

Rank	Firm	MEP design revenue ($)
1	Jacobs Engineering Group Inc.	1,549,650,401
2	Black & Veatch	1,042,980,000
3	URS Corp.	550,000,000
4	exp	158,380,000
5	Parsons Brinckerhoff	156,000,000
6	HDR Inc.	121,765,835
7	Stantec Inc.	107,000,000
8	Burns & McDonnell	98,590,000
9	Affiliated Engineers Inc.	94,533,000
10	Arup	88,516,976

Table 1: Top 10 firms are listed by MEP design revenue. Jacobs Engineering Group topped the list as the No. 1 firm with 14% of its gross revenue dedicated to MEP design. All graphics courtesy: *Consulting-Specifying Engineer*

Methodology

At the beginning of the year, the *Consulting-Specifying Engineer* staff collected and analyzed data from more than 100 consulting and engineering firms. Some of the top mechanical, electrical, plumbing (MEP), and fire protection engineering firms submitted their firm's profile to the *Consulting-Specifying Engineer* staff; however, not all consulting firms were willing or able to participate in this year's MEP Giants survey. The minimum MEP design revenue required for consideration is $1 million.

In 2013, more than 100 engineering firms provided their information for the MEP Giants program, with quite a few newcomers. Because many of these newcomers are relatively large, several perennial firms "fell off" the list. Data and percentages are based on the top 100 companies that responded to the request for information; the results do not fully represent the construction and engineering market as whole. However, with nearly identical questions asked in previous years and more than 100 engineering firms participating this year, we present a qualified look of where the top engineering firms stand in 2013.

The 2013 MEP Giants firms continue to work on several projects in hospitals, data centers, offices, and schools. Read about several project profiles in a special section at www.csemag.com/giants.

MEP Giants also indicated that they evenly split their time between new construction and retrofit/renovation, each coming in at 42%. Rounding out the projects are commissioning or retro-commissioning (7%); maintenance, repair, and operations (7%); and other (2%). For a more in-depth report on commissioning, look for the October 2013 issue on the Commissioning Giants.

Engineering employment expands

The 2013 MEP Giants firms employ nearly 60,000 engineers, up from more than 55,000 in 2012 and 49,500 engineers in 2011. Engineers in the mechanical, electrical, plumbing, and fire protection fields accounted for nearly 20,500 engineers, up from 18,000 engineers last year.

Figure 1 shows the breakdown of the mechanical, electrical, plumbing, and fire protection engineers employed by the 2013 MEP Giants. Note that 88% of the 20,499 engineers employed by these firms are either mechanical or electrical engineers, 10% are plumbing engineers, and 2% are fire protection engineers.

Several opportunities are open to MEP Giants outside the United States and North America while the U.S.-based construction market lags. For example, 48% of firms are providing engineering services in Asia, including China, India, and Japan. Other areas of growth include the Middle East (42% of firms are providing services), Europe (30%), the Caribbean (29%), and South America (26%).

When it comes to sustainable engineering, the number of U.S. Green Building Council LEED projects has held nearly steady over the past three years; 2285 projects were submitted for LEED certification in 2013, 2214 in 2012, and 2365 in 2011. The number of projects submitted in 2013 to the U.S. EPA Energy Star Buildings Label program remained steady as well, with 401 submitted in 2013 and 414 submitted in 2012.

The 100 firms listed here don't handle all aspects of engineering. Many subcontract specialty services, including: acoustics (64%), security system design (30%), computational fluid dynamics modeling (26%), and construction management (25%). Security system design saw the largest increase from 25% last year to 30% this year.

Smart technology

Like other businesses, engineering firms keep up with various technologies, especially software and design tools. At least nine out of 10 firms use the following software: computer-aided design (CAD), building information modeling (BIM), energy analysis, Revit MEP, and project management and collaboration.

New tools include smartphone apps, with several respondents using technologies offered by product manufacturers or app developers. In 2013, the MEP Giants are using apps in productivity and project management (54%), engineering calculations (44%), and file preview or product catalogs (43%). All of these represent a growth of at least 10% over last year's results. Product manufacturers and educators take note: These apps aren't going away. cse

Engineers on staff

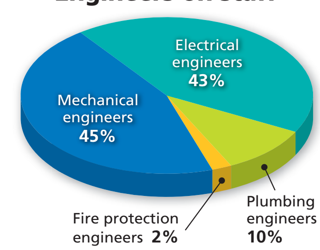


Figure 1: **Among the 20,499 mechanical, electrical, plumbing, or fire protection engineers employed by the 2013 MEP Giants, 9195 are mechanical engineers, 8753 are electrical engineers, 2058 are plumbing engineers, and 493 are fire protection engineers.**

Read the longer version of this online at: www.csemag.com/giants.

Table 2: Top 10 firms by gross annual revenue

Rank	Firm	Gross annual revenue ($)
3	URS Corp.	11,000,000,000
1	Jacobs Engineering Group Inc.	10,893,780,000
2	Black & Veatch	3,279,000,000
5	Parsons Brinckerhoff	2,637,922,000
7	Stantec Inc.	1,882,900,000
6	HDR Inc.	1,659,800,000
8	Burns & McDonnell	1,556,000,000
40	CDM Smith Inc.	1,213,000,000
4	exp	527,934,000
49	STV	373,538,000

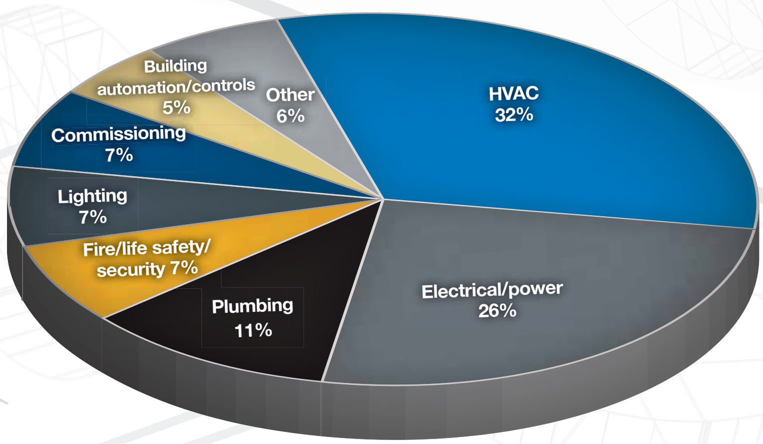
Table 2: **This shows the top 10 firms by gross annual revenue. URS Corp., with the highest gross annual revenue, reports 5% of its total as MEP design revenue.**

CONSULTING - SPECIFYING
engineer

CONSULTING - SPECIFYING engineer

MEP GIANTS 2013

PERCENTAGE OF MEP DESIGN BILLINGS:



by the numbers

$39,519,323,856
Grand total gross revenue

$6,062,878,885
Grand total MEP design revenue

59,853
Engineers employed by the 2013 MEP Giants

7,905
LEED Accredited Professionals

2,285
Projects submitted for U.S. Green Building Council LEED certification

91%
Indicate they provide engineering services in the South Atlantic region of the United States

71%
Cite the ecomony's impact on the construction market as their biggest corporate challenge

48%
Indicate they provide engineering services in Asia

MEP GIANTS INDEX

FIRM NAME	2013 RANK
Advanced Engineering Consultants Ltd.	98
Affiliated Engineers Inc.	9
AKF Group LLC	17
Alfa Tech	63
Allen & Shariff Corp.	84
Aon Fire Protection Engineering Corp.	42
Arup	10
Bala Consulting Engineers	60
Bard, Rao + Athanas Consulting Engineers LLC	27
Barton Assocs. Inc.	97
Black & Veatch	2
Bridgers & Paxton Consulting Engineers Inc.	56
Brinjac Engineering	93
BSA LifeStructures	52
Burns & McDonnell	8
Buro Happold Consulting Engineers	18
Cannon Design	16
ccrd partners	45
CDM Smith Inc.	40
CJL Engineering Inc.	70
Coffman Engineers Inc.	58
CTA Architects Engineers	50
DLR Group	38
Dynamix Engineering Ltd.	86
EEA Consulting Engineers	88
ESD (Environmental Systems Design Inc.)	28
exp	4
EYP	31
Fishbeck, Thompson, Carr & Huber Inc.	99
Gannett Fleming Inc.	61
Ghafari Assocs. LLC	43
GHT Ltd.	57
Global Engineering Solutions	94
Glumac	26
GPI/Greenman-Pedersen Inc.	68
H&A Architects & Engineers	39
H.F. Lenz Co.	44
Harley Ellis Devereaux	73
HDR Inc.	6
Heapy Engineering	48
Henderson Engineers Inc.	13
HGA Architects and Engineers	24
Highland Associates	55
I.C. Thomasson Assocs. Inc.	47
Interface Engineering	41
Jacobs Engineering Group Inc.	1
Jordan & Skala Engineers Inc.	53
Joseph R. Loring & Associates Inc.	59
Karpinski Engineering	71
KJWW Engineering Consultants	29
Kohler Ronan LLC Consulting Engineers	100
Kohrs Lonnemann Heil Engineers PSC (dba KLH Engineers)	66
LEO A DALY	23
Lizardos Engineering Assocs. PC	75
M.E. GROUP Inc.	85
M/E Engineering PC	46
Matrix Technologies Inc.	74
McClure Engineering	95
M-E Engineers Inc.	30
MEP Assocs. LLC	96
Mesa Assocs. Inc.	21
Michaud Cooley Erickson	51
Middough Inc.	15
Morrison Hershfield	92
Newcomb & Boyd	64
Optimation Technology Inc.	20
P2S Engineering Inc.	76
PageSoutherlandPage	36
Parsons Brinckerhoff	5
PEDCO E&A Services Inc.	89
Peter Basso Assocs. Inc.	78
Primera Engineers Ltd.	91
Professional Engineering Consultants PA	83
RDK Engineers	37
Rist-Frost-Shumway Engineering PC	82
RMF Engineering Inc.	35
Ross & Baruzzini Inc.	79
Salas O'Brien LLC	65
Sebesta Blomberg	33
Setty Group	80
Smith Seckman Reid Inc.	19
Spectrum Engineers	72
SSOE Group	22
Stanley Consultants	25
Stantec Inc.	7
STV	49
Syska Hennessy Group	11
ThermalTech Engineering Inc.	77
THORSON BAKER & Assocs. Inc.	90
TLC Engineering for Architecture Inc.	32
TME Inc.	68
Triad Consulting Engineers Inc.	54
TTG (TMAD, TAYLOR & GAINES)	34
URS Corp.	3
Vanderweil Engineers	14
WD Partners	62
Westlake Reed Leskosky	81
Wick Fisher White	87
Wood Harbinger	67
WSP	12

CONSULTING - SPECIFYING engineer

For information about this year's MEP Giants, and

RANK	FIRM NAME	LOCATION
1	Jacobs Engineering Group Inc.	Pasadena, CA, U.S.
2	Black & Veatch	Overland Park, KS, U.S.
3	URS Corp.	San Francisco, CA, U.S.
4	exp	Brampton, ON, Canada
5	Parsons Brinckerhoff	New York, NY, U.S.
6	HDR Inc.	Omaha, NE, U.S.
7	Stantec Inc.	Edmonton, AB, Canada
8	Burns & McDonnell	Kansas City, MO, U.S.
9	Affiliated Engineers Inc.	Madison, WI, U.S.
10	Arup	New York, NY, U.S.
11	Syska Hennessy Group	New York, NY, U.S.
12	WSP	New York, NY, U.S.
13	Henderson Engineers Inc.	Lenexa, KS, U.S.
14	Vanderweil Engineers	Boston, MA, U.S.
15	Middough Inc.	Cleveland, OH, U.S.
16	Cannon Design	Buffalo, NY, U.S.
17	AKF Group LLC	New York, NY, U.S.
18	Buro Happold Consulting Engineers	New York, NY, U.S.
19	Smith Seckman Reid Inc.	Nashville, TN, U.S.
20	Optimation Technology Inc.	Rush, NY, U.S.
21	Mesa Assocs. Inc.	Madison, AL, U.S.
22	SSOE Group	Toledo, OH, U.S.
23	LEO A DALY	Omaha, NE, U.S.
24	HGA Architects and Engineers	Minneapolis, MN, U.S.
25	Stanley Consultants	Muscatine, IA, U.S.
26	Glumac	San Francisco, CA, U.S.
27	Bard, Rao + Athanas Consulting Engineers LLC	Watertown, MA, U.S.
28	ESD (Environmental Systems Design Inc.)	Chicago, IL, U.S.
29	KJWW Engineering Consultants	Rock Island, IL, U.S.
30	M-E Engineers Inc.	Wheat Ridge, CO, U.S.
31	EYP	Albany, NY, U.S.
32	TLC Engineering for Architecture Inc.	Orlando, FL, U.S.
33	Sebesta Blomberg	St. Paul, MN, U.S.
34	TTG (TMAD, TAYLOR & GAINES)	Pasadena, CA, U.S.
35	RMF Engineering Inc.	Baltimore, MD, U.S.
36	PageSoutherlandPage	Austin, TX, U.S.
37	RDK Engineers	Andover, MA, U.S.

about how to enter in 2014, visit www.csemag.com/giants

WEB ADDRESS	TOTAL GROSS REVENUE FOR FISCAL YEAR ($ US)	TOTAL MEP DESIGN REVENUE ($ US)	TOTAL MEP REVENUE %	TOTAL ENGINEERS
www.jacobs.com	10,893,780,000	1,549,650,401	14%	14,916
www.bv.com	3,279,000,000	1,042,980,000	32%	3,100
www.urscorp.com	11,000,000,000	550,000,000	5%	11,151
www.exp.com	527,934,000	158,380,000	30%	897
www.pbworld.com	2,637,922,000	156,000,000	6%	6,037
www.hdrinc.com	1,659,800,000	121,765,835	7%	2,133
www.stantec.com	1,882,900,000	107,000,000	6%	3,250
www.burnsmcd.com	1,556,000,000	98,590,000	6%	1,904
www.aeieng.com	105,503,000	94,533,000	90%	395
www.arup.com	255,940,354	88,516,976	35%	728
www.syska.com	82,098,402	71,398,402	87%	295
www.wspgroup.com	78,982,000	63,975,420	81%	1,000
www.hei-eng.com	63,400,000	60,230,000	95%	382
www.vanderweil.com	64,818,040	57,541,639	89%	241
www.middough.com	122,000,000	57,340,000	47%	636
www.cannondesign.com	202,200,000	57,200,000	28%	138
www.akfgroup.com	62,000,000	56,000,000	90%	318
www.burohappold.com	194,220,000	55,000,000	28%	1,420
www.ssr-inc.com	76,624,442	52,870,865	69%	241
www.optimation.us	61,208,000	50,158,420	82%	157
www.mesainc.com	52,500,000	49,000,000	93%	86
www.ssoe.com	188,820,000	46,853,134	25%	440
www.leoadaly.com	171,225,253	46,230,818	27%	308
www.hga.com	112,300,000	45,100,000	40%	91
www.stanleyconsultants.com	150,000,000	42,450,000	28%	432
www.glumac.com	47,300,000	42,400,000	90%	76
www.brplusa.com	41,500,000	41,500,000	100%	149
www.esdglobal.com	38,763,000	37,987,740	98%	189
www.kjww.com	51,092,154	37,493,938	73%	202
www.me-engineers.com	35,385,861	35,385,861	100%	155
www.eypae.com	85,381,169	33,000,000	39%	106
www.tlc-engineers.com	35,924,021	31,282,007	87%	78
www.sebesta.com	31,185,273	31,185,273	100%	77
www.ttgcorp.com	53,049,110	30,775,687	58%	148
www.rmf.com	32,179,874	29,013,374	90%	120
www.pspaec.com	98,500,000	28,565,000	29%	43
www.rdkengineers.com	31,200,000	28,100,000	90%	123

CONSULTING - SPECIFYING engineer

CONSULTING - SPECIFYING engineer

For information about this year's MEP Giants, and a

RANK	FIRM NAME	LOCATION
38	DLR Group	Omaha, NE, U.S.
39	H&A Architects & Engineers	Glen Allen, VA, U.S.
40	CDM Smith Inc.	Cambridge, MA, U.S.
41	Interface Engineering	Portland, OR, U.S.
42	Aon Fire Protection Engineering Corp.	Lincolnshire, IL, U.S.
43	Ghafari Assocs. LLC	Dearborn, MI, U.S.
44	H.F. Lenz Co.	Johnstown, PA, U.S.
45	ccrd partners	Houston, TX, U.S.
46	M/E Engineering PC	Rochester, NY, U.S.
47	I.C. Thomasson Assocs. Inc.	Nashville, TN, U.S.
48	Heapy Engineering	Dayton, OH, U.S.
49	STV	New York, NY, U.S.
50	CTA Architects Engineers	Billings, MT, U.S.
51	Michaud Cooley Erickson	Minneapolis, MN, U.S.
52	BSA LifeStructures	Indianapolis, IN, U.S.
53	Jordan & Skala Engineers Inc.	Norcross, GA, U.S.
54	Triad Consulting Engineers Inc.	Morris Plains, NJ, U.S.
55	Highland Associates	Clarks Summit, PA, U.S.
56	Bridgers & Paxton Consulting Engineers Inc.	Albuquerque, NM, U.S.
57	GHT Ltd.	Arlington, VA, U.S.
58	Coffman Engineers Inc.	Seattle, WA, U.S.
59	Joseph R. Loring & Associates Inc.	New York, NY, U.S.
60	Bala Consulting Engineers	King of Prussia, PA, U.S.
61	Gannett Fleming Inc.	Camp Hill, PA, U.S.
62	WD Partners	Dublin, OH, U.S.
63	Alfa Tech	San Jose, CA, U.S.
64	Newcomb & Boyd	Atlanta, GA, U.S.
65	Salas O'Brien LLC	San Jose, CA, U.S.
66	Kohrs Lonnemann Heil Engineers PSC (dba KLH Engineers)	Ft. Thomas, KY, U.S.
67	Wood Harbinger	Bellevue, WA, U.S.
68	GPI/Greenman-Pedersen Inc.	Babylon, NY, U.S.
68	TME Inc.	Little Rock, AR, U.S.
70	CJL Engineering Inc.	Moon Township, PA, U.S.
71	Karpinski Engineering	Cleveland, OH, U.S.
72	Spectrum Engineers	Salt Lake City, UT, U.S.

about how to enter in 2014, visit www.csemag.com/giants

WEB ADDRESS	TOTAL GROSS REVENUE FOR FISCAL YEAR ($ US)	TOTAL MEP DESIGN REVENUE ($ US)	TOTAL MEP REVENUE %	TOTAL ENGINEERS
www.dlrgroup.com	116,400,000	27,500,000	24%	81
www.ha-inc.com	43,335,401	26,720,014	62%	158
www.cdmsmith.com	1,213,000,000	25,270,982	2%	2,031
www.interfaceengineering.com	25,193,936	25,193,936	100%	46
www.aonfpe.com	25,010,728	25,010,728	100%	99
www.ghafari.com	110,200,000	25,000,000	23%	208
www.hflenz.com	27,397,740	23,135,045	84%	48
www.ccrd.com	25,000,000	23,000,000	92%	55
www.meengineering.com	22,687,000	22,687,000	100%	135
www.icthomasson.com	23,500,000	22,300,000	95%	51
www.heapy.com	22,106,880	22,106,880	100%	76
www.stvinc.com	373,538,000	21,975,000	6%	521
www.ctagroup.com	43,028,636	20,653,745	48%	112
www.michaudcooley.com	20,000,000	20,000,000	100%	51
www.bsalifestructures.com	45,582,887	19,964,056	44%	39
www.jordanskala.com	20,374,428	18,667,929	92%	55
www.triadcei.com	19,138,700	17,600,000	92%	19
www.highlandassociates.com	27,000,000	17,550,000	65%	84
www.bpce.com	16,868,884	16,868,884	100%	36
www.ghtltd.com	16,834,469	16,834,469	100%	64
www.coffman.com	39,088,829	16,052,801	41%	217
www.loringengineers.com	15,000,000	14,700,000	98%	74
www.bala.com	16,430,000	14,615,000	89%	70
www.gannettfleming.com	305,600,000	14,517,000	5%	888
www.wdpartners.com	42,000,000	14,400,000	34%	61
www.atce.com	29,912,082	13,983,334	47%	30
www.newcomb-boyd.com	18,702,574	13,979,192	75%	149
www.salasobrien.com	15,237,000	13,713,000	90%	25
www.klhengrs.com	14,072,830	13,369,188	95%	109
www.woodharbinger.com	13,045,904	13,045,904	100%	52
www.gpinet.com	185,000,000	13,000,000	7%	412
www.tmecorp.com	16,000,000	13,000,000	81%	49
www.cjlengineering.com	12,992,858	12,841,251	99%	32
www.karpinskieng.com	12,076,943	12,076,943	100%	89
www.spectrum-engineers.com	11,108,943	11,108,943	100%	25

CONSULTING - SPECIFYING engineer

For information about this year's MEP Giants, and

RANK	FIRM NAME	LOCATION
73	Harley Ellis Devereaux	Southfield, MI, U.S.
74	Matrix Technologies Inc.	Maumee, OH, U.S.
75	Lizardos Engineering Assocs. PC	Mineola, NY, U.S.
76	P2S Engineering Inc.	Long Beach, CA, U.S.
77	ThermalTech Engineering Inc.	Cincinnati, OH, U.S.
78	Peter Basso Assocs. Inc.	Troy, MI, U.S.
79	Ross & Baruzzini Inc.	St. Louis, MO, U.S.
80	Setty Group	Fairfax, VA, U.S.
81	Westlake Reed Leskosky	Cleveland, OH, U.S.
82	Rist-Frost-Shumway Engineering PC	Laconia, NH, U.S.
83	Professional Engineering Consultants PA	Wichita, KS, U.S.
84	Allen & Shariff Corp.	Columbia, MD, U.S.
85	M.E. GROUP Inc.	Lincoln, NE, U.S.
86	Dynamix Engineering Ltd.	Columbus, OH, U.S.
87	Wick Fisher White	Philadelphia, PA, U.S.
88	EEA Consulting Engineers	Austin, TX, U.S.
89	PEDCO E&A Services Inc.	Cincinnati, OH, U.S.
90	THORSON BAKER & Assocs. Inc.	Richfield, OH, U.S.
91	Primera Engineers Ltd.	Chicago, IL, U.S.
92	Morrison Hershfield	Atlanta, GA, U.S.
93	Brinjac Engineering	Harrisburg, PA, U.S.
94	Global Engineering Solutions	Rockville, MD, U.S.
95	McClure Engineering	Saint Louis, MO, U.S.
96	MEP Assocs. LLC	Eau Claire, WI, U.S.
97	Barton Assocs. Inc.	York, PA, U.S.
98	Advanced Engineering Consultants Ltd.	Columbus, OH, U.S.
99	Fishbeck, Thompson, Carr & Huber Inc.	Grand Rapids, MI, U.S.
100	Kohler Ronan LLC Consulting Engineers	Danbury, CT, U.S.

about how to enter in 2014, visit www.csemag.com/giants

WEB ADDRESS	TOTAL GROSS REVENUE FOR FISCAL YEAR ($ US)	TOTAL MEP DESIGN REVENUE ($ US)	TOTAL MEP REVENUE %	TOTAL ENGINEERS
www.harleyellisdevereaux.com	37,100,000	11,000,000	30%	52
www.matrixti.com	29,006,654	10,968,742	38%	131
www.leapc.com	10,800,000	10,800,000	100%	75
www.p2seng.com	13,135,743	10,721,442	82%	50
www.thermaltech.com	26,900,000	10,600,000	39%	54
www.peterbassoassociates.com	11,016,000	10,116,000	92%	52
www.rossbar.com	22,207,233	9,993,255	45%	30
www.setty.com	9,975,475	9,975,475	100%	71
www.wrldesign.com	25,600,000	9,800,000	38%	38
www.rfsengineering.com	10,650,000	9,600,000	90%	29
www.pec1.com	29,500,000	8,950,000	30%	78
www.allenshariff.com	52,100,000	8,524,701	16%	44
www.megroup.com	8,468,881	8,468,881	100%	36
www.dynamix-ltd.com	8,133,153	8,133,153	100%	31
www.wfweng.com	8,126,951	8,126,951	100%	44
www.eeace.com	7,898,256	7,898,256	100%	22
www.pedcoea.com	10,200,000	7,650,000	75%	23
www.thorsonbaker.com	13,671,000	7,250,000	53%	63
www.primerachicago.com	20,233,150	6,917,000	34%	63
www.morrisonhershfield.com	21,871,877	6,899,166	32%	43
www.brinjac.com	7,917,674	6,890,645	87%	29
www.theges.com	6,850,000	6,850,000	100%	49
www.mcclureeng.com	7,410,000	6,600,000	89%	35
www.mepassociates.com	6,565,111	6,565,111	100%	39
www.ba-inc.com	6,551,902	6,551,902	100%	35
www.aecmep.com	6,408,191	6,408,191	100%	23
www.ftch.com	49,600,000	6,400,000	13%	155
www.kohlerronan.com	6,325,000	6,325,000	100%	46

ExecutiveBiz®
We Connect Executives™

August 22, 2013 // **NEWS**

RMF Engineering Aims to Boost Market Presence with New Office

By Naomi Johnson

RMF Engineering recently opened an office in Charlotte, NC, with a goal to boost its market presence in the fields of education, engineering and healthcare services.

Avery Monroe has been selected to serve as branch manager and lead a team that includes Teresa White, an electrical engineer, and Scott Broadfield, a mechanical designer, RMF said Monday.

The new workplace will cater to mainly mechanical, electrical and plumbing services that support projects of local, private and public organizations in the city.

Civil and structural engineering facilities, on the other hand, will still be handled at the company's Raleigh office.

Developments in Charlotte that involved RMF include the LEED Platinum-certified Rogers Science and Health Building of Queens University and Carolinas Medical Center.

The company, which brings to the Charlotte market its MEP knowledge as well as Revit modeling and production background, received the 2012 Circle of Excellence award from PSMJ Resources.

China:

Opportunities and bubbles in the Middle Kingdom

Tim Griffin, PE, LEED AP, IDEA USGBC Liaison

***Editor's Note:** "LEED + District Energy" is a quarterly column providing information about the U.S. Green Building Council's LEED rating system and how it applies to buildings served by district energy systems.*

This spring I had the opportunity to take my family on the trip of a lifetime. We spent two weeks visiting friends of ours who live in Xi'an, China. Our friends, who are teachers, have lived in China for the last 12 years and were able to use their knowledge of the language and culture to serve as amazing tour guides. This allowed us not only to experience China's impressive historic sites but also to live outside the typical tourist experience and engage in an authentic Chinese experience. We were able to live in typical Chinese apartments, eat real Chinese food and experience Chinese culture.

SOME SOURCES ESTIMATE THE SIZE OF CHINA'S POTENTIAL DISTRICT ENERGY MARKET AT MORE THAN $8 BILLION DOLLARS.

China is a fascinating country of both the ancient and new. While basically the same size as the U.S. geographically, China has more than five times as many people. World-class airports and high-speed bullet trains stand in contrast to what one might expect to see in developing countries. Tremendous wealth and poverty exist side by side. Signs of capitalism abound along with government-controlled quotas.

DISTRICT ENERGY OPPORTUNITIES

Contrasts continue in the Chinese approach to district energy. Throughout the country's urban centers, district heating reigns supreme. China's vast number of large cities provides the familiar recipe for successful district energy systems: With hundreds of millions of people living in high-rise apartments, these cities have tremendous cooling and heat load density. District hot water generation plants are prevalent with compact distribution systems efficiently delivering heating hot water to office buildings, factories and apartments. The Chinese have certainly bought into the value of district heating by investing in modern generation and distribution systems. Some sources estimate the size of China's potential district energy market at more than $8 billion dollars, and there are more than 1,000 combined heat and power plants planned. A Swiss Asian District Energy Financial Fund website states, "... District Energy is recognized by the Chinese government as one of the most cost effective and potentially largest sources of clean energy in China."

In juxtaposition, cooling systems in China are far from state of the art. Until recently, many Chinese buildings, both residential and commercial, were built without air-conditioning systems. They have since retrofitted most of these facilities by adding small, ductless split systems to provide cooling. While this may be an easy fix for an older facility, this approach continues with new construction as well. The vast majority of new facilities I saw across the country included a separate ductless split system cooling unit for every room. Besides being aesthetically unappealing, these systems are generally inefficient and do not have long life expectancies. By relying on individual building systems instead of district cooling, China is missing opportunities to achieve greater energy efficiency and reduce energy use.

This typical Chinese district hot water heating plant in the city of Xi'an serves both residential and commercial customers.

Courtesy Tim Griffin.

What efficiency benefits district cooling would deliver! China needs to decrease the growing demand on its power grid, which cannot be built fast enough to keep up with the economic and consumer growth. In addition, all the fossil fuel-fired large power production plants I saw scattered across the countryside are big contributors to a weather pattern called the "haze." I had heard how bad China's air quality was, but words cannot describe the experience of actually breathing the country's polluted air. Sometimes the pollution was so thick that visibility was reduced to a few hundred yards. Surprisingly enough, there was much reported in the Chinese press during our visit about the general population's air quality concerns. If these reports are allowed in a state-controlled newspaper, one must suspect the government is increasing its desire to do something about the problem. State-of-the-art district cooling systems could go a long way toward lowering demands on the power grid and reducing the pollution pouring out of power plants.

Perhaps the challenges the Chinese government faces in moving its more than 1 billion people forward will create the perfect environment for a district cooling explosion within the country.

IT'S DIFFERENT THIS TIME

As exciting as potential opportunities for district cooling in China are, there was something else I witnessed that may have a significant impact on our industry in the near future. Several years ago, I had the opportunity to attend IDEA's Middle East Cooling Conference in the United Arab Emirates (UAE). I remember being struck by the unbelievable amount of construction going on. It was as if they were trying to build downtown Manhattan all at once. Construction cranes as far as the eye could see. Where were all the people going to come from to occupy these buildings? There was definitely a "build-it-and-they-will-come" mentality. When I questioned the torrid growth, I was told, "It's different this time," and I was given all the reasons the UAE's current growth was not going to follow the "old" economic models. Since my visit, however, Dubai in particular has had some economic challenges.

The growth in China struck me as similar to that in Dubai – replicated across an entire country. In fact, China has built entire cities where no one even lives yet under the "build-it-and-they-will-come" philosophy. At one point, in a city in central China, I did a 360-degree turn to count construction cranes. I saw 25. I would have seen more if not for the haze. Interestingly enough, they only seem to be constructing one type of building in China: high-rise apartments. They are building them as far as the eye can see. Large concrete shells, mostly devoid of interior finishes, stand as silent giants across the country.

I quickly realized why the prices of concrete, steel, copper and other building materials have been rapidly rising. They are all going to China! I also saw what appeared to be the biggest bubble I have ever seen – one that greatly dwarfs the size of the 2007 U.S. housing bubble. What happens when the Chinese stop buying apartments, as speculative investments, that nobody will live in? What happens when 50 million Chinese construction workers suddenly find themselves unemployed? The economic rule of bubbles postulates that the larger the bubble, the higher-impact the pop. Based on what I saw, it should be a big bang!

Upon returning, a business colleague of mine shared a piece from the TV news show *60 Minutes*. It not only confirmed my suspicion but suggested the problem

Firetube boilers in the Xi'an district energy system

Courtesy Tim Griffin.

New high-rise apartments like these on the right and rear are overtaking older apartments in Xi'an and are under construction across China – part of the country's current housing boom.

Courtesy Tim Griffin.

is worse than I could see. You can find that story ("Chinese Real Estate Bubble," March 3, 2013) at http://tinyurl.com/a3fykrr. It will certainly make you think.

POINTS TO PONDER

Being in the rental property business, I was in a great position to see the U.S. housing bubble grow. In 2006 and 2007, I began to have tenants – to whom I almost did not rent a year earlier because their credit was so bad – inform me they were moving on because they had bought a home. I could not imagine why any sane organizations would loan money to people with such poor credit history. Not only were they loaning them money, but it was no money down, interest only, with adjustable rate balloons, etc. The only requirement to qualify for a mortgage then was a pulse – and not even a strong one.

It is one thing to recognize a bubble and quite another, however, to know how to position oneself to thrive when it pops. While I was smart enough to steer clear of adding additional properties at ridiculous prices and knew better than to be caught in the adjustable rate mortgage trap, I failed to recognize the collateral damage that would impact banks, underwriters like Fannie Mae and insurers like AIG. Unfortunately I owned stock in some of those companies, which today is worth pennies on the dollar.

WHAT EFFECT WILL THE POPPING OF CHINA'S RESIDENTIAL HOUSING BUBBLE HAVE ON THE WORLD ECONOMY, CONSTRUCTION AND OUR DISTRICT ENERGY INDUSTRY?

So here we stand in front of another bubble. That it will pop, I believe, is clear. When it will pop is another story. The million-dollar question, however, is, What effect will the popping of China's residential housing bubble have on China, the world economy, the construction industry as a whole and our district energy industry? The obvious answer is downward pressure on construction materials. Caterpillar, a major provider of mining equipment, saw its stock drop significantly already as signs of a slowdown have already begun in the world's mines that supply raw materials to China. Will lower material prices lead to a construction boom in the U.S. and Europe? Or will China drag the world into another recession? If anyone knows the answer, give me a call quickly.

Some are still saying "it's different this time" in China and can give you lots of reasons why. It always seems to be different this time – until it is not anymore, and then it is too late. There are both opportunities and perils for the district energy industry tied to China. The potential for district energy to solve many of the very difficult challenges faced by the Chinese government is huge. However, when the bubble bursts, the ripple effects will be felt throughout our industry.

Tim Griffin, PE, LEED AP, is IDEA's liaison with the U.S. Green Building Council and serves on IDEA's board of directors. He is a principal and branch manager with RMF Engineering Inc., a firm specializing in district energy system planning, design and commissioning. A registered engineer and a LEED Accredited Professional, Griffin has a Bachelor of Science degree in mechanical engineering from North Carolina State University and a Master of Business Administration degree from Colorado State University. He authored the book *Winning With Millennials: How to Attract, Retain, and Empower Today's Generation of Design Professionals*. He may be reached at tgriffin@rmf.com.

BUILDING DESIGN
+CONSTRUCTION

August 08, 2013 // **NEWS**

Energy research animates science sector [2013 Giants 300 Report]

After an era of biology-oriented spending—largely driven by Big Pharma and government concerns about bioterrorism—climate change is reshaping priorities in science and technology construction.

By Julie Higginbotham, Senior Editor

After an era of biology-oriented spending—largely driven by Big Pharma and government concerns about bioterrorism—climate change is reshaping priorities in science and technology construction. “Engineering and chemistry funding are going up now, as is energy research, which seems to continue to get federal funding,” says Andy Vazzano, FAIA, LEED AP, Science and Technology Practice Leader at SmithGroupJJR. “Meanwhile, the sequester and budget cuts are having a negative impact on NIH funding for biomedical research.”

The focus on human health hasn’t totally faded, with many research universities still building new labs—especially those that tie research to clinical practice. “Anything that begins with ‘trans’ or ‘inter’ is still a major trend,” says Ryan Abbott, Science and Technology Project Director at Sundt Construction and a BD+C “40 Under 40” honoree (Class of 2012). “Translational, interdisciplinary. Modern science is a team sport.”

Though the purpose-built med school building is the iconic face of S+T, adaptive reuse is getting a second look for advantages in cost and speed. Many clients are also seeking higher levels of green; LEED Platinum, once thought impossible for labs, is no longer unique, and clients are increasingly eyeing net-zero.

In addition, look for public/private partnerships to assume a greater role, even in the rarefied atmosphere of the Ivy League. Harvard, for instance, has rethought its Allston science campus during a recession hiatus. When the site cranks up again next year, the program will include a 36-acre, privately developed “enterprise research campus” for related companies in pharma, biotech, and venture capital.

TOP S&T SECTOR ENGINEERING FIRMS
2012 S+T Revenue ($)

1 Affiliated Engineers $19,824,000
2 Middough $13,900,000
3 URS Corp. $11,772,124
4 Bard, Rao + Athanas Consulting Engineers $10,500,000
5 RMF Engineering Design $9,200,000
6 Vanderweil Engineers $7,851,900
7 Paulus, Sokolowski and Sartor $7,500,000
8 WSP USA $5,772,095
9 Science Applications International Corp. $3,103,152
10 STV $2,937,000

DEPARTMENTS | CUSTOMER CLOSEUP

NORTH CAROLINA STATE'S PHYTOTRON BUILDING:

Growing plants – and energy savings

NCSU's Phytotron Building is a leading center for controlled environment research in the U.S. Designed for plant studies, the facility is also useful for animal and insect research where control of day length and temperature is desirable.

Courtesy North Carolina State University. Photo Marc Hall.

To view other "Customer Closeup" profiles, visit *District Energy* magazine online at www.districtenergy-digital.org/districtenergy/2013Q3 and search "Customer Closeup" in all issues.

Located on the main campus of North Carolina State University (NCSU) in Raleigh, the Phytotron Building is home to the institution's College of Agricultural and Life Sciences. Built in 1968, the 40,000-sq-ft facility includes 60 artificially lit growth chambers, nine photoperiod rooms and five temperature-controlled greenhouses on the roof. A phytotron is a facility where plants can be grown and studied under various environmental conditions, ranging from Alpine cold to desert heat and drought to jungle humidity.

When it was constructed, NCSU's Phytotron was one of only six such facilities in the world. It has been served by campus steam since its original construction, and a campus chilled-water connection is currently being added. Two interconnected plants on the NCSU main campus supply steam and chilled water to 115 and 85 buildings, respectively.

Given the research conducted in the Phytotron facility, it is critical that the building maintain a wide range of temperatures and humidity levels. These varying demands also mean the building requires a much higher level of energy than typical campus research facilities. With an understanding of these energy needs, NCSU's Facilities Department embarked on a project in March 2012 to evaluate and upgrade the mechanical and electrical systems as part of a self-performed energy performance contract.

RMF Engineering Inc. was selected to provide complete design, energy modeling, investment-grade energy audit (IGEA) and construction administration services. The project goal was to implement energy conservation measures (ECMs) to significantly reduce energy use and utilize the energy savings to finance the construction costs and design. Lifecycle cost analyses were performed for all ECMs. This was the first "self-performed" energy project of its kind for a state-owned facility. The energy audit and review process was similar to that used for traditional third-party energy performance contracts, but by eliminating the third party and obtaining its own financing, NCSU is able to realize greater cost savings.

The project scope included eliminating building chilled- and condenser water systems with connection to the campus chilled-water loop; new glycol chillers for low-temperature growth chambers; power reductions in growth chamber and general lighting; upgraded greenhouse HVAC; upgraded building HVAC with additional variable air volume systems; new direct digital controls; water conservation/plumbing; steam conversion to heating water; electrical transformer replacement; new roofing; and minor architectural modifications.

The team took an in-depth look at options for growth chamber lighting systems, one of the largest energy components of the building systems. Options analyzed included LED, fluorescent and incandescent lighting; condenser and chilled-water light cap cooling; new versus modified chamber fans and coils; and revised chamber HVAC configurations. The cost and performance of completely new, modernized chambers was also evaluated. The IGEA portion of the project was led by ARUP, as a consultant to RMF.

The highest energy savings were realized from upgrades to the greenhouse HVAC and to growth chamber lighting and HVAC. The best (lowest) payback periods were achieved with the modifications to the building HVAC, greenhouse HVAC, chilled-water systems and building lighting.

Energy reductions of more than 50 percent per year and cost savings of nearly 60 percent over the 18-year financing period are projected with implementation of all recommended ECMs. The ECMs have an estimated simple payback of less than 10 years. The team plans to track progress and verify that savings are achieved, and the university hopes to apply this successful process on future projects.

For more information, contact Paul Harry, PE, of RMF Engineering Inc. at paul.harry@rmf.com.

July 3, 2013 // **NEWS**

Brian Wodka Named an RMF Infrastructure Team Head

Brian Wodka has been appointed a team leader of infrastructure services at RMF Engineering for the company's planned expansion in York, Pa.

The company has added five employees to its York office and plans to add two more in the next six months, RMF said.

As part of the expansion, RMF said it will boost its portfolio of local inspection, field services and traditional building services.

Wodka, who joined RMF in 2000, currently leads the company's power plant assessment and boiler inspections team.

He also serves as vice chairman of ASME, a non-profit engineering standards news and resources organization.

June, 2013 // **NEWS**

ASME: Applications and benefits of RAM

By Brian M. Wodka, P.E.

A new standard from ASME was recently released for public review regarding reliability, availability and maintainability (RAM) of power plants. This article will discuss the current status of the standard, as well as answer some common questions about RAM.
RAM is intended to be a risk-engineered availability program that prioritizes equipment for maintenance and identifies where resources can be most effectively utilized.

In the previous article, "availability" was defined as a function of "maintainability" and "reliability."
The priorities of a power plant were discussed as being safety, then production and then efficiency.
The purpose and structure of the standard also were mentioned. In addition, possible fringe benefits, including insurance premium reduction and improved funding opportunities that could be realized by using the new standards were discussed.

The Purpose of RAM
Many maintenance programs in use today have the typical problems of budget, manpower, effectiveness, completeness

and accountability, to name a few. Any of these issues can render a maintenance program ineffective. If a maintenance program causes equipment to be ignored for any of the listed reasons resulting in an unplanned outage, then that program is not only ineffective, but actually counterproductive.

This is the case all too frequently. For this reason, ASME has taken the lead on trying to identify the fundamental causes of why maintenance programs fail, why reliability is not achieved and why plant availability cannot be sustained. To do so, ASME has formed a standards committee to research and investigate these issues and work on developing a standard that will finally get lasting results and ultimately bring sustainable availability into reach in a practical way.

During the past 40 years, there have been many different versions and interpretations of both RAM and reliability-centered maintenance (RCM), not just the ones used by the government.

Standardization could remove vague interpretations, variety in scope and quality, and provide clear direction on structure and implementation. RCM was standardized in the late 1990s. Even though government entities have issued manuals and guidelines, no major standard organization has taken on the task of attempting to create a standard specifically for power plants.

In 2009, ASME International decided to recognize the importance of RAM by forming a committee to develop a standard. The Reliability, Availability and Maintainability of Power Plants (RAM) Committee was created and tasked to review decades of research and documentation. This was done in an attempt to create a standard by which the concept of RAM could be universally implemented into the non-military and non-nuclear power industries.

The goal is to issue a RAM standard versatile enough to establish the requirements for incorporating RAM into either a new power plant design or the operations of existing power plants.

The new RAM standard focuses on the key priorities, as defined by the owner, of safety, production and efficiency. From these priorities, risk and criticality is then defined, assessed and assigned to all the equipment within the scope. An appropriate level of reliability and/or redundancy will be engineered into the equipment, then the most appropriate maintenance program (RCM, CBM, PM or RM) is individually assigned to assure availability. These decisions will be balanced with cost and manpower. Being able to customize to various risk levels and budgets will permit smaller facilities to also utilize the standard.

Unlike RCM, the end result of RAM is not just a maintenance program. The new RAM standard focuses on achieving the owner's ultimate goal of availability. This is done by addressing both maintenance and reliability. The reliability aspect might involve specifications, system descriptions, operating procedures and/or quantitative analysis. The depth and complexity of the RAM program's components will be based upon the needs and budget of the owner.

RAM provides clear direction and utilizes quality control methods. This ensures responsibility and accountability are defined without losing sight of the goal of availability.
The standard requires support from upper management to ensure accountability can be enforced. A RAM Manager is assigned and held accountable for the program's development, implementation and supervision.

The RAM Program is a living document that permits continuous improvement and adaptation to changes in a power plant throughout its life cycle. This helps to prevent confusion, obsolescence and, ultimately, disregard.

For those in the mission critical industry, lack of availability is really not an option. The proper maintenance and reliability program can mean whether a hospital stays open during a crisis. By utilizing RAM, a critical care or government facility that has had trouble in the past might finally have a means of putting their arms around the issue to stabilize maintenance and regain control of availability.

Questions about RAM
Since the concept of RAM is being reorganized and modernized, there are many fundamental questions that arise. Here are answers to some of the common questions:

What is "RAM"? Why would I be interested in it?
"RAM" is an acronym for "Reliability, Availability and Maintainability" which represents a concept that optimizes the balance between risk and budget to achieve availability goals. This provides a practical and justified reliability and maintenance program that is properly prioritized to meet the owner's needs.

RAM has attempted to specifically address all the factors that led the previous maintenance and reliability programs to fail. In addition to addressing the factors of failure, RAM kept in mind the practicality of ensuring a way to keep the program flexible enough to be as simple or complex as the owner needs.

What is an "availability program"?
An availability program is a living document that focuses on a plant's availability concerns instead of reliability or maintainability separately. Reliability addresses uptime and includes design.

Maintainability addresses downtime and includes repair. However, reliability programs might not address maintainability and maintainability programs might not address reliability.

As shown by the equation, availability is a function of both reliability (uptime) and maintainability (downtime). By having a program focus on availability, both reliability and maintainability are inherently addressed and coordinated.

What differentiates RAM from other maintenance programs?

---

01. Reactive Maintenance (RM)

History: This is simply neglecting the equipment until if fails. If maintenance is viewed as "actions performed to prevent a failure," then RM is the lack of maintenance.

Description: This type of maintenance is to wait until there is a failure of the equipment before addressing it. The common description of reactive maintenance is "run-to-failure."

Use: Even though this form of maintenance is usually the result from neglect of another type of maintenance, there are times that this is the preferred method of maintenance. Inexpensive, non-critical pieces of equipment do not justify more time-involved methods of maintenance to prevent failures. The problem with RM is that in addition to exposure to system or plant outage, it usually cannot be anticipated and costs more to repair the failure due to the premium that must be paid for immediate response.

Example: Light bulbs.

Comments: By its nature, RM induces unplanned outages. Since unplanned outages of critical and expensive components have a high probability of costing much more than simple preventive maintenance, RM is usually not employed.

---

02. Preventive Maintenance (PM)

History: Realizing that RM is an unacceptable form of maintenance for any system critical component, the next improvement in maintenance is to perform preventive maintenance.

Description: This maintenance is intended to occur on a schedule (usually by time or operational hours).

Use: This is what most equipment operation and maintenance manuals recommend. PM works on the concept that likelihood of failure is proportional to the age or operating hours of the equipment. The PM theory is to err on the side of conservatism by performing maintenance more often than not enough.
Example: Automotive oil.

Comments: This form of maintenance might have significant cost ramifications. Through the years, it has been proven that PM is ineffective at controlling failure rates. The probability of failure does not necessarily increase with age, so the PM might be providing excessive maintenance, which itself causes greater opportunity for human error.

---

03. Predictive Maintenance (PdM) or Condition-Based Maintenance (CBM)

History: In the 1980s, at the same time as the microprocessor and computers were being introduced to the industrial maintenance world, the concept of PdM or CBM was being heavily utilized to address the shortcomings of PM.

Description: The underlying concept of PdM or CBM is "if it is not broken, don't fix it." The equipment is routinely inspected and, based on its condition (a selected tell-tale parameter), maintenance is performed only as needed.

Use: The inspection is to be performed while the equipment is operating, to avoid affecting availability. The idea is to maximize operation and minimize unnecessary maintenance. The problem with predictive or condition-based maintenance is that it depends on properly selecting both the right parameter(s) for the determination of maintenance and the right inspection interval. Also, if a thorough inspection is not performed of the entire piece of equipment, it exposes the equipment to a failure mechanism that might have been preventable with PM.

Example: Belt-driven equipment, with the squealing belt being the indicator.

Comments: One of the most popular methods of using PdM is vibrational analysis for rotating equipment. For larger power generation stations, PdM also is used for the turbine oil by having the oil chemically analyzed to determine replacement schedule. To perform PdM/CBM on most equipment is still generally considered unnecessary.

---

04. Reliability-Centered Maintenance (RCM)

History: Power plants were finding that with limited resources, much of the time spent on PdM or CBM was wasted checking insignificant items that ended up being inspected too frequently. This naturally led to the development of risk-based equipment prioritization. As RCM became very popular, the term was being exploited with various interpretations that were not true to the original concept. In the late 1990s and early 2000s the Society of Automotive Engineers released two standards for RCM, SAE JA1011 and SAE JA1012. These have set the bar for what is required in order to be called “RCM.”

Description: The idea utilizes the development of maintenance tasks based on different analytical methods, such as Fault Trees or Failure Modes and Effects Analysis (FMEA), to establish risk priority.

Use: RCM is used to select and prioritize equipment maintenance in order to maximize equipment reliability. The program evaluates which components justify higher levels of maintenance.

Comments: The original concept started in the 1970s. The research was funded by the government with the intent to utilize the concept to improve mission success of military and space aircraft. By the 1980s, RCM was proven successful and its scope had expanded into the Navy and nuclear industry. By the mid-1990s, the practicality and effectiveness of RCM was proven acceptable to the point that NASA introduced the first version of its “Reliability-Centered Maintenance Guide for Facilities and Collateral Equipment.” The criticality of the work that NASA is involved in requires an effective maintenance plan to assure availability.

However, there are reasons RCM hasn’t caught on throughout the power industry. This is due to the usual reasons; resistance to change and fear of the unknown. People might have never heard of RCM, and when they do, they are afraid that it is too much work, too involved or too expensive, and readily dismiss it. This is the uncommitted, short-term thinking that keeps some power plants operating in obsolescence. Two premier experts and authors in the field of RCM have the following quotes:

“RCM is a program developed by engineers for engineers. Unfortunately, for most applications and average users, it results in paralysis by analysis,” said Jim August.

“The actual success rate for implementing an RCM program is in the 5-10 percent range,” said Neil Bloom. “Putting it another way, over 90 percent of all RCM programs result in failure!”

Where RCM, or any maintenance program, can fail is where most great programs fail – practicality. You can have a beautiful new RCM program developed, but if it is too complex or impractical, it can be just another (expensive) document sitting on a shelf being ignored.

Ultimately, the purpose of all of these maintenance programs, including RCM, is to maximize the reliability of an existing system. Maintenance does not address the design of the system. Design is where the maximum reliability of a system is defined.

So the fact remains that all of these programs are still maintenance programs. In addition to addressing maintenance, in order to achieve the real goal of availability, reliability needs to be increased, which can only be done through design. What is needed is an availability program.

---

05. reliability, Availability, Maintainability (RAM)

History: RAM has a very similar history to RCM. Its origins were in the 1970s and its intent also was to provide an overall governing program that provides availability assurance for the military. It was a parallel concept to RCM with fundamentally the same goal. Where RCM was embraced more by industry and NASA, RAM was primarily the protocol for the Department of Defense for new and advanced military combat equipment and weaponry.

Description: RAM is a risk-engineered availability program that identifies and prioritizes where your resources could be most effectively utilized to achieve overall availability goals. It is a living document that addresses design, construction, operation and maintenance throughout the lifecycle of the plant.

Use: It addresses reliability through risk-analysis, specification requirements and design considerations. Maintenance is based on acceptable risk and available resources. It provides a means of monitoring and controlling maintenance costs. RAM also assigns responsibility and accountability to ensure effective implementation.

Comments: RAM has developed with the field of Systems Engineering and involves more emphasis on the design and construction phases than RCM. For that reason, RAM is more encompassing, cradle to grave.

Table 1 summarizes the components of each of the described maintenance programs:

What is in the RAM standard? How is it structured? Realizing that there are fundamental differences in designing an availability program for a new plant vs. an existing power plant, the new RAM Standard is envisioned as the first of three anticipated standards: General Process, New Design and Existing Systems. This allows users to easily focus on developing a RAM program specific to their needs without having to sift through inapplicable information.

The following is a brief description of the major parts of the new standard:

General process
The standard that was recently released is the General Process, which lists and describes requirements and aspects that should be considered in the development of the RAM Program. It includes all the required basic information applicable to both new designs and existing systems. The General Process standard of the RAM standard clearly identifies the following three major components:

- The elements of a RAM program that should be considered for their applicability.
- The sections and contents of the RAM program document.
- The phases in the RAM lifecycle that correspond with the phases of the lifecycle of the power plant.

Ram elements
The reliability, availability and maintainability of a power plant are affected by a multitude of different factors. A list of potential elements that could be incorporated into your customized RAM Program is provided in the standard. This list should be evaluated for each element's applicability and practicality.

Some of the elements include methods of supporting operations, planning and scheduling work, traceability, failure risk assessment and available technology. These are general categories with descriptions of the purpose and suggested approaches. All associated factors must be assessed in the evaluation of these elements for practicality. These could include required labor, complexity, precision of monitoring and testing, and the cost of the program's components, which can vary tremendously based on the type of power plant, budget and availability requirements.

The provided list of elements in the standard is not meant to be considered comprehensive, but only as a starting point for determining the best program components for a specific plant.

RAM program
The purpose of a RAM program is to explain how to identify, achieve and maintain the availability goals of a power plant by defining requirements for equipment and system reliability and maintainability. This document consists of required elements, but is customized to the individual power plant.

The sections of a RAM program consist of a narrative, basis of design and equipment list, as well as sections that describe failure risk analysis, maintenance and monitoring, validation, change implementation and finally, budget estimates for the operation of the plant throughout its life cycle.

The program describes how to implement the selected RAM elements into the design, construction and operation of the plant.

The RAM Program is designed to be a living document that can be adjusted as data is gathered on the system. By using this feedback/editing process, it allows the RAM program to not only tune itself to be most effective, but also evolve with the changes in the plant with time. This permits the program to sustain practicality and usefulness, preventing obsolescence.

The RAM lifecycle
This section of the standard describes the development process of the RAM Program. It identifies how the selection of the elements and their implementation into the program correspond with the design, construction and operation phases of the power plant.

The RAM Lifecycle explains the 4 phases of development and implementation of the RAM Program:

- Requirements and goals
- Design
- Construction and commissioning
- Operation
- The RAM standard describes how the program is established in the first three phases, and utilized in the fourth phases as a living document throughout the life of the plant.

New Design
The RAM New Design standard is not developed yet, but is anticipated in the next few years. Ideally, an owner would opt to have the new RAM Standard incorporated into the initial stages of the design of a new power plant. The New Design standard will be specifically developed to ensure all aspects of the power plant incorporate reliability, availability and maintainability.

Existing Systems
The RAM Existing Systems standard also is not yet developed and anticipated in the next few years.

This standard will be designed to be utilized by existing power plants that are interested in benchmarking their current RAM status, as well as defining a RAM Program to use to redefine the operations and maintenance curriculum.

How can I use the RAM standard?
This standard will have value when power plant owners require its compliance. This standard is issued by a world recognized, reputable standardization organization. This ensures when a power plant owner or prospective owner decides to have the ASME RAM standard adopted and a RAM Program implemented, there is no "cut-rate" product from the low-bidder that will be able to meet the stringent availability requirements. That is the purpose of the standard. That is the difference

between ASME's RAM standard and all the other preceding reliability/maintainability concepts.

CONSULTING - SPECIFYING engineer

May 28, 2013 // **NEWS**

Designing Labs, Research Buildings

Participants:
Nedzib Biberic, PE, LEED BD+C, Mechanical Engineer, PAE Consulting Engineers, Portland, Ore.
Michael Chow, PE, CxA, LEED AP BD+C, Member/Owner, Metro CD Engineering LLC, Powell, Ohio
David S. Crutchfield, PE, LEED AP, Division Manager, RMF Engineering, Baltimore
Dave Linamen, PE, LEED AP, CEM, Vice President, Stantec, Edmonton, Alberta
Jay Ramirez, Senior Vice President, ESD Global, Chicago

CSE: Please describe a recent lab project you've worked on—share problems you've encountered, how you've solved them, and aspects of the project you're especially proud of.

David S. Crutchfield: We recently completed a new lab building that included a vivarium on the ground level, one level of offices, and three levels of labs. During the late stages of the design, the funding source dried up and the five-story building was completed with floor No. 1 being a completely built but unoccupied vivarium, floor No. 2 being an occupied office component, and the top three floors shelled for future wet labs. The air handling equipment was all purchased and installed with the initial construction. After the construction was completed, funding for the shelled floors was released. Unfortunately, during the lull in the construction, the program for the lab and vivarium changed. Our task became one in which we worked with the planners to determine how best to fit the changed program components into the core/shell design to ensure that the HVAC equipment bought in the initial construction would work with the new program. A lot of test fitting and re-test fitting was necessary and ultimately we were able to match the new program up with the capacity of the installed equipment.

Dave Linamen: We designed a new physical sciences building for a major university in New York, approximately 190,000 gross sq ft. The building houses research and teaching for chemistry and physics. There were four major chemistry labs, each with 11 6-ft fume hoods. There were also state-of-the-art physics labs with demanding vibration limitations. The building was bounded on three sides by existing buildings. There was one central shaft for all mechanical and electrical services that extended vertically in the building. Immediately beneath the penthouse, there were executive offices, so sound and vibration were of serious concern. The university monitors and manages energy closely for all buildings, so we knew our predictions for energy use would be compared to actual energy use.

First we developed a very sophisticated energy model that accurately represented all of the components of the building that contribute to energy use. We then completed a sensitivity analysis to determine which systems and components had the greatest influence on energy use, and how those systems and components actually affected the building energy use. The model confirmed what we already knew, that variable air volume (VAV) was the single strategy that resulted in the greatest energy savings from a cost/benefit perspective. The second most effective strategy was using a single system to serve labs, offices, and conference/lecture hall spaces. The next most effective strategy based on cost/benefit from energy savings was using occupancy sensors to expand the temperature control deadband when labs were unoccupied, which in a university environment was significant percentage of the time. The next most effective strategy was consciously designing the entire air handling system to minimize air pressure drop and, consequently, fan horsepower. We designed the single HVAC air system with one fully redundant air handling unit, but under normal (non-failure) conditions, all air handlers operate at reduced air volume, and hence, reduced velocity and pressure drop through filters and coils. Through the duct system, air velocities systematically step down from 1700 fpm in the risers to 1400 fpm in the horizontal mains to 1000 fpm in the branches to 500 fpm in diffuser necks. The horizontal mains are designed as extended plenums that reduce total air pressure drop and provide flexibility to accommodate high air demand anywhere in the duct system. Heat recovery was also provided to result in the lowest possible energy use.

The building was proven to be the most energy-efficient lab building among several that were recently built on the campus. Energy use is less than 200,000 Btu/sq ft/year, which is excellent performance for such an intense lab building, and the budget for the mechanical, electrical, and plumbing (MEP) systems was within the typical range for similar science buildings. The actual first year energy use recorded by the university was within 2% of the predicted energy use.

Jay Ramirez: ESD is completing/closing a confidential project with a budget of $270 million including site development, central utility plant, manufacturing, short-term storage, administrative offices, quality assurance/control product test laboratory, and owner provided equipment. The goal was a facility that meets market demand at competitive international market prices as well as a one-year project schedule and budget-mission accomplished. The lesson in this project was not so much the technical solution, but the conveyance of information and willingness to exchange and share design ideas, make timely decisions, and respect the opinions and intellectual experience of the entire design team (owner/designer/contractor). We changed the way we thought about project delivery. This project was a success because of the proactive and flexible exchange of ideas and communication.

CSE: What unique enclosures, cleanrooms, or other types of rooms have you worked on recently?

Ramirez: We recently completed a project that required a hydrogen peroxide emergency purge system. This was achieved by using oxygen sensors to measure levels and placing the HVAC system in full purge mode at predefined oxygen levels. Auxiliary exhaust fans, variable frequency drives, automated dampers, and sequence of operation purge modes were programmed into the system.

Linamen: Probably the most unique was a room for specialty physics where the criteria were extremely demanding. The room was in the lowest level of the building, and the floor was a thick concrete mat that was completely isolated from the surrounding floor. Only minimal ventilation air supply was permitted in the room to maintain air quality. Cooling and heating were from a radiant source. single requirement has improved each participant's confidence both internally and externally with clients.

The first year of our LDP concluded with tremendous results. Each of the seven participants developed a formal growth opportunity for RMF, which they will spearhead upon graduation from the program. To support this objective, each participant completed and presented a business development plan to corporate management for approval.

CSE: What are some common missteps that engineers might make on a laboratory project?

Michael Chow: Cleaning up power should be considered as many laboratory instruments have sensitive power parameters. Consideration should be given also to using uninterruptible power supply (UPS) systems.

Crutchfield: We sometimes run into lab projects where the old 12 air changes per hour (ACH) rules are still being enforced by the environmental health and safety folks at the various institutions. Couple that with the desire for constant volume hoods, which seem to be favored by maintenance staff, and it's a recipe for an underperforming building. When we discuss this with the owners and suggest alternate compliance and safety methods, they often recognize that there are better ways to accommodate lab airflows, but many owners are still reluctant to change from their institutionally set policies. We aren't always able to convince them that alternate methods should be used for their projects, but we feel that it is our responsibility to show them the alternatives, and the economics of the alternatives, so that they can be more informed as owners. The goal is to help them ultimately understand their internal policy, and compare that to current state-of-the-art procedures, so that if they want to make policy changes, they have full understanding of the issues involved.

Ramirez: Design for flexibility in control strategies, input/output expandability, and provide for plenty of instrumentation. Laboratory users are constantly changing, particularly in R&D facilities. Specifying the proper control architecture for achieving functional changes a laboratory space may see over the course of its life, specifying proper material for application (metals, gasket seals, temperature and pressure scales, etc.) to achieve functional changes in the laboratory. Of course, this must be balanced with project budget.

Linamen: One common mistake is in thinking that offices, labs, and classrooms/lecture rooms in lab buildings all need to be served from separate HVAC systems. Segregating these spaces on separate systems requires added space for equipment and supply/return/exhaust risers. For a physical sciences building we worked in, there were sophisticated research and teaching labs, as well as classrooms/lecture halls and offices. There is one HVAC system for the entire building, and one main supply air riser, return air riser, and exhaust air riser. Laboratory air is 100% exhausted. What is frequently not recognized is that for most mixed-use lab buildings, the lab air requirement is usually a major part of the total HVAC air requirement for the entire building, usually 70% or more. If multiple HVAC systems are provided, a percentage of the return air from the offices and classroom spaces must be rejected, so that a corresponding percentage of ventilation air can be provided to maintain air quality. However, if one common HVAC system serves all spaces and if the lab air requirement is a high percentage of the total air requirement, 100% of the air from the offices and classroom spaces can be returned. This reduces the total air requirement for the building. This usually results in fewer air handling units for the building, so it saves first cost, it improves overall flexibility because labs can be converted to non-lab functions and vice versa without major changes to the HVAC, and the non-lab spaces have excellent air quality because they receive higher than normal percentage outside air. This usually makes it more convenient to provide redundancy, because redundancy is only required for the one system.

CSE: When working in labs outside the United States, what differences, challenges, or best practices have you observed?

Crutchfield: Our experience has confirmed that laboratory standards outside the U.S. have not evolved to the extent they have in the U.S. Standards outside of the U.S. have remained unchanged largely because the international markets have not developed as many new state-of-the-art lab facilities as we have in the U.S. Many of the criteria points such as load densities, air change rates, and fume hood face velocities have not been challenged because the need simply has not occurred. However, with the globalization of industry groups, this is beginning to change. In the European market, attention to overall health and safety within the lab environment requires focused risk assessment by the project team. The project team routinely consists of owners, design professionals, lab operators, and maintenance staff. We have found this refreshing, as clients now understand the critical role appropriate operating procedures serve for laboratory health and safety.

Ramirez: In the United States, it is general practice to assign about 25% of a fee to construction administration. This is generally in the standard design/bid/build project delivery model. Delivery of a similar project abroad is generally a design/assist or design/build delivery model. This will require significantly more on-site support, and commonly we can see the fee structure being more like 55% design and 45% construction administration and/or on-site support, if not an even split. Depending on the project schedule, this is probably the best way for design professionals to manage their risk.

CSE: What tools or knowledge do engineering schools need to provide young engineers in order to successfully specify systems in labs?

Linamen: This is editorializing, but engineering schools need to teach students how to think. They don't need to teach more content. They need to teach students how to solve problems in a comprehensive way, utilizing all of the tools in their knowledge toolbox. When they get engaged in designing specific building types, the senior design team members can teach them about the critical aspects of lab design. It is not realistic to believe students can graduate from engineering school knowing how to design every building type. In their early years after graduation, they should look for the opportunities to design different types of buildings, and from those experiences, decide on which types of buildings they wish to specialize.

CSE: When designing a lab that is part of a multi-use building (such as in a hospital or university building), what unique challenges do you have?

Ramirez: In a fee-competitive environment the decision making process and end users requirement definition can cause design agencies financial harm and schedule impact. Being well prepared and offering solutions/options during early concept design and schematic design will help your clients "help you." As healthcare and institutional design professionals, we know our business and can provide sound engineered solutions. We need to take a proactive role in the early stages of the project to help stay on schedule and on budget and assure the client is making sounds choices for its facility.

Crutchfield: We have found that independent zoning, the access control, and security levels increase in multi-use labs. With many research labs operating beyond the typical 9 a.m. to 5 p.m. office hours, designing the systems such that the labs can stay operational while the non-lab areas are set back allows for flexibility in the operation of the building, which often leads to energy efficiencies. The labs are designed for continuous operation and the multi-use areas for noncontinuous operation. A second issue that we deal with on many higher education labs is the need to hide the fact that the lab is there to reduce the potential for vandalism or protests. Nothing broadcasts “lab” like a set of Strobic fans on top of a building. Integrating the exhaust systems into the building architecture so that they are hidden can alleviate some of those concerns.

Linamen: Something else we have learned from university labs is that they are very frequently unoccupied. Our studies have shown they are unoccupied as much as 60% of the normal daytime hours. We use occupancy sensors to not only reduce lighting levels where it does not cause safety issues, but we also use the occupancy sensors to expand the thermostat deadband when the spaces are unoccupied. We let it expand +/-3 F during daytime hours and +/- 6 F during nighttime hours. This saves reheat energy in labs that are dominated by exhaust airflow and saves cooling and fan energy in labs that are dominated by internal heat gain. We have found this energy savings to be significant over an entire year, and the cost of the occupancy sensors is very low in the overall scheme of things. Because of the typical high airflow rates for labs, recovery from the setback is usually very quick if the lab suddenly becomes occupied.

Another mistake designers make is designing the mechanical, electrical, and plumbing (MEP) infrastructure strictly to serve the initial intended use of the building. We should be thinking in terms of 40- to 50-year life when designing the building infrastructure, and research and science done in lab buildings will evolve significantly over that time period. Lab building MEP infrastructure should be designed with this in mind.

CSE: Describe your involvement in a recent integrated project delivery (IPD) lab or research facility.

Linamen: We have a very large lab project that is currently being completed utilizing an IPD process. It has been a true learning experience. I honestly believe IPD is the future, but it will take some time for owners, designers, and builders to perfect the process. The biggest challenge is in understanding how the other team members function and then determining how our industry can be a valuable partner in the collective process. Communication is key. Our design team had to work collaboratively with the construction team at the project site for several months to really get the barriers to communication completely eliminated. Some team members just couldn’t adjust to the new way of doing business, and they had to be replaced. This all took time. If we could do the same project with the same people again, we could probably cut the time in half. Because the relationships are so important in IPD, it may become advantageous to form key alliances between designers and builders in order to pursue work.

Crutchfield: We’ve found that IPD has lessened the owner’s exposure to costly changes on complex lab renovation projects. Being able to share our design concepts with the folks who are responsible for phasing and scheduling lets us design systems that function, while allowing the contractor team the level of comfort with us to be able to suggest alternatives without the specter of a change order. We’ve also found that when the contractor can procure, and we can coordinate with, the actual lab equipment being provided early in the design, we avoid over-designing systems to accommodate a range of potential equipment.

CSE: In specialty facilities, like vivariums, what issues have you come across?

Linamen: Security requirements for vivariums are more critical than for most labs or other building types. Often, animal holding rooms house animals from several researchers. They each want to make sure access to the spaces is limited to only those people who are authorized, and they like to know how often and by whom the rooms are being accessed.

Crutchfield: The requirement to keep the animals within the owner- or Association for Assessment and Accreditation of

Laboratory Animal International designated temperature/humidity/lighting levels is always a primary concern with vivariums and is animal specific. Providing an appropriate and cost-effective level of redundancy and reliability for these spaces while maintaining an appropriate first cost can be a challenge. We often seek cost-effective ways to gain reliability and redundancy for the vivarium by connecting the vivarium HVAC systems to adjacent lab HVAC systems for emergency backup. In the event of a loss of primary vivarium HVAC equipment, the backup is not a dedicated standby system, but rather a backup that relies on the excess capacity in the lab systems. We strive to find novel opportunities to keep costs down while maintaining proper levels of redundancy and reliability, and not simply relying on adding standby systems.

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

May 22, 2013 // **NEWS**

View Web Version | Add to Safe Sender List

HPAC *Fastrack*

Engineering resources at your fingertips

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

May 22, 2013

FASTRACK Features

Power-Plant Reliability, Availability, Maintainability

By BRIAN WODKA, PE, CEM, LEED AP; RMF Engineering Inc.; Baltimore, Md.

Asked to name the most important trait of a power plant—reliability, availability, or maintainability—most building owners and operators would say reliability. But is it really?

FULL ARTICLE

FASTRACK News

Ideas to Advance Building Industry Shared During Capitol Hill Briefing

Recommendations implementable in the near term that can serve as the basis of a national buildings policy were shared during a briefing on Capitol Hill hosted by the High-Performance Buildings Caucus of the U.S. Congress to kick off High Performance Building Week May 13.

FULL ARTICLE

HEATING/PIPING/AIR CONDITIONING HPAC ENGINEERING

May 20, 2013 // **NEWS**

Power-Plant Reliability, Availability, Maintainability

Military protocol being adapted for power plants

By Brian Wodka, PE, CEM, LEED AP; RMF Engineering Inc.

Asked to name the most important trait of a power plant—reliability, availability, or maintainability—most building owners and operators would say reliability. But is it really?

It is true that a power plant is a system of interdependent subsystems and that, if one of the subsystems fails, the entire power plant may be at risk of shutting down—a case for reliability being the most important trait. It also is true that most of the components in a power plant have parts that are rotating, reciprocating, or experiencing some type of stress cycle (thermal or mechanical), often under harsh conditions, and if the components are not monitored and maintained properly, they can fail quickly—a case for maintainability being the most important trait. However, it also is true that, most of the time, equipment must be shut down for maintenance to be performed. If a boiler is shut down for cleaning and inspection, it cannot generate steam. It may be extremely reliable, but it is unavailable the week it is shut down. With a power plant providing a utility typically required continuously, availability—the probability of functionality when required—is the most important trait of a power plant.

How can availability be maximized? A function of both reliability and maintainability, availability can be improved by maximizing uptime (reliability supplemented or enhanced by redundancy) and minimizing downtime (high maintainability).

Maximize uptime, minimize downtime—not unexpected advice. Still, it is much easier said than done. Let's take a quick look at how this has been attempted over the years to see what does and does not work and why.

TYPES OF MAINTENANCE

Reactive Maintenance

Commonly referred to as "run to failure" (see "Running (Literally) to Failure," HPAC Engineering, September 2010, http://bit.ly/Arnold_0910), reactive maintenance involves ignoring equipment until it fails. It is appropriate for inexpensive, non-critical pieces of equipment (e.g., light bulbs). The problem with it is that failures usually cannot be anticipated. Also, repair costs are higher because of the premium that must be paid for immediate response.

Preventive Maintenance

Recommended in most equipment operation-and-maintenance manuals, preventive maintenance occurs on a schedule. Its basis is the concept that the likelihood of failure is proportional to the age or operating hours of equipment. The idea is that maintenance is better performed too often than not often enough. Changing the oil in a car falls into this category.

This form of maintenance has intrinsic cost ramifications that can be significant. More importantly, it has been shown to be ineffective in controlling failure rates, the reason being the probability of failure does not necessarily increase with age, and maintenance performed in excess increases the opportunity for human error and can shorten the life of parts.

Predictive/condition-based Maintenance

During the 1980s, the concept of predictive, or condition-based, maintenance came about. The underlying concept of predictive maintenance is, "If it ain't broke, don't fix it." Equipment is inspected routinely, with maintenance performed only as needed. The determining factor is a chosen indicator, such as a squealing belt on belt-driven equipment. Inspections are performed while equipment is operating so as not to affect availability. The idea is to maximize operation and avoid unnecessary maintenance.

The problem with predictive maintenance is that it is only as good as the indicator(s) chosen to determine whether maintenance is needed and the interval at which inspections are performed.

Reliability-centered Maintenance

With predictive maintenance, power-plant operators with limited resources found they were wasting much time frequently checking insignificant items. This led to the development of reliability-centered maintenance, whereby maintenance tasks are prioritized according to risk using analytical methods, such as fault trees, or failure-modes-and-effects analysis.

Though it may seem new and cutting edge, reliability-centered maintenance has been around since the 1970s. It started as a government-funded initiative to improve military-aircraft and space missions. By the 1980s, it had proved successful enough that its scope was expanded to the Navy and nuclear industry. During the late 1990s, it was standardized by the Society of Automotive Engineers.1,2 In 2000, NASA published the first edition of “Reliability-Centered Maintenance Guide for Facilities and Collateral Equipment.”3

Despite a proven track record, reliability-centered maintenance has failed to gain widespread acceptance in the buildings industry, largely because of assumptions it is too complex and requires too much work. Where it easily can fail is where most great ideas fail: in the implementation. Experts estimate that as little as 5 percent of reliability-centered maintenance programs are implemented properly. Without the means for proper implementation, even the best-developed reliability-centered maintenance program can be just another (expensive) document sitting on a desk getting ignored.

Achieving Real Results

Reliability, availability, maintainability (RAM) is a concept with a history very similar to that of reliability-centered maintenance: Its origins are in the 1970s, and its intent was to assure availability for the military. Whereas reliability-centered maintenance was embraced more for aerospace, RAM primarily was the Department of Defense’s protocol for new and advanced combat equipment and weaponry. RAM concentrates more on the design and construction phases than reliability-centered maintenance. For that reason, it tends to be more of an all-encompassing, cradle-to-grave concept.

In 2009, ASME created a committee tasked with reviewing decades of research and documentation related to RAM and developing a standard for new and existing power plants.

The standard, the first draft of which is expected this year, focuses on three key priorities identified by power-plant owners: safety, production, and efficiency. Equipment has been assessed and a judgment as to risk or criticality made. To ensure availability, an appropriate level of reliability and/or redundancy is prescribed and the most appropriate maintenance program (reactive, preventive, predictive/condition-based, reliability-centered) given. Maintenance-program costs are estimated to aid budgeting. The standard can be customized to various facility sizes, risk levels, and budgets.

The standard requires assignment of a RAM manager, an individual who is responsible for the program’s teaching, implementation, and maintenance. A RAM program is a living document permitting continuous improvement and adaptation throughout a power plant’s life. This helps to prevent confusion, obsolescence, and, ultimately, disregard.

	RM	PM	PdM/CBM	RCM	RAM
Prevents failures		*	*	*	*
Minimizes excess maintenance	*		*	*	*
Prioritizes risk			*	*	*
Accountability requirements				*	*
Reliability specifications					*
Budgetary estimate					*

Comparison of reactive (RM), preventive (PM), predictive/condition-based (PdM/CBM), and reliability-centered (RCM) maintenance and reliability, availability, maintainability (RAM).

Conclusion

For those in the mission-critical industry, availability is a must. A proper maintenance and reliability program can be the difference between whether or not, say, a hospital stays open during a crisis. By utilizing RAM, operators of a critical-care or government facility that has had trouble keeping up with repairs or is plagued by unplanned outages may finally have a means of stabilizing maintenance and regaining control of availability.

References

1) SAE. (2009). Evaluation criteria for reliability-centered maintenance (RCM) processes. Warrendale, PA: SAE International.

2) SAE. (2011). A Guide to the reliability-centered maintenance (RCM) standard. Warrendale, PA: SAE International.

3) NASA. (2008). Reliability-centered maintenance guide for facilities and collateral equipment. Washington, DC: National Aeronautics and Space Administration. Available at http://www.wbdg.org/ccb/NASA/GUIDES/rcmguide.pdf

The leader of the power-plant-assessment-and-reliability team of RMF Engineering Inc., Brian Wodka, PE, CEM, LEED AP, has been performing power-plant assessments and boiler inspections for 12 years. He is a National Board of Boiler and Pressure Vessel Inspectors-commissioned boiler inspector; a licensed first-class stationary engineer in Maryland; the vice chair of the ASME committee tasked with developing standards related to the reliability, availability, and maintainability of equipment and systems in power plants; and a member of Maryland's Board of Boiler Rules and Board of Stationary Engineers. He holds a bachelor's degree in marine mechanical engineering from State University of New York Maritime College and a master's degree in mechanical engineering from Johns Hopkins University.

ce NEWS
business and technology for civil engineers

April, 2013 // **NEWS**

Solving a leadership void

By Duane Pinnix, P.E., C.C.P.

In summer 2011, the A/E industry was mired in the deepest recession since the Great Depression. Yet, RMF found itself on a record growth pace. Our clients – like many across the industry – shifted their focus to the upfit and improvement of existing facilities while capital projects were put on hold. Services such as master planning, energy auditing, condition assessments, retro-commissioning, maintenance/repair, and energy conservation were in high demand. Our firm's diversity in the marketplace allowed an aggressive response to clients' needs, and growth continued throughout 2011.

Meanwhile, several of our peer firms had to close shop and others struggled with staffing levels considerably reduced. One firm, considering roll up options, approached RMF about a merger that would enable us to expand in two regional markets. The deal was quite appealing and it came on the heels of RMF opening new offices in Georgia and Ohio. Our only apprehension was from concerns about our ability to lead these new initiatives successfully.

It soon became apparent that regardless of RMF's favorable position for steady growth, we were facing a fundamental leadership void.

During the next decade, the national baby boomer trend will also impact RMF – one third of our leaders will either retire or transition to retirement. This fact became a hot topic in our boardroom as we had not developed a strategy to fill the leadership void; we had more business opportunities than we had leaders to attack.

When this revelation was understood, our board approved the concept of an internal Leadership Development Program (LDP). The LDP is similar to what is delivered by a traditional MBA program, but with specific focus on our business.

During the third quarter of 2011, our management team developed a syllabus for the LDP, including topics such as finance, human resource planning, business development, business unit management, personal accountability, and growth. We implemented a program that would run for two years, addressing different subjects each quarter. We leveraged the skill set of a current leader at the firm to develop the program from the ground up, using internal and industry resources.

An initial budget for the program was established and we were off and running fearless into the process. The fourth quarter of 2011 started with a listing of potential LDP candidates, followed by a short list. Then, we selected "The 7," as they are currently known. Before they were invited to participate, The 7 were paired with a corporate mentor who would support and direct their participation in the program. Each candidate was presented with a formal invitation to participate; all seven accepted the opportunity without hesitation.

The LDP formally kicked-off with a two-day project management boot camp conducted by a management consulting firm. Moving into 2012, two-day workshops were scheduled and held monthly. Attendance was mandatory.

Workshops included approximately 12 hours of classroom time and evening social events for team building. Each month, participants had formal assignments, both individual and group, depending on the subject matter. Several assignments involved problem solving of traditional issues where team dynamics were diverse and in conflict. We stressed the importance of effective communications and required that each participant achieve the competent communicator designation through Toastmasters. This single requirement has improved each participant's confidence both internally and externally with clients.

The first year of our LDP concluded with tremendous results. Each of the seven participants developed a formal growth opportunity for RMF, which they will spearhead upon graduation from the program. To support this objective, each participant completed and presented a business development plan to corporate management for approval.

Through this process of strategically filling the leadership void, we have learned that when in doubt, act. Don't be complacent; challenge traditional thinking and be flexible moving forward.

We are confident that our program will yield seven leaders who are better prepared to lead RMF into the future and facilitate the transition of owners. Team building that has occurred among the five offices involved in the program is immense and has allowed some of the traditional silos common in the A/E industry to be shattered because participants were required to collaborate in challenging scenarios to complete technical assignments. Our total cost to date in terms of time and financial capital has been significant, but well justified.

Duane Pinnix, P.E., C.C.P., president and CEO at RMF Engineering, has been at the helm of RMF since becoming majority owner in 1998. He joined the firm 29 years ago as a project engineer and is now responsible for the general oversight of RMF and executive management of its branch offices.

Pinnix can be contacted at: duane.pinnix@rmf.com.

THE DAILY RECORD
BREAKING BUSINESS, LEGAL AND GOVERNMENT NEWS

April 12, 2013 // **NEWS**

RMF Engineering expands York office

RMF Engineering, of Baltimore, announced the expansion of its infrastructure services at its office in York, Pa. The office, which opened last year as RMF's 10th location in the U.S., is expanding to give clients a more localized approach to infrastructure services and field services such as commissioning, condition assessments, energy audits, and arc flash studies.

The expansion also includes a boost to RMF's local inspections and traditional building services. As a measure of support, the firm is expanding the local office by five employees and plans to add two additional employees within the next six months. RMF is working closely with York County School of Technology, York Technical Institute and York College to recruit new technical personnel who will support the service expansion in York, as well as the region served by that office (central Pennsylvania, Delaware and the Eastern Shore).

BALTIMORE BUSINESS JOURNAL

April 11, 2013 // **NEWS**

People on the Move: Brian Wodka

Date added: April 11, 2013

Submission Type: Promotion

Current employer: RMF Engineering

Current title/position: Team Leader

Position level: Senior Manager

Position department: Operations

Previous position: Mechanical Engineer, Boiler Inspector

Duties/responsibilities: The national engineering firm, RMF Engineering (headquartered in Baltimore, Md.), has appointed Brian Wodka, PE, CEM, LEED AP, to lead the expansion of infrastructure services in York, Pa. Wodka will oversee the local expansion of field services (e.g. commissioning, condition assessments, arc flash studies), as well as vessel inspections.

THE BALTIMORE SUN
LIGHT FOR ALL

April 09, 2013 // **NEWS**

RMF Appoints Brian Wodka to Team Leader

The national engineering firm, RMF Engineering (headquartered in Baltimore, Md.), has appointed Brian Wodka, PE, CEM, LEED AP, to lead the expansion of its infrastructure services in York, Pa. Wodka will also oversee the local expansion of field services (e.g. commissioning, condition assessments, energy audits, and arc flash studies), as well as vessel inspections. Wodka is a mechanical engineer and a published author.

He joined RMF 13 years ago and has extensive experience in the design and engineering of heating plants and distribution systems for large campuses, including higher education, laboratory / research facilities and government installations.

Wodka also leads the power plant assessment and reliability team at RMF. He has performed power plant assessments and boiler inspections for the last 12 years. Wodka is the vice chair on ASME's committee for developing standards for reliability, availability, and maintainability of power plants (RAM).

CONSULTING - SPECIFYING engineer

April 08, 2013 // **NEWS**

RMF Engineering Expands Infrastructure Services

RMF Engineering's York, Pa., Office Is Expanding Its Infrastructure Services To Provide A Localized Approach To Field And Infrastructure Services. Brian Wodka Has Been Appointed The Team Leader For The Company's Expansion.

RMF Engineering has announced the expansion of its infrastructure services at the firm's office in York, Pa. The office is expanding to give clients a more localized approach to infrastructure services and field services such as commissioning, condition assessments, energy audits, and arc flash studies. The expansion also includes a boost to RMF's local inspections and traditional building services. The firm is growing the local office by five employees and plans to add two additional employees within the next six months. Brian Wodka PE, CEM, LEED AP, has been appointed the team leader for the infrastructure group in York.

Wodka, who was previously based out of RMF's headquarters in Baltimore, is a mechanical engineer and a published author. He joined RMF 13 years ago and has extensive experience in the design and engineering of heating plants and distribution systems for large campuses, including higher education, laboratory / research facilities, private corporations and government installations.

Wodka also leads the power plant assessment and reliability team at RMF. He has performed power plant assessments and boiler inspections for the last 12 years. Additionally, Wodka is the vice chair on ASME's committee for developing standards for reliability, availability, and maintainability of power plants (RAM).

CPBJ now .COM
POWERED BY THE CENTRAL PENN BUSINESS JOURNAL

April 04, 2013 // **NEWS**

RMF Engineering expanding York County office

By Tim Stuhldreher

RMF Engineering Inc., a Baltimore-based firm working in the infrastructure and energy sectors, today said it plans to expand its York County office and add as many as four positions, which will double the office staff.

There is growing work in the infrastructure, energy audits, power plant design and general energy-assessment fields for engineering firms, said Brian Wodka, RMF's project manager who leads the infrastructure group.

"We noticed a demand in the region and an opportunity to step in and help out," he said.

Wodka will be moving to RMF's York Township office soon to increase the infrastructure services there.

RMF is working with York College, YTI Career Institute and the York County School of Technology to add as many as two technician staff this year, Wodka said. The company could add two more engineers within a year.

"There's a good sense of community in the York area and hopefully we can reach out and bring the schools in to what we're doing," Wodka said.

LEED® + District Energy

My Week at Greenbuild

Tim Griffin, PE, LEED AP, IDEA USGBC Liaison

Greenbuild 2012, attended by some 40,000 conference-goers, was held Nov.14-16 at San Francisco's Moscone Center.

***Editor's Note:** "LEED® + District Energy" is a quarterly column providing information about the U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) rating system and how it applies to buildings served by district energy systems.*

The week before Thanksgiving, people from around the world descended on San Francisco for the annual Greenbuild International Conference and Expo, the signature event hosted by the U.S. Green Building Council (USGBC). Greenbuild 2012 marked the first time a representative from IDEA presented on district energy at this conference.

As a Greenbuild virgin (that's actually what they call first-timers), I was not prepared for the sheer size and scope of the event. It is the world's largest conference and expo dedicated to green building. At this most recent event, there were estimates of 40,000 attendees and more than 1,500 exhibitors from around the globe. Held in the Moscone Center, the conference required convention space in all three of the center's exhibit halls – each on a separate city block with its own exhibitor space, training rooms and special exhibits. The conference ran 15 concurrent education tracks throughout the week, and the nights were filled with hundreds of lavish invitation-only parties throughout the city. (Unfortunately, none of the invitations were directed at IDEA's USGBC liaison.)

The city of San Francisco certainly rolled out the red carpet for this conference. City and state dignitaries were present, hotels and restaurants were prepared, and even all the rickshaws in town were branded with Greenbuild advertisements. It seemed no matter where you went in San Francisco, Greenbuild attendees dominated the scene.

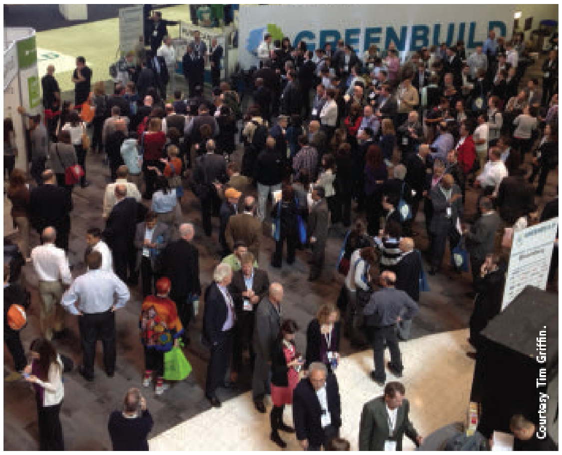
> Greenbuild is the world's largest conference and expo dedicated to green building.

The magnitude of the USGBC's planning effort was certainly apparent as well. There were hundreds of volunteers within the conference centers and on every street corner wearing black shirts with "Ask Me" written on the front, ready to answer any question you might have about where to go next. Badges included bar codes used to track your attendance at various educational sessions and to allow vendors to record your information if you had interest in their offerings. The exhibits not only filled the three exhibit halls but also spilled into the streets, where I toured a fascinating 700-sq-ft green home that had the amenities of a much larger space. (It included the ability to seat 12 for dinner at a table that easily converted into a table for one; all 12 seats pieced together into one as well.)

Trying to get through the exhibit halls was overwhelming if not impossible. I spent the better part of a day just working my way through one. Most of the exhibits were large and creative. In fact, one cooling tower vendor brought to the exhibit an actual cooling tower with 800 tons of cooling capacity. The majority of the vendors were not from companies we normally see exhibiting at IDEA. Some of their product offerings were fascinating in terms of creativity: preinsulated concrete forms for building walls that connect together like Legos, parking lot surfaces that allow rainwater to penetrate, various methods for creating green roofs. The list goes on. While some ideas, from an engineering standpoint, seemed impractical to implement, economically challenging and overreaching in their claims, many were impressive both in their simplicity and creativity. I walked away with a feeling of having gotten a glimpse of our future and excited about what that may be.

Presenting District Energy

A look into the future was also provided in how the conference was delivered as well. The majority of presentations were not given in a traditional format with a stage, podium and slide deck. Instead, each presentation room had unique setups that encouraged presenters to engage the audience and be creative in their approach to conveying their message. Rooms held up to 300



More than 1,500 exhibitors from around the world participated in the Greenbuild Conference and Expo, which occupied all three Moscone Center exhibit halls.

Tim Griffin (left), IDEA's USGBC liaison, and Mike Opitz of Cadmus educated a Greenbuild audience on district energy and its sustainability benefits. Together with Llewellyn Wells of Living Cities, they presented their message in the format of a TV show: *The Daily Show With Jon Stewart – Green Edition*.

attendees, and each included a sound team to manage microphones, lighting and even TV cameras. In addition, presenters could poll the audience, with audience members texting in their answers and the results showing in real time. It had a very *American Idol* feel to it all.

Some presenting teams did well with the format, coming up with novel ways to communicate interesting and informative messages. Others clearly struggled as they simply tried to take a traditional presenting approach and fit it in a new model where it would not work. In addition, some seemed to misunderstand their audience, preaching a green message to a room of already fully committed green advocates – reminding me of what we refer to in the South as "preaching to the choir."

A speaking opportunity at Greenbuild is not easy to attain. Many more proposals for presentations are rejected than accepted. The proposal review process requires potential presenters to submit videos from previous sessions and a list of speaking references, which are all due at the beginning of the year. I was fortunate enough to be part of a presentation team that was selected. Our team included Mike Opitz, a principal with Cadmus, who spent several years as a vice president with the USGBC. In his time there, he oversaw the effort to write the district energy guidance documents. Our other presenter was Llewellyn Wells, president of Living Cities, a Colorado organization that works to develop sustainable urban communities; part of Living Cities' plan includes district energy development. Llew formerly worked with Amory Lovins of Rocky Mountain Institute, who was the keynote speaker at IDEA's 2012 annual conference.

The room where we presented was called Theatre in the Round. The stage itself was a small octagon with the audience seated 360 degrees around the speaker. (So much for finding your best side.) All presenters had to have some type of creative theme – no monotone speeches accompanied by a bunch of slides – so our team spent the summer brainstorming options. We settled on delivering our message as a TV show. The show we picked was Comedy Central's *The Daily Show With Jon Stewart – Green Edition*. Mike was the host, and Llew and I were the guests. We believed this approach, if well-delivered, could be both interesting and effective; but achieving this required injecting many humorous moments and coming off as unscripted. If unsuccessful, well, it would bomb. However, nothing ventured, nothing gained, so away we went with our plan.

I was pleased for the most part with the results. While some parts drifted into preaching to the choir, overall we got a lot of laughs while managing to educate an audience of around 150 people on district energy. We covered what it is and how it can play a powerful role in achieving overall sustainability goals. During questions at the end, audience members wanted to know how to determine when district energy makes sense in their communities and what messages to take back to their stakeholders.

When the presentation ended, I was surrounded by a group of around 10 folks from six different countries. They wanted to share how they are using district energy in impressive ways to meet their sustainability goals and to ask questions about how they can do more. The majority of U.S. attendees represented a highly educated component of the millennial generation. They wanted to know more about how district energy could be used within the communities where they both work and live. Others complained about the challenges they have faced from traditional electric power providers when promoting combined heat and power facilities and wanted to know what lobbying efforts IDEA was pursuing to overcome these obstacles.

The Green Movement

A few years ago, I heard a lot of predictions that the green movement was a passing fad and that an economic slowdown would return people to "reasonable" thinking. Since that time we have moved through a recession only to see the influence of organizations like the USGBC increase. One of the many news organizations to cover the expo, *USA Today*, reported that in a recent survey, 51 percent of companies stated that more than half their construction projects will be certified as green by 2015.

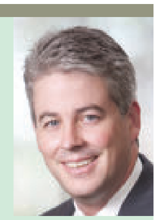
Also, a survey of corporate executives performed by Turner Construction found 90 percent of those executives are committed to green construction. The study suggested, however, that the reasons for this had less to do with the need for LEED certification than they did purely economic factors. Companies are starting to find a business case for green construction that extends beyond branding their buildings.

> Companies are starting to find a business case for green construction that extends beyond branding their buildings.

As I wandered through the exibit halls and watched vendors and consultants round up potential clients for various events, the business case was evident. Many of America's Fortune 500 companies made significant investments in the Greenbuild expo. They did not do so to make themselves feel better. They expected a return on their investments. Their forecasters and strategic development leaders see growing markets with tremendous opportunities to be captured in green construction. Unfortunately, I did not find any of these vendors promoting district energy. Even larger organizations with divisions involved with district energy at some level were not talking about the district energy message. It was disappointing that in four days in San Francisco I did not run into one familiar face from IDEA.

There are significant challenges for our industry ahead. The green movement appears to be gaining momemtum and driving structural change in the building industry. Soon, a new LEED rating system version will be released, and a lot of the language relative to the treatment of district energy within LEED has yet to be written. There are forces within the green movement that believe strongly that district energy is an outdated technology that should be abandoned in all cases. Even within ASHRAE, an organization that should better understand district energy's potential benefits, there are professionals on standard-writing committees who believe the same.

With every challenge there is an opportunity. We have a good message to disseminate and a positive role to play in helping the green movement achieve its sustainability goals. I'm convinced, as most of you are as well, that district energy offers the most sustainable solutions for utilizing energy in areas with significant load density. Yet, many in the construction industry do not understand how district energy can increase energy efficiency, promote sustainability and increase renewable energy use. We must do a better job of getting our message out there or risk becoming irrelevant.



Tim Griffin, PE, LEED, AP, is IDEA's liaison with the U.S. Green Building Council and serves on IDEA's board of directors. He is a principal and branch manager with RMF Engineering Inc., a firm specializing in district energy system planning, design and commissioning. A registered engineer and a LEED Accredited Professional, Griffin has a Bachelor of Science degree in mechanical engineering from North Carolina State University and a Master of Business Administration degree from Colorado State University. He authored the book *Winning With Millennials: How to Attract, Retain, and Empower Today's Generation of Design Professionals*. He may be reached at tgriffin@rmf.com.

BALTIMORE BUSINESS JOURNAL

February 08, 2013 // **NEWS**

Largest engineering firms in the Baltimore area

Ranked by number of registered engineers working in the Baltimore area, ties broken by total engineers

	Name Address Phone / website	Registered engineers local/total	2012 billings local/total	Sample of primary services	Sample of projects in design	Top local executive, title (email)
1	**Whitman, Requardt & Associates LLP** 801 S. Caroline St., Baltimore 21231 410-235-3450 / www.wrallp.com	142/ 216	$71 million/ $107 million	civil engineering, architecture, construction mgmt., environmental science, planners, structural, mechanical	Cumberland CSO storage facility, Purple Line, 20th Command Headquarters-APG, Red Line	Joseph Makar and David McCormick, partners
2	**Johnson, Mirmiran & Thompson** 72 Loveton Circle, Sparks 21152 410-329-3100 / www.jmt.com	126/ 224	$73.6 million/ $116.3 million	transportation, buildings/facilities, water/wastewater, CM/CI, environmental, GIS/IT	11th St. Bridge, BWI RSA program management, Kirk Bus Division facility, Baltimore sewershed designs	John A. Moeller, president
3	**Rummel, Klepper & Kahl LLP** 81 Mosher St., Baltimore 21217 410-728-2900 / rkk.com	106/ 232	$72.49 million/ $139.41 million	transportation, natural/man-made environmental, civil/site, utility/energy planning, design, and CM/CI	Potomac PS, Flower Ave., Nat. Museum for African Amer. History, Charles St. reconst, Levindale Hospital	six partners[1]
4	**URS Corp.** 4 N. Park Drive, #300, Hunt Valley 21030 410-785-7220 / www.urscorp.com	105/ dtd	$49.75 million/ dtd	engineering, architecture, environmental, water, wastewater, construction inspection, aviation, planning/permitting	Intercounty Connector, Woodrow Wilson Bridge, Baltimore Beltway, WSSC, MD 355, BWI, JFK	Alan H. Straus, vice president/ office manager (alan.straus@urs.com)
5	**KCI Technologies Inc.** 936 Ridgebrook Road, Sparks 21152 410-316-7800 / www.kci.com	65/ 119	$71.1 million/ $141.2 million	transportation, civil/site, structural, M/E, environmental, construction mgmt., surveying, telecom/utility	ICBN, Nursery Road bridge, Balt. City 800 MHz South Ring, Hurricane Sandy post-storm standby	Terry F. Neimeyer, CEO and chairman (terry.neimeyer@kci.com)
6	**Century Engineering Inc.** 10710 Gilroy Road, Hunt Valley 21031 443-589-2400 / www.centuryeng.com	55/ 109	$23 million/ $40 million	civil, structural, MEP, geotechnical, planning, highway, bridge, water resources, traffic, GIS	African penquin exhibit at Md. Zoo, LED roadway lighting pilot project, Kelly Branch stream restoration	Francis X. Smyth, CEO (fsmyth@centuryeng.com)
7	**Gannett Fleming Inc.** 7133 Rutherford Rd., #300, Windsor Mill 21244 443-348-2017 / www.gfnet.com	43/ 350	n/av	study, design, construction-phase engineering for transportation, water resources, facility infrastructure	Towson Reservoir covers, Purple Line, Catonsville pumping station, North Ave. rehabilitation	W. Arthur Barrett, senior vice president and regional director (wbarrett@gfnet.com)
8	**Whitney, Bailey, Cox & Magnani LLC** 849 Fairmount Ave., #100, Baltimore 21286 410-512-4500 / www.wbcm.com	42/ 57	$13.65 million/ $17.79 million	site, structural, highway, bridge, traffic, water resources, marine and industrial engineering	I-95 toll plazas, FCC used motor oil re-refinery, Dundalk Readiness Center addition	Leon Kriebel, president (lkriebel@wbcm.com)
9	**RMF Engineering Inc.** 5520 Research Park Drive, Baltimore 21228 410-576-0505 / www.rmf.com	37/ 62	$17.5 million/ $32.2 million	mechanical, electrical, plumbing, fire protection, energy, civil, structural engineering; master planning, auditing	health care, laboratory, higher education, government projects; central plant and utility distribution, energy audit	Duane S. Pinnix, president and CEO
10	**Wallace, Montgomery & Associates LLP** 110 West Road, Suite 300, Towson 21204 410-494-9093 / wallacemontgomery.com	37/ 37	$16.3 million/ $16.3 million	highway, structural, construction mgmt., traffic, transit, planning, utilities, water resources, environmental	Red Line, Purple Line, I-95/Contee DB, SHA on-call highway design, SHA bridge design	Antonio A. Mawry, Stuart B. Taub and Frank S. Waesche III, partners
11	**TAI** 11155 Dolfield Blvd., #210, Ow. Mills 21117 410-356-3108 / www.taiengineering.com	35/ 37	$18.2 million/ $25.9 million	process, mechanical, electrical, structural, automation and controls, telecom	power plant pollution control system expansion, secure gov. campus facilities, sodium hypochlorite production facility	James J. Angelo, president (jangelo@taiengineering.com)
12	**EA Engineering Science & Technology** 225 Schilling Circle, Hunt Valley 21031 410-584-7000 / www.eaest.com	29/ 49	n/av	environmental engineering, remedial design, solid waste mgmt., landfill design, water/wastewater	Harford County landfill, MdTA tank removal/replacement, Fort Belvoir regional stormwater facility	Ian D. MacFarlane, president and CEO (imacfarlane@eaest.com)
13	**STV Inc.** 7125 Ambassador Rd., #200, Baltimore 21244 410-944-9112 / www.stvinc.com	28/ 420	$21.37 million/ $246.41 million	architecture, planning, civil/site engineering, transportation, structural, environmental, planning, landscape	dtd	Anthony J. Corteal Jr., senior vice president (anthony.corteal@stvinc.com)
14	**Hughes Associates Inc.** 3610 Commerce Dr., #817, Baltimore 21227 410-737-8677 / www.haifire.com	28/ 95	$16.94 million/ $53.62 million	fire protection engineering/design, fire, building and ADA code consulting, commissioning, fire research/testing	Under Armour visitor center, UMD Baltimore School of Pharmacy, Md. Zoo, Lake Shore & Clarksburg ES	Phillip J. DiNenno, president (pdinenno@haifire.com)
15	**Pennoni Associates** 8818 Centre Park Dr., #200, Columbia 21045 410-997-8900 / www.pennoni.com	25/ 198	$12.58 million/ $125.72 million	sustainability, environmental, geotechnical, laboratory testing, land devel., landscape arch., materials testing	high-speed test track traffic control at APG, Guilford finished water improvements, Deer Creek pumping station	Ron Moore, regional vice president (rmoore@pennoni.com)
16	**Mueller Associates Inc.** 1401 S. Edgewood St., Baltimore 21227 410-646-4500 / www.muellerassoc.com	21/ 21	$6.7 million/ $6.7 million	mechanical electrical and plumbing engineering	Morgan State Univ. School of Business, Bowie State Univ. Natural Sciences, UMCP St. John Teaching & Learning Ctr.	Robert A. Marino, president and chairman (rmarino@muellerassoc.com)
17	**EBA Engineering Inc.** 4813 Seton Drive, Baltimore 21215 410-358-7171 / www.ebaengineering.com	19/ 33	$18.09 million/ $18.09 million	civil/site, construction mgmt./inspection, environmental, geotechnical, materials testing, structural, surveying	Maryland House of Correction, Inter-County Connector, Social Security building, bridge condition inspection/rating	Nanda K. Sen, president (nanda.sen@ebaengineering.com)
18	**Burdette, Koehler, Murphy & Assoc. Inc.** 1423 Clarkview Road, #500, Baltimore 21209 410-323-0600 / www.bkma.com	17/ 40	n/av	mechanical, electrical, plumbing, mission critical, commissioning	I-95 travel plazas, Baltimore County 911, UD Life Sciences building, Magnolia MS, Chase Brexton	James L. Barrett Jr., president (barrett@bkma.com)
19	**McCormick Taylor Inc.** 509 S. Exeter St., 4th Floor, Baltimore 21202 410-662-7400 / www.mccormicktaylor.com	16/ 110	n/av	wetlands, stream restoration, cultural resources, policy devel., highway/ bridge design, transportation	Brock Bridge Road at Md.-198, PB-85 stream restoration, SHA, Prince George's Co. Contee Road extension	Dana P. Knight and Andy B. Smith, vice presidents
20	**James Posey Associates Inc.** 3112 Lord Baltimore Drive, Baltimore 21244 410-265-6100 / www.jamesposey.com	15/ 15	n/av	mechanical, electrical, plumbing, and fire protection engineering	JHU Malone Hall, Dundalk/Sollers Point High School, Cannon House office building modernization	Stephen J. Hudson, president (shudson@jamesposey.com)
21	**Allen & Shariff Corp.** 7061 Deepage Drive, Columbia 21045 410-381-7100 / www.allenshariff.com	14/ 22	$8.5 million/ $52.3 million	mechanical, electrical, plumbing, fire protection and technology systems engineering design, commissioning	114 E. Lexington St. in Baltimore, Balt. Royal Sonesta Hotel, Rotunda redevelopment, UA Ivory Gym	Mary Cannon, president; Zack Shariff, CEO
22	**Hillis-Carnes Engineering Assoc. Inc.** 10975-A Guilford Road, Annapolis Jctn. 20701 410-880-4788 / www.hcea.com	11/ 15	$9.82 million/ $24.56 million	geotechnical engineering, drilling/ subsurface investigation/instrumentation, deep foundation design	Mondawmin Mall, Cold Spring Lane	Richard M. Hillis (rhillis@hcea.com) and William M. Carnes (bcarnes@hcea.com), principals
23	**Kibart Inc.** 901 Dulaney Valley Rd., #301, Towson 21204 410-494-1111 / www.kibart.com	11/ 11	$4.65 million/ $5.35 million	mechanical, electrical, plumbing, and IT design, construction administration, and commissioning services	Johns Hopkins Hospital, UMB and UMCP on-call, Loch Raven H.S., NIH, Riderwood Retirement Community	P. Edwin Abbott Jr., president (pea@kibart.com)
24	**Greenman-Pedersen Inc.** 10977 Guilford Road, Annapolis Jctn. 20701 410-880-3055 / www.gpinet.com	10/ 181	$14.5 million/ $150 million	municipal engineering, CM/CI, survey/ photogrammetry, landscape architecture	I-95 Section 100 express toll lanes, Looper Park, Jones Falls Trail Phase IV, MSHA statewide coatings inspection	Daniel J. Maletic, senior vice president (dmaletic@gpinet.com)
25	**RTKL Associates Inc.** 901 S. Bond St., Baltimore 21231 410-537-6000 / www.rtkl.com	9/ 18	n/av	MEP engineering, structural engineering	Exelon Baltimore headquarters	five vice presidents[2]

NOTE: More than 75 companies were surveyed for this List, but some did not respond by deadline.
SOURCE: The companies provided the information for this List.
[1] Mark D. Dumler, Thomas E. Mohler, Michael W. Myers, Mike Potter, David W. Wallace and Carolann D. Wicks.
[2] Jennifer Barnes (jbarnes@rtkl.com), Mark Kendall (mkendall@rtkl.com), William McCarthy, Stephen Spinazzola (sspinazzola@rtkl.com) and Dave V. Thompson (dthompson@rtkl.com).

Compiled by: Carolyn M. Proctor.

dtd=declined to disclose n/av=not available
CURRENT: Feb. 8, 2013

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

January 09, 2013 // **NEWS**

Low-NOx Burners for Industrial Boilers

How low can—and should—you go?

By VINCE BASILIO, PE, CEM; RMF Engineering Inc

Operators of industrial-size centralized hot-water- and steam-generating facilities on college, hospital, and government campuses are under increasing pressure to restrict nitrogen-oxide (NOx) emissions, as state environmental agencies enforce federal law intended to decrease respiratory-related health concerns.

Internal view of a low-NOx burner for an industrial boiler.

Limiting NOx Formation

There are three major types of combustion-related NOx: thermal, fuel bound, and prompt.
Internal view of a low-NOx burner for an industrial boiler.

Thermal. Thermal NOx is created by high flame temperature in the presence of oxygen. The key to limiting thermal NOx is to reduce peak flame temperature and restrict oxygen availability and exposure at peak temperature. There are two main ways burner manufacturers have accomplished this without post-combustion control: steam injection and flue-gas recirculation (FGR).

Steam injection—injecting steam into a flame—works because steam temperature is considerably lower than flame temperature—in the case of a boiler operating at 300 psig, 421°F vs. 2,400°F to 3,400°F. Also, steam is pure water, which is not free oxygen.

FGR is the process by which exhaust gas is introduced into the combustion-air stream prior to a burner. Flue gas also is relatively cool (300°F to 550°F, depending on the design of the boiler and whether there is a feedwater economizer) with respect to flame temperature, and flue gas has little oxygen from the combustion process.

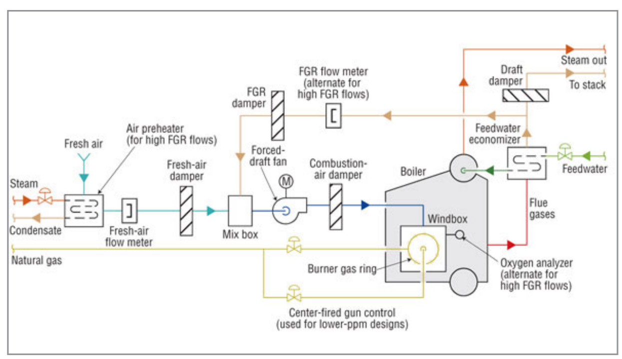


FIGURE 1. Typical low-NOx induced FGR flow for industrial-style boiler.

FGR is more prevalent than steam injection simply because of economics—generating steam for injection is more expensive.

Fuel bound. Fuel-bound NOx is inherent in fuel and cannot be reduced, except via post-combustion processes. Compared with other fuels, such as oil, the fuel-bound nitrogen in natural gas is low and considered insignificant.

Prompt. Prompt NOx "occurs through early reactions of nitrogen molecules in the combustion air and hydrogen radicals from the fuel."[1] Recent "ultralow-NOx" designs have limited the generation of prompt NOx by minimizing the formation of substoichiometric regions in the flame.

More on FGR

Early designs used a fan other than the combustion-air fan to move flue gas, a method called "forced" FGR. The current standard burner design incorporates "induced" FGR, whereby the relatively negative pressure near the inlet of the combustion-air fan pulls flue gas into a "mix box," where the flue gas and combustion air combine on the way to the inlet of the combustion-air fan (Figure 1). There is no separate FGR fan—the combustion-air fan does all of the work. There may be a non-modulating damper between the fresh-air intake and mix box to increase velocity in the fresh-air-inlet duct and create a more negative pressure to fight the stack effect pulling the flue gas to atmosphere.

Burners that require FGR use more motor horsepower because more gas must be moved in the burner. Also, there is a slightly higher static requirement for the fan because more gas is going through the boiler. This decreases the efficiency of the boiler.

FGR usually pulls flue gas downstream of the feedwater economizer, as opposed to upstream, because, downstream, flue gas is cooler, denser, and, thus, less of a horsepower draw on the fan than it is upstream. If the stack is approximately 50 ft or higher, and there is a damper to control boiler draft outlet pressure, FGR is pulled from upstream of the draft damper to limit the opposing pressure from which the fan needs to pull.

Some burner manufacturers are beginning to market internal FGR, whereby flue gas within the furnace recirculates back into the flame. This approach reduces volume through the fan and, thus, lowers horsepower requirements. Additionally, it can increase overall efficiency.

How Low Can You Go?
With a 100-million-Btuh-fuel-input gas boiler, the average emission factor for an uncontrolled burner is roughly 85 ppm; for a low-NOx burner, it is 42 ppm, and for a low-NOx burner with FGR, it is 26 ppm.1 Keep in mind these are average emissions; they are not regulation requirements and are not to be used as a basis for an air-permit application. You need to verify predicted performance with the burner manufacturer and state it in your specifications.

In a standard D-style industrial boiler firing natural gas, a standard burner without FGR can achieve 85 to 100 ppm, while a burner with FGR with staged air/fuel can achieve 30 to 50 ppm. FGR rates can be 5 to 15 percent of total boiler flue-gas output, depending on a host of variables; most operators will not sense a difference in burner performance or interaction with controls. Initial designs used either a gas ring alone or a gas ring with spuds or pokers. Recent designs for 30 ppm to 9 ppm use these combinations, but also use a center-fired gun with separately modulated control valves to help with flame staging and spread and to keep the flame stable at lower loads. These designs require less FGR than previous designs for the same emissions rates and can be evaluated as an energy-saving measure for existing installations of low-NOx burners. In fact, some manufacturers state they can achieve 30 ppm or less without FGR, a significant development in the advancement of burner technology.

When approaching 9 ppm, prompt NOx is addressed, in addition to thermal NOx. FGR rates increase to 20 to 30 percent, and control feedback is required to maintain NOx emissions. There is more hardware in the burner for staging fuel and air. Some burner designs can achieve about 5 ppm to 6 ppm. These designs limit prompt-NOx formation more aggressively and focus even more on air and fuel mixing and internal and external circulation zones. It is important to note that circumstances must be right, and before these levels are pursued, an engineering evaluation is required.

While the focus of this article is on reducing NOx formation at the burner, there always is post-combustion control technology, such as selective catalytic reduction (SCR), which can reduce NOx emissions to 1 ppm. In SCR, ammonia is introduced into the flue-gas stream upstream of a catalyst, where it transforms NOx into nitrogen and water. Compared with the technologies described above, SCR typically is not cost-effective for industrial boilers, but is used in extreme cases, when limits are tight.

What Does It Mean?
Now that you know how low you can go, what does it mean to your plant? Many factors can be affected, based on how much FGR you need and the design of the burner and boiler. All of these factors need to be considered.

To ensure a consistent radiant-temperature heat sink around the flame, low-NOx-burner manufacturers generally mandate no refractory tile on the floor, and some request limited or no refractory on the target (rear) and even burner end walls. Because of the air staging, more length may be needed in the furnace to ensure the flame does not impinge on the rear wall. To handle the amount of flue gas coming into the burner and related staging hardware, the depth of the windbox may be extended by a few feet over that of a standard burner. All of this means a physically longer boiler.

The staging of air into the furnace may require a higher static pressure, which may require additional fan horsepower. Also, the staging of fuel into the air may require a higher natural-gas pressure to satisfy turndown requirements. Natural-gas pressure at the inlet of the regulating pressure valve can be 10 to 30 psig.

Depending on NOx-emissions requirements, FGR flow may or may not be modulated as part of the control process. Burners with lower emission requirements generally have modulating dampers, with the control signal provided via the measurement of flow through the FGR duct or by use of an oxygen analyzer in the windbox.

Note that for burners 30 ppm and higher, controls can be relatively simple. For burners 9 ppm and lower, having the burner manufacturer provide the logic and controller generally is recommended, if not required. Fully metered, cross-limited controls are the norm for these systems, and airflow must be measured upstream of the mix box—avoid using differential draft pressure across the boiler. Maintaining instrumentation is more important with lower-NOx burners, so a more aggressive service contract or competent in-house instrument technician is required. Also, you want to specify that the burner manufacturer hire the startup personnel and ensure that enough time—generally, at least a week per burner—is allowed. If more than one unit is to be installed and started up at a time, still allow for at least a week because no two burners or startups are alike. Consider the availability of experienced burner technicians in the event an urgent issue arises.

Because of the sensitivity of air and fuel mixing and staging for burners 9 ppm and lower, more time is needed for stabilization when changing load. If there are major swings in campus demand, consider base loading boilers (if possible). Otherwise, expect a little more offset and lag in header-pressure control.

With FGR in the flue-gas stream, the temperature through the combustion-air fan, through the duct, and into the windbox is elevated. Burners designed for 30 ppm and higher generally have combined temperatures low enough that insulation is not required for personnel protection. At 9 ppm and lower, insulation becomes a consideration.

Generally, burners 9 ppm and lower must have fresh air above a certain temperature to prevent water vapor from condensing out of the FGR; otherwise, liquid water will fill up the windbox. A steam-coil air preheater is required to heat fresh air during colder months. An air preheater, however, adds air pressure drop and maintenance requirements. An outage of the air preheater means the burner cannot be fired when it is needed most.

How Low Do You Need to Go?

Knowing the extent to which you need to reduce NOx, which is dependent on your geographic location, the size of your equipment, and how much fuel you burn, is important. Seeking professional help from firms experienced with your state's laws as well as federal requirements is highly recommended.

A new boiler's NOx emissions may be limited to a 12-month rolling peak. When the primary demand is for heating, fuel-input requirements relate heavily to ambient temperature. Relative demand is extremely low during summer, almost immediately dropping the annual potential fuel fired to 75 percent or lower.

Note that emissions guarantees from burner manufacturers generally are in the 4-to-1 turndown range, although a burner may be able to operate at 8-to-1 or even 10-to-1. Make sure the state agency writing the permit understands the operational limits of your burner. You do not want to get stuck operating a burner with a turndown capability of only 4-to-1.

One last thing regarding air-permit applications: Be careful specifying emissions limits based on literature from a burner manufacturer. Leave a cushion. If a manufacturer is guaranteeing 9 ppm, place that in the boiler/burner-purchase specifications, but try to have the air-permit restrictions based on something a little higher, such as 11 ppm. This will give plant operators some breathing room, allowing them to continue operating while planning for tuning if parameters start to get loose.

Retrofitting

Whether you have a burner that fires natural gas and you need to reduce NOx emissions or a burner that fires oil and you need to add gas firing, the best place to start is the original burner manufacturer, who is best able to advise you as to your options. Other manufacturers may have to invest some level of engineering.

Retrofits of coal-fired boilers must be evaluated on a case-by-case basis. Most furnaces are relatively tall, but skinny compared with D-style boilers. Multiple burners usually are required to maintain similar heat output. Burners can be placed on the sides in configurations that allow the coal grate, which can be packed down with sand and refractory, to stay. Burners also can be located at the bottom pointing upward. In some cases, overfire air fans can be re-used to reduce NOx emissions. Thirty ppm for coal retrofits is achievable. Going lower is possible for some configurations.

Reference

1) EPA. (1995). Compilation of air pollutant emission factors, volume i: Stationary point and area sources. Research Triangle Park, NC: U.S. Environmental Protection Agency.

Vince Basilio, PE, CEM, is an associate with RMF Engineering Inc. For nearly 20 years, he has been the lead design engineer for dozens of industrial and institutional steam- and cogeneration-plant renovations and expansions. His work for RMF has taken him to areas of the United States with some of the most stringent NOx-emissions regulations. He has a degree in mechanical engineering from the University of Delaware. He can be reached at vince.basilio@rmf.com.

December 31, 2012 // **NEWS**

Partner at 35? Why I Know I'm Not Ready Just Yet

By Bryan Wodka

On January 3, 2012, I received an e-mail from the president of my company, RMF Engineering, with an attached document. My heart racing, I felt like a high school senior about to open the application response letter from his favorite college. I thought, "Is this it? Is this how I get asked to become a partner in the firm?" Nope. So what was it?

First, let me paint you a picture.

Bryan Wodka

Back in 2001, a few months out of college, I was hired by RMF in Baltimore and have worked there for 12 years.

As a mechanical engineer specializing in powerplants and infrastructure, I have accumulated multiple licenses, commissions, certifications and a graduate degree. I am a member of and actively involved in an ASME International standards committee and Maryland state boards (boiler rules and stationary engineers).

Now age 35, I am often called an overachiever and a go-getter, but I'll admit I occasionally overstep. I am the only one in the company who wears a tie every day. Yeah, I'm "that guy."

When it became clear that, instead of reading about the onboarding procedures of new partnership, I was being selected for the opportunity to be part of a "new leadership development program," it was a firm slap to my narcissistic ego. When I saw the words "two-year program," I stopped reading.

A two-year program! My ego was angry. Was this a pathetic attempt to buy more time before offering me a partnership?

Don't get me wrong: I was grateful to be selected for the leadership program, but the idea that the partnership opportunity was at least two years away was a bit disheartening.

I actually discussed the letter with the head of our department and confided my feelings. He talked me off the ledge. What I did not realize was that I was on the cusp of a vital change in my professional growth and perspective.

Out of 250 employees, only seven were selected to enroll in the program, mostly from different offices. As the leadership development program began, we were each paired up with a company director as a mentor.

The program is loosely based on an MBA curriculum intended to teach what a partner needs to know that is not taught in most engineering schools. We have focused on effective leadership techniques, corporate planning, public speaking, hiring and firing—and that was just in the first six months!

Bonds of Trust

In addition to meetings, reading books and homework, we get together for social and team-building events, such as dinners, side projects, seminars and white-water rafting outings. The intent is that while we are learning, the seven of us develop a bond and trust. I almost hate to admit it, but this touchy-feely stuff is actually working.

What was most eye-opening for me was the look behind the curtain of the corporate aspect of the company. I knew that a lot was being done, but I believe my ignorance is what gave me the sense of entitlement and arrogance. I felt like "I could do that"—comparing myself to other partners—when I really didn't even know all their responsibilities.

For me, this new perspective has developed a much higher level of respect for the management of the firm; more important, it has shown me that maybe I am not ready to become a partner just yet. I can't believe I just wrote that.

One important lesson the company has learned from past mistakes is not to grant partnership based simply on tenure. The purpose of the leadership program is to be the "machine" that properly prepares people for partnership.

That is the reason why I am genuinely glad I am participating in the program before "forcing" myself into partnership.

I look back and realize how obsessed I was with achieving partner status. Blinded by the allure of profit-sharing, I didn't realize the responsibilities that come with the role. Now, I will have a much greater opportunity to make more profit for the company (and myself).

Instead of striving for a title, I am learning to be an effective leader.

Instead of devoting myself to the struggle to satisfy the minimum requirements for partnership, now I'm thinking first of fulfilling the needs of the company and growing into the position.

Brian Wodka, P.E., CEM, LEED AP, is a mechanical engineer at RMF Engineering and leader of the firm's powerplant assessment and reliability team. He can be reached at Brian.Wodka@rmf.com.

HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING

November 28, 2012 // **NEWS**

HEATING/PIPING/AIR CONDITIONING
HPAC
ENGINEERING
HOT TOPICS

HPAC Engineering Hot Topics

A monthly digest of the Top Stories viewed online at HPAC.com

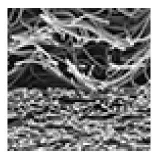
November Hot Topics

Mechanical Systems Week

Matt Michel Interview

Click Here to View

An Inside Look at Air Filters

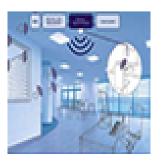


Air pollution is a problem in public buildings. Studies show indoor air may be two to five times more polluted than outdoor air, 1 causing or aggravating an estimated 50 percent of all illnesses and 2 costing the U.S. economy upward of $160 billion in...READ MORE

Keys to Designing More-Effective Control Systems

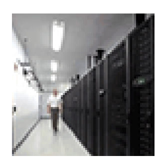
Building-control systems are notorious for failing to meet the performance expectations of their designers and operators. Much of the problem can be attributed to the convoluted process through which they are implemented, which separates...READ MORE

Energy-Harvesting, Wireless Automation



2012 has been a year of blistering heat, wildfires, and drought throughout much of the United States. With the specter of climate change looming, experts believe such extreme weather events will only become more common. As temperatures increase and...READ MORE

Data-Center Energy-Management System Reduces Costs Associated With HVAC



To better meet the needs of local businesses and to draw new business from outside of the state, Tech Vault Inc., provider of data-center, colocation, private-cloud, disaster-recovery-hosting, and managed services, set out to turn a 20-year-old building in South Burlington, VT., into a world-class...READ MORE

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

Social Media

Find us on Facebook

Latest from Twitter

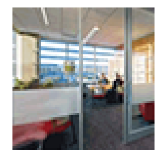
Popular Articles

- How Do You Cross the Generational Divide?

University of Virginia's Jordan Hall: Use of BIM in a Laboratory Renovation

When it opened in 1972, Jordan Hall on the campus of the University of Virginia (U.Va.) in Charlottesville, Va., was a premier research facility. Nearly 40 years later, the HVAC infrastructure of the seven-story, 250,000-sq-ft building, home to the U.Va. School of Medicine, no longer could be maintained and was...READ MORE

You Can't Fight This Outstanding Design



2012 HPAC Engineering Design Awards WINNER: Thanks to heads-up work by the team at Phoenix-based SmithGroupJJR, led by Project Engineer Jonathan Silhol, Chandler's new city hall showcases some of the HVAC industry's latest technologies and stands as an example of outstanding HVAC design work...READ MORE

A Penton Media Publication

November 28, 2012 // **NEWS**

HPAC Fastrack

Engineering resources at your fingertips

November 28, 2012

FASTRACK Features

University of Virginia's Jordan Hall: Use of BIM in a Laboratory Renovation

By STEFAN DOMBY, PE, LEED AP, RMF Engineering Inc., Baltimore, Md.

When it opened in 1972, Jordan Hall on the campus of the University of Virginia (U.Va.) in Charlottesville, Va., was a premier research facility. Nearly 40 years later, the HVAC infrastructure of the seven-story, 250,000-sq-ft building, home to the U.Va. School of Medicine, no longer could be maintained and was prone to regular failures. Experimental product and data were being lost, and operating costs were spiraling out of control.

FULL ARTICLE

HEATING/PIPING/AIR CONDITIONING
HPAC ENGINEERING

November 05, 2012 // **NEWS**

University of Virginia's Jordan Hall: Use of BIM in a Laboratory Renovation

By Stefan Domby, PE, LEED AP RMF Engineering

When it opened in 1972, Jordan Hall on the campus of the University of Virginia (U.Va.) in Charlottesville, Va., was a premier research facility. Nearly 40 years later, the HVAC infrastructure of the seven-story, 250,000-sq-ft building, home to the U.Va. School of Medicine, no longer could be maintained and was prone to regular failures. Experimental product and data were being lost, and operating costs were spiraling out of control.

PHOTO A. The roof of Jordan Hall was covered with 200 small exhaust fans, which presented a maintenance challenge in the form of continuous roof leaks where exhaust risers connected to the fans. The high-dilution-exhaust-fan system that replaced the fans can be seen on the far right.

In 2010, U.Va. hired RMF Engineering Inc. and DPR Construction to overhaul Jordan Hall's HVAC infrastructure. The work, which was to be performed while the building remained operational, included the replacement of eight 30,000-cfm air handlers, as well as the steam, reheat, and chilled-water systems and supply and partial-exhaust ductwork, and the addition of a major energy-recovery system. The most significant engineering and construction challenge was posed by the transition from 200 stand-alone exhaust fans to a central high-dilution-exhaust-fan system (Photo A).

The use of building information modeling (BIM) by the project team allowed the transition to occur in an organized manner clearly understood by the client, the contractor, and facility users.

Each exhaust fan was modeled based on drawings made and measurements taken during field investigations. The project team devised a concept whereby an architectural enclosure would serve as a walkable corridor and an exhaust manifold connecting the 200 exhaust risers to eight new 40,000-cfm high-dilution exhaust fans (Figure 1). An existing vivarium exhaust system was not incorporated into the new manifold system partially because the vivarium staff wanted independent air systems. The vivarium system has a larger external static pressure that would have an adverse effect on the efficiency and energy use of the laboratory manifold system. Similar analysis was used to justify the two dedicated and independent dilution exhaust fans shown alongside the eight main dilution exhaust fans in Figure 1 and Photo B. These fans serve the anatomy laboratory, where the use of high-pressure-loss dissection tables makes the use of separate fans much more energy-efficient.

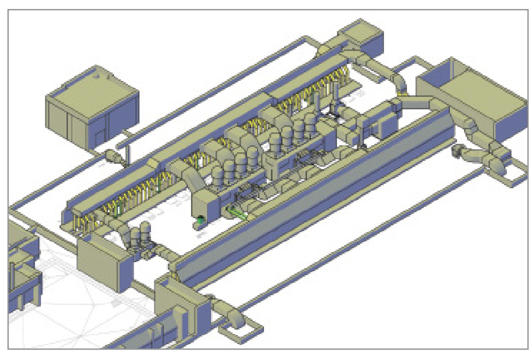


FIGURE 1. Building information model of Jordan Hall's central exhaust system.

Working with the building information model, the design and construction team established a process for relocating 10 fans simultaneously through the use of industrial flexible ductwork and wooden platforms. This was necessary because the structural lattice for the architectural enclosure needed to be constructed where the original fans and exhaust-riser roof penetrations were located. The entire architectural enclosure was prefabricated through the use of BIM drawings. Ten-foot sections were lowered into place with a crane and bolted together. The top portion of the architectural enclosure serves as part of the exhaust ductwork. The exterior is constructed of the same insulated-foam injection panels used for the air handlers and dilution-fan exhaust plenums. Additional structural-steel framing (Photo C) was required because of wind loading at the top of the building. A final cladding was adhered directly to the exterior panels (Photo D). The roof of the enclosure was provided with an EPDM membrane to protect against water leaks at the 200 riser penetrations, a problem that had plagued the building in the past.

The dilution fans and associated plenums were installed first and connected to half of the exhaust manifold, allowing the point-of-use fans to be transferred to the manifold exhaust system.
The eight high-dilution exhaust fans formed the central distribution point for the new exhaust manifold system. The BIM structure

for the dilution fans, provided by the manufacturer, served as the starting point. The operating external system static pressure was confirmed by determining the highest operating static pressure of the existing utility exhaust fans. The final operating static pressure incorporated the internal filters, heat-recovery coils, and isolation dampers of the system. Direct-drive fans were used to minimize vibration and reduce fan-belt and bearing maintenance.

PHOTO B. Central exhaust system under construction with new manifold and existing fans.

Each fan essentially was replaced with an industrial-strength flexible connection (seen in yellow in Figure 1 and in red in Photo C) extended from the existing transite exhaust riser up to a premanufactured dampered connection on the exhaust manifold. The flexible ductwork had to be corrosion-resistant as well as rated for a minimum of 3 in. of negative static pressure. Each connection shown in Photo C was provided with an opposed-blade-damper section with a testing, adjusting, and balancing (TAB) section. As each existing exhaust fan was transferred to the manifold system, the previously connected riser's airflow was monitored to ensure it remained relatively constant. Each riser was out of service for approximately 30 min, while its point-of-use exhaust fan was converted. Fume hoods were tested through face-velocity measurement once airflow to the risers was restored. The fume hoods were put back in service at that time.

PHOTO C. New exhaust-duct manifold.

Motor-control centers for the existing 200 exhaust fans were located in small rooftop enclosures in close proximity to where the new dilution fans were to be located. These central electrical distribution hubs needed to stay operational throughout the phasing and transformation process. The central exhaust manifold system was designed in BIM to allow the removal of the motor-control centers. After a number of options were test-fitted with the help of BIM, four large exhaust connections were extended from each of the dilution-fan plenums up over the electrical enclosures into the exhaust-manifold mains. This process set the functional elevation of the architectural enclosure for the ductwork system. From an electrical-design perspective, the dilution fans were re-fed through an emergency feeder from the basement of the building, terminating in air-conditioned variable-frequency-drive vestibules attached to each of the dilution exhaust-fan plenums. This eliminated the need for a new motor-control center and simplified balancing of the exhaust risers.

Modeling the configuration of the enclosure allowed massing and architectural elements to be reviewed by the university and issues related to the incorporation of the exhaust manifold into the structure to be resolved. Organizing connections from the exhaust risers were coordinated quickly so that volume dampers could be adjusted, automated dampers replaced, and the like.

PHOTO D. Architectural enclosure nearly complete.

The final configuration includes two parallel architectural exhaust manifolds—one on each side of the high-dilution-exhaust-fan plenums. (Photo D shows one side of the nearly completed system.) This configuration, along with a redundant exhaust fan on each plenum, allowed the university's facility staff to maintain the new exhaust system without complete loss of airflow to a riser.

BIM helped the team to understand potential conflicts. The university's chief concerns were related to the rebalancing of the risers to keep up with churn. Those concerns were addressed with the TAB sections, which allow accessibility for accurate airflow readings. The design team envisions the installation of metering valves to automate the balancing system when funding becomes available.

In addition to design and engineering, BIM played a crucial role in project scheduling. DPR Construction incorporated construction-phasing requirements for the entire project into the building information model. This allowed the organization of thousands of tasks into a construction master plan, knocking months off of the original schedule.

An associate with RMF Engineering Inc., Stefan Domby, PE, LEED AP, has significant experience in the design and analysis of mechanical systems serving health-care, laboratory, institutional, federal, and industrial facilities, including use of computer modeling techniques. Recently, he completed work on two biomedical research laboratories at the National Institutes of Health in Bethesda, Md. The larger laboratory, which incorporates a state-of-the-art heat-recovery system and many specialty systems and was designed with an interstitial mechanical space to optimize flexibility for renovations, is the recipient of several national energy awards.