



# Central Oklahoma Chapter

ISSUE 3 - December  
2013-2014 EDITION

## Sou'Wester

Monthly Newsletter of the Central Oklahoma Chapter



Chapter President  
David Royal

**T**he 2014 Winter Conference takes place Jan. 18-22 at the New York Hilton. To register and for complete Conference information, visit [www.ashrae.org/newyork](http://www.ashrae.org/newyork). Advance Registration for the conference ends December 31<sup>st</sup>. The headquarters hotel, the Hilton New York Midtown, has already sold out of their lowest priced rooms. However, there are plenty of other options.

### UPCOMING EVENTS

#### November Meeting

January 8th at 50 Penn Place in 3rd floor retail space

11:30am Lunch (\$20 at the door)

12:00pm Presentation by Brandon Wallace, BRD Noise and Vibration Control, Inc "HVAC Acoustic Strategies for Indoor & Outdoor Applications" 1:00pm Wrap-Up

*President's Message continued on Page 2*



## PRESIDENT'S MESSAGE

*Continued from Page 1*

ASHRAE just announced the winners of this year's Technology Awards. Summaries of the winning projects are posted on our Blog @ <http://ashraecok.org/blog.php?id=43> . The ASHRAE Technology Awards recognize outstanding achievements by members who have successfully applied innovative building design. Their designs incorporate ASHRAE standards for effective energy management and indoor air quality. The awards communicate innovative systems design to other ASHRAE members and highlight technological achievements of ASHRAE to others around the world. Winning projects are selected from entries earning regional awards.

We also like to encourage you to consider submitting an ASHRAE Technology Award application. ASHRAE Technology Award winners are recognized by peers as being innovative and capable of achieving a high level of competence. Winning projects are highlighted in articles in the *ASHRAE Journal*. The Society provides press releases to industry publications and *ASHRAE Insights*. *Winners of these awards highlight their accomplishments prominently in their marketing efforts. Information on the Technology Awards can be found here:* <https://www.ashrae.org/membership--conferences/honors--awards/technology-awards-program-overview>

If you haven't checked it out yet, the blog on our new website (<http://ashraecok.org/blog.php?c=1>) is updated several times a month with Government Affairs updates, Standards updates, Calls for papers, Industry news, Energy Efficiency updates, etc.

We have some interesting upcoming meetings scheduled after the holidays. Come join us @ 50 Penn Place soon.

On behalf of the Board of Governors.....Happy Holidays!

David Royal

*ASHRAE Central Oklahoma Chapter President*

**Membership News**

By Tim Jones

Please join me in extending a warm welcome to our new ASHRAE members. They are:

**Madison Schultz, Atul Swamy, Christopher Thomas, Bill Baldwin, Hank Edmunds and Kashif Nawaz, .**

We look forward to getting to know each of you and look forward to seeing you at the monthly Chapter meetings. I would like to encourage each of you to get involved in one of the many committees that work behind the scenes to meet the needs of our local membership and the objectives of ASHRAE.

As a reminder to the membership, the chapter calendar of events, monthly newsletter, and special events and activities can be accessed on the web site. November was 'membership promotion'. Please continue to forward information on any potential new members to me.

### December Meeting Preview:

Peter Hmelyar, Regional Vice President for Aircuity, Inc., came and spoke at our December meeting. 45 members showed up to hear Peter's presentation on "Effective Control of outside Air." Peter touched on the opportunity for energy savings by optimizing outside air and called for building owners and managers to focus more of their attention on control methods of outside air. Peter went on to discuss various technologies that provide Demand Control Ventilation and touched on the benefits of each.

### October Meeting Review:

The first formal meeting of the year was a nice change-up to our typical presentation topics. We had 50 members show up for our October meeting to hear Luke Prescott, Senior Account Specialist with Bluebeam Software, discuss the benefits and real-world applications of leading technology solutions. He spoke about software, document management systems, and hardware that enable architecture, engineering, and construction firms to work digitally.

### November Meeting Review:

Trying to diversify the topics we were able to bring in representatives from FSB that competed in the local BIMStorm™ OKC Challenge. We heard the many different perspectives of the participants on the team and saw how 3D modeling can be utilized during the conception/design phase of a project. For those that didn't get a chance to attend the meeting, BIMStorm™ OKC was a competition where different groups of individuals (professionals, students, etc.) collaborated in a "BIM" environment to develop design alternatives with rapid analysis for decision-making purposes. The objective was to bring together students from the University of Oklahoma with planners from the City of Oklahoma City and industry professionals in a 24 hour "storm" focused on the Oklahoma City River District. The goal of the project was to create a mixed use building along the Oklahoma River as part of the core to shore redevelopment. Design professionals from local firm FSB developed a wakeboarding mixed use development and presented their findings.



### Why I Like History

By Alan Loeffler, Chapter Historian

Are you a history buff? Are you an expert on World War II? How about antiques? Are you a collector? Many of us enjoy some part of history. I was thinking the other day, why I like history, and why I enjoy being historian of our chapter. Here's what I jotted down:

1. This chapter is a family affair. After joining our chapter 30+ years ago, I discovered that the Loeffler family had been involved with Central Oklahoma Chapter since day one in 1935. I was the 4<sup>th</sup> family member to go through the leadership chairs. There's a pride factor there somewhere.
2. I learn from history. "Those who don't know history are destined to repeat it." –Edmond Burke There is something about experience. As our president David Royal recently said in an email referring to the fact that this is his second time to lead an ASHRAE chapter as president, "This isn't my first rodeo!"
3. I love to try to place myself in the mindset of our ancestors and pioneers. When I see the exterior of an old building, an old piece of equipment, or an old mechanical room, I think of what the owner, the engineer or the mechanic thought when it was new. How proud of that job was he? How did the building owner brag on his new building to his friends (60 years ago)? What were the dreams of these people? What drove them in their work? That's fun for me to think about.
4. Inspiration. When I come across a pioneer, or a person who developed something new, a person who made "something from nothing", that impresses me. "Maybe I could do that, too..."
5. I'm writing history. What you and I are doing right now will be history very shortly. Will those who look back on this year 20 years from now smile or frown? Will they be impressed or shake their head? What kind of history am I writing?

Let's "write some good history" this chapter year.



## ASHRAE Publishes 2013 Version of IAQ Standard

**Contact:** Jodi Scott  
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**ATLANTA** – The 2013 version of ASHRAE's indoor air quality standard contains several revisions to help users better meet its requirements.

Newly published, ANSI/ASHRAE Standard 62.1-2013, *Ventilation for Acceptable Indoor Air Quality*, sets minimum ventilation rates and other requirements for commercial and institutional buildings.

The 2013 standard combines the 2010 standard and 10 published addenda to that edition, providing an easy-to-use consolidated standard. Specific information on the contents of each addendum and approval dates for each addendum are included in Informative Appendix J at the end of the standard.

"The 2013 version of Standard 62.1 continues the trend of increasing clarity while adding flexibility," Roger Hedrick, Standard 62.1 committee chair, said. "These changes will allow designers and building operators to meet the requirements of the standard and provide adequate ventilation airflow to occupants while reducing excess ventilation and the associated energy consumption."

The 2013 edition of the standard revises and improves the standard in several ways. A number of changes remove inconsistencies within the standard and improve clarity. Significant changes include:

- Table 6-2, Zone Air Distribution Effectiveness is modified to increase the ventilation effectiveness of underfloor air distribution systems that meet certain conditions.
- Requirements for the quality of water used in humidification systems are modified and clarified.
- Building level pressurization requirements were clarified, including adding a definition of "exfiltration."
- A performance alternative to the prescriptive exhaust rates is added. This approach differs from the Indoor Air Quality Procedure, the existing performance-based method for setting supply ventilation rates, in that monitoring of the concentrations of contaminants of concern is required and provides the basis for control of exhaust flow rates.
- Some changes to the ventilation rates and space types in Table 6-1 are made. These add refrigerated warehouses and change the ventilation rate for sports related spaces to include a per occupant component which then allows the use of demand controlled ventilation in these spaces.
- The filtration requirement on air entering wetted cooling coils has been modified to change the MERV rating from 6 to 8. This change will reduce potential for particulate deposition on the coils that could lead to biological or other contamination on the coils.
- Toilet exhaust air that is cleaned to Class 1 may be recirculated.

The cost of ANSI/ASHRAE Standard 62.1-2013, *Ventilation for Acceptable Indoor Air Quality*, is \$79 (\$67 ASHRAE members). To order, contact ASHRAE Customer Contact Center at 1-800-527-4723 (United States and Canada) or 404-636-8400 (worldwide), fax 678-539-2129, or visit [www.ashrae.org/bookstore](http://www.ashrae.org/bookstore).

**Y**EA is for any ASHRAE Member aged 35 and younger. It is a committee developed by ASHRAE to create a community of young members to help develop your professional foundation (whether through educational programs, expanding your network, etc.). I plan to have several social meetings and a couple of events. I am excited to meet everybody. If you are interested in participating in YEA and have not been contacted by me yet, please give me a call or email. Our goal this year is to increase turnout at the YEA events and hopefully have a great time with other ASHRAE members of similar ages and experiences.

We had our first social at Republic (thanks to Trane and EEI for picking up tab!!!). I will send out invite for our next Happy Hour and work on scheduling an event. We are always looking for sponsors for the YEA events as well. If your company is interested please let me know. If you would like more information about YEA, please contact me or go to [www.ashrae.org/YEA](http://www.ashrae.org/YEA).

# BOARD OF GOVERNORS MEETING MINUTES

## ASHRAE Central Oklahoma Chapter

### Board of Governor's Meeting Minutes

**December 16, 2013 – Junior's Restaurant**

President David Royal called the meeting to order at 11:45 AM

Attendees:

**Chapter Officers Present:**

David Royal—President  
Joe Sanders—President Elect  
Shaun Sexton—Treasurer

**Board of Governors Present:**

Tim Jones  
Jason Keyes  
Rick Marsh  
Mark Fergason  
Stephanie Thomas  
Michael Wilson

**Absent:**

Grant Flurry  
John Semtner—Secretary  
Joe Sanders—President Elect  
Daniel Brazeale  
Brian Sauer

**Members Present:**

Bryan Garcia  
Caleb Spradlin  
Aruna Abhayagoonawardhana  
Adam Shupe

**Meeting Minutes:**

Meeting Minutes from September 23<sup>rd</sup>, Board of Governors Meeting were presented. Tim Jones made a motion to accept, Jason Keyes seconded. Minutes were approved.

**Treasurer's Reports:**

Shaun Sexton emailed the financial reports for September and October to all BOG members earlier in the day and reviewed them with the Board. The reports were placed on file.

**President's Report:**

David shared the password to the StarChapter Admin site and encouraged committee members to take online training.

David reported that the Ad Hoc investment committee met with a Bank of Oklahoma investment advisor and selected 4 separate investments for the CRC funds. A check for \$10,335.38 (Previous year's allocations plus last year's) is being sent to the investment advisor for the purchase of the investment instruments.

**Committee Reports:**

**Membership:** Tim Jones – Reviewed the latest membership report with the Board. He personally contacted 14 of the delinquents who assured him they were renewing. Unfortunately we are going to lose several members who have retired or have left the industry. However, we are currently at a net of +1. Our goal is +4.

**Research Promotion:** Adam requested that we send in \$500 of the profits from the golf outing to RP by the October 31 deadline for the ASHRAE Region VIII scholarship fund.

**Special Events & Newsletter:** Bryan Garcia – Still has \$1,300 of sponsorship pledges to collect. He also asked for committee reports for the newsletter which he is planning on publishing this week.

**Technology Transfer:** Daniel Brazeale via Tim Jones – Speakers for all meetings for this year are set and confirmed. He still needs a speaker for the May meeting.

**Government Affairs:** Adam Shupe is a member of the Oklahoma City Building Code Commission.

**History:** Jason Keyes presented a proposal from Joel David Digital for digitizing our historical photographs and other important documents. For \$350 Mr. David will digitize up to 300 items. Motion to approve tabled until the final budget is approved.

**Student Activities:** Caleb Spradlin – Has sent scholarship information to the OU & OSU student chapter presidents. A

**YEA:** Michael Wilson – Reported that 6 YEA members attended their first official Happy Hour at the Republic GastroPub.

**New Business:** David Royal presented the Audit Committee Checklist that Tino prepared after the auditing committee completed their review of last year's books. Tim Jones made a motion to make the checklist a "Rules of the Board" for future reference. Mark Furgason seconded the motion. The motion passed unanimously.

There was no other new business

President David Royal adjourned the meeting at 12:45 PM

# Chapter Finances

11/25/2013  
CENTRAL OKLAHOMA CHAPTER ASHRAE  
BALANCE SHEET  
As of 11/25/2013

Account	Total
<u>Assets</u>	
Bank and Cash Accounts	
Bank of the West CD01	0.00
Bank of the West CD02	0.00
Checking-BOK	25,468.36
Petty Cash Meeting Meal Change	0.00
Undeposited Funds	0.00
<b>Total Bank and Cash Accounts</b>	<b>25,468.36</b>
Other Assets	
Accounts Receivable - old	0.00
<b>Total Other Assets</b>	<b>0.00</b>
Account Receivable	
Accounts Receivable	0.00
<b>Total Account Receivable</b>	<b>0.00</b>
Investment Accounts	
Bank of Oklahoma CD03	0.00
Bank of Oklahoma CD03 (Cash)	0.00
BOK Pershing	10,335.38
BOK Pershing (Cash)	0.00
<b>Total Investment Accounts</b>	<b>10,335.38</b>
<b>Total Assets</b>	<b>35,803.74</b>
<u>Liabilities</u>	
Other Liabilities	
Prepaid Meals	0.00
<b>Total Other Liabilities</b>	<b>0.00</b>
Tax Liabilities	
Sales Tax	0.00
<b>Total Tax Liabilities</b>	<b>0.00</b>
<b>Total Liabilities</b>	<b>0.00</b>
<b>Net Worth</b>	<b>35,803.74</b>

11/25/2013  
CENTRAL OKLAHOMA CHAPTER - TREAS-  
URER'S REPORT - INFLOWS/OUTFLOWS  
10/30/2013 through 11/25/2013

Subcategory Total	
<u>Inflows</u>	
Dues, Society	520.00
Interest Income	0.30
Receipts, Chapter Meals	
Nov 13	670.38
<b>Total Receipts, Chapter Meals</b>	<b>670.38</b>
<b>Total Inflows</b>	<b>1,190.68</b>
<u>Outflows</u>	
AHR 2013 Reimbursement	500.00
Chapter Meals/Meeting Exp	
Nov 13	653.39
<b>Total Chapter Meals/Meeting Exp</b>	<b>653.39</b>
Chapter Website	
Chapter Website - Unassigned	100.00
<b>Total Chapter Website</b>	<b>100.00</b>
Research Contributions	
13-14	500.00
<b>Total Research Contributions</b>	<b>500.00</b>
<b>Total Outflows</b>	<b>1,753.39</b>
<b>Income less Expenses</b>	<b>(562.71)</b>

# BOARD OF GOVERNORS CONTACT INFORMATION

Officer Name	Role	Company	Phone	Email
David Royal	President	Automated Building Systems	(405)840.2931	David.royal@abscompanies.com
Joe Sanders	President Elect	RB Akins Company	(405)947.6502	jsanders@rbakins.com
John Semtner	Secretary	ADG	(405)808.5894	jbsemtner@netscape.net
Shaun Sexton	Treasurer	050 Engineering Company	(405)236.2030	ssexton@050engineering.com
Alan Loeffler	Historian	Federal Corporation	(405)239.7301	aloeffler@federalcorp.com
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Daniel Brazeale	YEA Coordinator	Engineered Equipment	(405)525.7722	dbrazeale@eei-ok.com
	Board of Governors			
	Tech Transfer Chair			
Grant Flurry	Board of Governors	Federal Corporation	(405)239.7320	gflurry@federalcorp.com
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Timothy Jones	Member Promotions	Engineered Equipment	(405)525.7722	tjones@eei-ok.com
	Board of Governors			
Brian Sauer, P.E.	Board of Governors	F+S+B	(405)840.2937	bsauer@fsb-ae.com
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Stephanie Thomas	Board of Governors	TME, Inc	(405)463.6570	stomas@tmecorp.com
Michael Wilson	Board of Governors	Guernsey US	(405)416.8373	Michael.wilson@guernsey.us
	YEA			
Adam Shupe	Research Promotion	Burns McDonald	(405)200.0306	ashupe@burnsmcd.com
Bryan Garcia, P.E.	Webmaster	Trane Company	(405)717.7614	bdgarcia@trane.com
	Special Events			
	Newsletter			
Caleb Spradlin	Student Activities	TME, Inc	(405)463.6570	cspradlin@tmecorp.com



Board of Governors at Sportsman's Club on October 29, 2012.

## Upcoming Meetings and Events

Date	Event	Topic	Presenter
11/6	November Meeting	BIM Storm OKC	FSB BIM Team
12/4	December Meeting	Insuring Energy Efficient and Healthy Buildings— Effective Control of Outside air	Peter Hmelyar, Aircuity
1/8	January Meeting	HVAC Acoustics Strategies for Indoor and Outdoor Applications	Brandon Wallace, BRD— Noise and Vibration Control, Inc.
2/5	February Meeting	Single Zone VAV	Brett Smith, Aaon
3/5	March Meeting	Liquid Desiccant AC Technology	Trevor Wende, Advantix Systems
4/2	April Meeting	Acoustics that make the Grade, Improving Sound Performance in Classroom Environments	Lily Wang, Distinguished Lecturer
5/7	May Meeting	TBD	TBD

## TECHNICAL FEATURE

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### Technical vs. Process Commissioning

# Preparing a Cx Plan

BY DAVE MCFARLANE, MEMBER ASHRAE

When working to complete a complex project, it's often said that if you don't have a plan, then you're planning to fail. And when commissioning a new building, no one involved in the project's planning, design, or construction wants to fail to deliver a successful outcome to the building's owner.

A project that uses carefully documented, step-by-step processes to design a building, construct it, and verify its proper operation is likely to be a success. But when key steps are missed (or missing), the resulting challenges and issues often mean that the building will fail to meet the owner's expectations. The commissioning plan (Cx Plan) clearly describes what every party involved in the project must do to end up with a successfully commissioned building—and a happy owner.

#### Laying the Foundation for the Commissioning Plan

The previous articles in this series introduced the technical commissioning (Cx) process and discussed the importance of communication between the building owner and the design, construction, and Cx teams. After completing the Owner's Project Requirements (OPR) and Basis of Design (BOD) documents, the

This is the fourth in a series of articles that explain the technical commissioning process for new buildings. The series (and the first article) is titled "Technical Commissioning: The Commissioning Process that Works." Some of these articles' content is based on ASHRAE Guideline 0-2005, *The Commissioning Process* (published 2005) and the National Environmental Balancing Bureau (NEBB) *Whole Building Systems Technical Commissioning Procedural Standards Manual* (revised April 2013). In addition, some of the information in this article has been taken from an unpublished NEBB standard titled *NEBB Standard Owner's Project Requirements (OPR) Guideline* (June 20, 2011). This article also draws upon an unpublished "sample" OPR document created by NEBB for the fictional "ABC Headquarters Office Building" (Jan. 2, 2011).

next step on the path to project success is preparing a detailed, step-by-step Cx Plan. This article serves as a general overview of how to prepare a Cx Plan.

#### Understanding the Commissioning Plan

ASHRAE Guideline 0-2005, *The Commissioning Process* defines the Cx Plan as "a document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process."

The National Environmental Balancing Bureau (NEBB) offers a similar definition, stating the Cx Plan is "a document that outlines the project scope; and defines responsibilities, procedures, schedules, and documentation requirements of the commissioning process."

By delineating the owner’s expectations for all parties involved in the Cx process, a successful Cx Plan removes many of the “surprises” that can pop up during the Cx process. For example, the Cx Plan describes the tests, observations, and verifications that will be used in the design-review portion of the Cx process. The Cx Plan also lists specific Cx-related requirements for each subcontractor, and outlines the pre-functional and

ABOUT THE AUTHOR *Dave McFarlane is a principal project director at Atkins in Fort Myers, Fla.*

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functional and performance tests that the commissioning authority (CxA) will perform and/or observe.

Unlike creating the OPR and the BOD—which are collaborative documents involving every party involved in the building project—the Cx Plan describes the specific tasks of the Cx team. Therefore, the CxA must write the Cx Plan.

The Cx Plan helps ensure project success by:

- Explaining how the CxA will monitor the project’s design and construction.
- Describing the pre-functional tests and functional performance tests (FPTs) that will be needed, and how the CxA will observe and/or perform those tests.
- Explaining how all control sequences will be validated.
- Describing how the testing, adjusting, and balancing (TAB) report and other key equipment and system tests will be verified. *Note:* Future articles in this series will address specifics about the design review process, pre-functional tests, and FPTs.

“Why all this effort?” you may ask. “What problem are you trying to solve?” Technical commissioning practitioners are often retained to find out why buildings do not work as expected—or required. And when trying to sort out “problem” buildings, they often discover design flaws, installation issues, incorrect control sequences, invalid test and balance reports, and similar problems—*all of which can prevented or significantly mitigated with a well-crafted OPR, BOD, and Cx Plan.*

The Cx process is actually made up of four phases: planning, design, construction, and post-occupancy. Therefore, the Cx Plan is a “living” document that must change and adapt throughout the project. For example, during the design phase, the Cx Plan will include generic tests and forms. But during the construction phase, the CxA must update and finalize the Cx Plan based on the actual installed equipment so the final version of the plan can be used to confirm proper operations during post-occupancy.

The multiple phases of the Cx Plan will be discussed in detail in the remaining articles in this series.

## Building the Plan

Start your Cx Plan with a statement similar to this:

*The building owner has retained [company name] as the project’s Commissioning Authority (CxA). The purpose of this Commissioning Plan (Cx Plan) is to thoroughly describe the scope, organization, schedules, responsibilities, resource allocation, and documentation requirements of the entire Commissioning Process. Therefore, the specific commissioning requirements of the project’s design team—as well as the requirements of the various project subcontractors—are listed and described in detail throughout this Cx Plan. For details, refer to the various Sections of the project specifications, including General Conditions, Architectural, Mechanical, and Electrical.*

It’s also important to incorporate key statements into the Cx Plan to help eliminate elements of surprise during the Cx process, including:

- A complete description (name, contact information, address, etc.) of the company that has been engaged to serve as CxA.
- A clear endorsement of the CxA, specifically noting that the building owner has officially empowered the CxA to represent his/her interests during the entire scope of project design and construction.
- Clear, detailed descriptions of the Cx-related tests that will be conducted as work progresses.

## Making Your Plan Unique to Your Project

No one likes to continually reinvent the wheel. For that reason, it may be tempting to recycle text from other Cx Plans you’ve developed. But while it’s fine to reuse selected verbiage, it’s important that your plan doesn’t end up as just a group of standardized boilerplate text blocks wrapped around a set of project specifications. Instead, make sure every Cx Plan you develop includes detailed descriptions of the specific components, equipment, systems, tests, and team members—and the exact roles that team members will play in the Cx process.

Table 6 of the second article in this series (OPR, August 2013, p. 38) referenced sample building components and systems that are normally mentioned in the Cx Plan, including:

- Building envelope
- Mechanical (HVAC) equipment
- Plumbing system
- Fire protection systems
- Electrical systems
- Fire alarm
- Security systems
- Communications systems.
- Elevators, intercom systems, and other specialty sys-

tems may also be included in the Cx process.

Consider the example of a building’s mechanical systems. In the third article in this series (BOD, October

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2013, p. 21), Table 1 described sample HVAC system design criteria. All of those design elements (ventilation requirements, HVAC noise limitations, servicing and access requirements, and smoke detection/fire prevention) and all corresponding subcontractors must be documented in the Cx Plan.

Selecting Your Commissioning Team

Along with descriptions of the systems, components, and equipment to be commissioned, your Cx Plan must list the various project team members who will be required to conduct testing—and the systems and components they’ll be testing.

The Cx team should include the CxA, the owner’s representative, a member of the maintenance staff, a representative from the general contractor (GC) and/or construction manager (CM), a member of the design team, and a representative from all of the subcontractors responsible for the systems to be commissioned. Each one of these individuals—and their backup representatives—should be listed in the Cx Plan, including full **name**, **title**, and detailed **contact information**:

However, it’s not enough to simply define your Cx team members. The Cx Plan must list their **specific duties**. It’s likely that the individual duties of each team member will change from project to project. But to help ensure a successful technical Cx process, certain basic duties for each project role should be factored into every project:

**Owner:** As noted in previous articles, the owner must play an active role in preparing the OPR document and must be a strong advocate for the Cx process. *Note:* The entire Cx process is likely to disintegrate if people realize the owner is not committed to enforcing the Cx requirements.

**Design Team:** The design team prepares the BOD document; therefore, they must schedule their workflows to allow a realistic amount of time for the CxA and the owner/owner’s representative to review the design documents at each step of the design process.

Design reviews should be scheduled after or near the completion of each of the three steps in the design process:

1. Schematic design (SD): completion;
2. Design development (DD): completion; and
3. Construction drawings (CD): 95% completion.

TABLE 1 Cx team representatives by role		CX TEAM REPRESENTATIVE
Architectural, Mechanical, Electrical, & Other Applicable Sub-Consultant	General Contractor/Construction Manager	Owner, Owner's Representative, and Maintenance Staff Representative
		Commissioning Authority (CxA)
Engineers		

A thorough design review (the topic of an upcoming article in this series) helps eliminate problems and misunderstandings when they are still relatively easy to correct. In contrast, problems discovered after the bid date or the contract award will probably result in change orders, which means delays, added costs, and an unhappy owner.

**Cx Authority:** The CxA is responsible for handling a broad range of Cx-related tasks, including:

- Verifying that the architect’s and engineer’s designs satisfy the OPR and BOD documents.

- Determining the criteria to be used for the Cx process.
- Reviewing all design drawings and specifications to make sure the basic contractual requirements of individual systems and component providers are included in the Cx Plan.
- Comparing the final, approved shop drawings against the requirements in the OPR document.
- Organizing, conducting, and documenting periodic Cx team meetings.
- Preparing the agenda for the pre-installation meetings held with the individual contractors.
- Preparing pre-functional field-installation verification check sheets for the CxA and the installing contractors.
- Preparing pre-functional performance-testing check sheets for the CxA and the installing contractors.
- Preparing FPTs for the CxA and the control contractors (based on the OPR document).
- Performing site visits to observe and document component and system installation.
- Checking completed construction control reports to confirm compliance with specified requirements.
- Maintaining the OPR document by reviewing construction meeting minutes and change orders to capture changes, substitutions, or other issues.
- Helping to prepare a construction sequence and schedule that promotes an orderly project startup.

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- Participating in the startup scheduling process to ensure that all systems are installed, started, and completed in proper sequence.
- Preparing and maintaining an issue log book that documents deficiencies, issues, questions, and retesting requirements/activities.

**GC/CM:** The general contractor/construction manager must prepare an accurate, critical-path construction schedule that shows step-by-step how the building must be constructed. The GC/CM is also responsible for creating and coordinating the schedule of construction events—and ensuring that all subcontractors perform their work in compliance with the final project drawings and specifications.

The construction schedule requires input from all project trades, subconsultants, and subcontractors. A proper schedule must accurately account for every phase of the construction process. The schedule must also list the various line items that make up the project’s critical-path milestones—none of which can begin until the preceding task is completed.

Consider this sample list of milestones: To ensure the construction phase is properly completed, the Cx Plan should list critical-path milestones for the HVAC contractor such as:

- Install equipment.
  - Wire equipment to proper electrical panels.
  - Connect equipment to proper ducts and pipes.
  - Flush and clean pipes; fill with proper fluid.
  - Start equipment and verify proper operation.
  - Paint walls.
  - Install wall thermostats and temperature sensors.
  - Install ceiling grids.
  - Install diffusers, registers, and filter elements.
  - Perform point-to-point tests on all control systems;
- verify graphics, and calibrate sensors.
- Complete system testing, adjusting, and balancing.
  - Conduct FPTs to verify systems operate as specified.
  - Complete final, third-party FPTs.

Note that each critical-path milestone depends on the previous one. For example, you can’t test, adjust, and balance systems until all controls systems are working properly. And control systems can’t be tested until thermostats are installed and systems are wired and filled with hydronic fluids. In turn, systems can’t be test-run until they’re connected to the appropriate pipes and ducts.

Many of us see projects for which the mechanical and electrical construction schedules are created without the benefit of critical-path thinking. But when the project falls behind schedule, the completion date almost never changes, which means the project’s final stages compress to the point where all trades are working in the same space at the same time.

This kind of frenzied rush to completion seldom delivers a building that works properly. Too often, systems aren’t even properly tested until the occupants move in. The result? Unhappy occupants and a dissatisfied owner. So, it’s vital that the GC/CM to prepare an accurate critical-path schedule that incorporates enough time for all contractors to properly check their systems— and enough time to accommodate the Cx process.

To support the GC/CM in creating the critical-path schedule, the Cx Plan should list specific projected time durations for every step in the Cx process. Don’t forget that most pre-functional tests and inspections can be performed concurrently with the project’s mechanical/electrical/plumbing tasks. In contrast, FPTs are critical-path tasks that cannot be performed concurrently with other functions.

## TECHNICAL FEATURE

SYSTEM TO BE COMMISSIONED (NOT ALL SYSTEMS LISTED HERE WILL APPLY TO ALL PROJECTS)	CX TEAM REPRESENTATIVE
HVAC	THE HVAC Contractor(s)
HVAC Ducts	Sheet Metal Contractor
Air-Handling Units	Mechanical Contractor
Plumbing	Plumbing Contractor
Testing, Adjusting, and Balancing	Test, Adjust, and Balance Contractor
Automatic Temperature Controls	Temperature Control Contractor
Hydronic Piping/Pumps	Piping Contractor
Water Treatment	Water Treatment Contractor
Exhaust Fans and Wiring	Mechanical Contractor
Air Terminal Units	Mechanical Contractor
Air-Handling Units	Mechanical Contractor
Ground-Source Heat Pumps	Mechanical Contractor
Geothermal Well Field	Well field Contractor
Energy Recovery Units	Mechanical Contractor
Terminal Heat Transfer Units	Mechanical Contractor
Electrical	Electrical Contractor
Lighting/Lighting Controls	Electrical Contractor
Variable Frequency Drives	Electrical Contractor
Emergency Generator/UPS	Electrical Contractor
Building Envelope	Exterior Wall, Roofing Contractor(s)
Fire Protection and Alarm System	Fire Protection Contractor(s)
Security	Security Contractor
Communications	Telecommunications and IT Systems Representatives

All contractors and subcontractors are responsible for properly executing their work according to the final, approved project plans and specifications. And all trades must be represented in the Cx Plan (*Table 2*).

There's no question most contractors want to perform quality work that satisfies customers and wins them repeat business. Most tradesmen don't purposely cut corners or leave out components to reduce their costs. But equipment installations sometimes don't meet project specifications. So here's a proven method to help prevent poor subcontractor performance: Make sure the Cx Plan includes clear descriptions of all subcontractor tasks. Then conduct a series of pre-installation meetings for all trades involved in the project—*before* they begin any work. Inform the subcontractors that there will be a test at the end of the project, and you'll help them pass. It's also important that a representative from both the design team *and* the owner attend all of the subcontractor meetings. The CxA should lead the meetings and review the details of the various specifications and requirements that each trade is expected to comply with, including explaining the pre-functional installation and startup tests that each subcontractor must complete to verify compliance with project specifications. During the meetings, subcontractors are required to explain how they intend to execute their work in conformance with the project's plans and specifications. When the installation of specific components and systems begins, the CxA should visit the contractors on-site and observe their first installations. This may be the first window, the first variable air volume (VAV) box, the first duct leakage test, etc. When the CxA and the subcontractor agree that the initial installation is satisfactory and all pre-functional tests are properly completed, the contractor can complete the remainder of the installation process. The CxA should review the remaining work during the regularly scheduled biweekly or monthly Cx meetings. To ensure that all systems are working as intended before third-party testing and verification, the installing contractors must perform all FPTs. So be sure to factor sufficient time for both the contractors and the Cx team into the critical-path schedule. The CxA cannot complete final verification until all contractors complete their FPTs. Finally, the Cx Plan should specify the agenda for all Cx meetings. In addition, the Plan should document all of the requirements for a proper training program to be created for the building's maintenance staff.

TABLE 2 Cx team representatives by system/subcontractor

Ensuring the Plan Is Properly Filed

The Cx Plan must be included in the project construction documents. I recommend including the plan in the “General Conditions” under “Section 01900—Commissioning.” Since all trades are bound by the General Conditions, this location is a good place for all Cx-related documents. Other trade-specific requirements should be included in the appropriate trade Section of the project specifications.

Conclusion

■ A detailed and thorough Cx Plan plays a vital role in communicating the owner's and designer's expectations to the various contractors involved in a construction project. Everyone wants to be associated with a successful project, and a solid Cx plan is an important step toward the ultimate project goal: a satisfied building owner.