

It's More Than Design: Construction & Building Operation



By **Nick Ferzacca, P.E.**; **Martha G. VanGeem, P.E.**, Member ASHRAE; **Tom Lawrence, Ph.D., P.E.**, Member ASHRAE

Architects and engineers are familiar with applying codes and standards affecting system design. However, standards for high performance buildings must recognize that the construction process and building operation have a large impact on the environment. While Sections 5 through 9 of Standard 189.1-2009 primarily impact the design and selection of building systems, Section 10 specifies requirements during the construction of the building as well as plans for building operation. All of the requirements in Section 10 are mandatory, so there are no prescriptive or performance paths.

The section is divided into two main sections: requirements during construction and requirements for plans for operation. Construction activities addressed include acceptance testing, commissioning, erosion and sediment control, and construction indoor air quality management.

It is impossible and inappropriate for Standard 189.1-2009 to specify detailed operating procedures for the wide range of building types, climate zones, and owner needs affected by the standard. Instead, the standard requires the development of plans for operation that include water and energy consumption tracking, IAQ monitoring, maintenance and service life, and transportation.

Since Standard 189.1-2009 was primarily written with the intent for adoption into building codes, the

requirement for developing 'plans for operation' is the only real method available for the standard to influence the building operation after a certificate of occupancy is issued.

Acceptance Testing & Commissioning

To ensure optimal building performance it is important to verify that systems are operating as designed and meet the needs of the owner. Standard 189.1-2009 includes requirements for

About the Authors

Nick Ferzacca, P.E., is associate principal, Architectural Engineers, Inc., in Boston. **Martha G. VanGeem, P.E.**, is a principal engineer, Building Science and Sustainability, at CTLGroup, Skokie, Ill. **Tom Lawrence, Ph.D., P.E.**, is public service associate, Faculty of Engineering, University of Georgia, in Athens, Ga.



Section 10:

Construction And Plans For Operation

Requirements for construction and operation plans—including the commissioning process, building acceptance testing, measurement and verification and reporting of energy use, water use and indoor air quality—are specified to assist building owners in achieving high-performance operation.

acceptance testing, which is required for all building projects, and a more extensive commissioning process, which is required for buildings greater than 5000 ft² (465 m²). In both cases, requirements are separated into activities that must occur before obtaining a building permit and activities before building occupancy to reflect common project milestones.

For acceptance testing, an acceptance representative must be designated prior to obtaining a building permit to lead, review, and oversee completion of acceptance testing activities, and the representative must review construction documents to verify relevant sensor locations, devices and control sequences are properly documented. Before the building is occupied, acceptance tests must be performed that include sign offs from all parties, and system manuals must be provided to operating staff. Where buildings exceed 5,000 ft² (465 m²) a full commissioning process is required, and this is assumed to also meet the requirements for acceptance testing.

Similar to the enhanced commissioning requirements in LEED and ASHRAE Guideline 0, a commissioning authority (Cx) must be designated and the Cx must lead a process documenting the owner's project requirements (OPR), as well as review construction documents throughout the design process. The design team must document a basis of design that reflects the needs developed in the OPR. During building construction, systems must be commissioned to verify proper performance and conformance to the OPR and owner's personnel must be trained as part of the commissioning process.

Systems requiring commissioning include HVAC, IAQ, refrigeration, the building envelope, lighting controls, shading controls, irrigation, plumbing,

domestic and process water and pumping, water heating, renewable energy systems, water measurement devices, and energy measurement devices.

In addition, procedures, documents, tools, and training must be provided to the building staff to maintain these systems during the service life of the building.

Erosion and Sediment Control

Construction activities near streams, rivers, and lakes have the potential to cause water pollution and stream degradation. To address this concern, Standard 189.1-2009 requires the development of an erosion and sediment control (ESC) plan for all construction activities. The ESC plan must conform to the more stringent requirements of the most current version of the U.S. EPA National Pollutant Discharge Elimination System (NPDES) or local erosion and sedimentation control standards and codes.

IAQ Construction Management

Even with the careful selection of building materials, products such as adhesives, paints, carpets and furnishings can emit air pollutants. To reduce indoor air quality problems, Standard 189.1-2009 requires a building "flush out" process. Two options for meeting the flush out requirements are provided.

First, simply delivering a total volume of outdoor air, measured in total air changes (TAC) to the building will meet the flush out requirements. The TAC is calculated using the space volume and the system design outdoor air requirements according to ANSI/ASHRAE Standard 62.1. Alternatively, contaminant testing of HVAC airstreams must demonstrate that concentration levels of specific contaminants do not exceed a threshold.

Standard 189.1-2009 includes a list of 35 volatile and nonvolatile organic compounds and acceptable threshold levels based on national standards such as ANSI/ASHRAE Standard 62.1 and California's Department of Health Services document commonly referred to as Specification 01350. To meet the IAQ testing requirement, ventilation systems must be operated continuously at the design outdoor airflow rate for a minimum of 24 hours before testing to establish a baseline "occupied" condition. Contaminants are tested at the breathing zone level. If the concentration levels of a specific contaminant are exceeded, only the failed contaminants must be retested after corrective action, such as additional area flushing, is taken.

Regardless of which flush out compliance path is used, permanent HVAC systems are prohibited from being operated during

construction except for system startup, testing, balancing, and commissioning, and all filters and controls must be in place and operational during flush out.

Mold growth in buildings is a major concern affecting poor indoor air quality and occupant health. Building materials that are unprotected during construction and become moist can act as a source for mold growth. Standard 189.1-2009 requires that materials with absorptive properties that are stored or installed on construction sites must be protected from moisture damage. Building materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project. The standard does not prohibit use of materials that may have had mold growth, which has been abated, as long as there are no visible signs of biological growth.

Vehicle staging areas must be established for loading or unloading materials. These staging areas shall be located 100 ft (30 m) from any outdoor air intakes, operable openings, and hospitals, schools, residences, hotels, daycare facilities, elderly housing, and convalescent facilities.

Plans for Operation

How a building is operated may be the single most significant variable of the building's environmental impact. Efficient building systems operated improperly increase energy use and waste resources. Indoor air quality can suffer if air-monitoring procedures are not used to uncover faulty operation. Building systems and components that are poorly maintained and serviced can further deteriorate building performance. It is impractical, and inappropriate, for Standard 189.1-2009 to specify detailed operating procedures for the wide range of building types, climate zones, and owner needs affected by the standard. Instead, the standard requires the project team to develop plans for operation. The intent is to facilitate a vital link and collaborative process between designers and building operators resulting with a plan that is based on the knowledge of system design coupled with the needs of the building owner. While Standard 189.1-2009 does not dictate specific operational requirements, it places certain requirements about what the plan must include.

Water and Energy Use

The quality improvement movement of the 1970s was based on the premise that "you can't improve what you don't measure." Building inefficiencies, which may be easily corrected, can go unnoticed simply because

they are undetected. To address this issue, Standard 189.1-2009 requires that the plan for operation include a process for tracking and assessing energy and water use. The initial assessment must be completed after 12 months, but no later than 18 months after building occupancy, and assessments must be completed at least every three years. The plan must require energy and water use reports. Energy reports must also include:

- Hourly load profile for each day;
- Monthly average daily load profile;
- Monthly and annual energy use; and
- Monthly and annual peak demand.

Water use and energy consumption data must also be entered into the ENERGY STAR Portfolio Manager for those building types addressed by this program to track building performance. In addition, documents related to the measurement and verification of energy efficiency must be provided to the owner and retained by the owner.

Erosion from construction activities can cause significant damage.



Indoor Environmental Quality Plan

Regular indoor environmental quality measurement and verification programs are required to be included in the Plan for Operation. The IEQ plan must include the requirements of Section 8 of ANSI/ASHRAE Standard 62.1, as well as specific requirements for monitoring outdoor airflow and indoor air quality measures.

Standard 189.1 also requires a plan for general cleaning during building operation according to Green Seal Standard GS-42. This includes cleaning products that are environmentally preferable as well as green cleaning practices. The standard covers cleaning of entryways, floors, restrooms and dining rooms; vacuuming; disinfecting; solid waste, trash collection, and recycling.

Maintenance and Service Life Plan

The plan for operation must include maintenance plans addressing all mechanical, electrical, plumbing and fire protection systems, and a service life plan addressing structural, building envelope, and hardscape materials. These plans are meant to inform facility managers about operational needs, and reveal long-term impacts of design decisions to the design team.

The maintenance plan uses ANSI/ASHRAE/ACCA Standard 180 as a basis for HVAC systems. Standard 180 provides recommendations for maintenance of HVAC systems, and so the intent of Standard 189.1-2009 is that maintenance plans for electrical, plumbing and fire pro-

To reduce indoor air quality problems, building flush out is required before occupancy.



tection systems must use similar approaches as Standard 180 as appropriately applied to these other systems.

The service life plan is based on similar requirements in CSA S478-95 Guideline on Durability in Buildings. This plan requires identification of materials that need to be inspected, repaired, or replaced during the design life, generally at least 50 years. For these products, the estimated service life, maintenance frequency, and access for maintenance must be identified. This plan is submitted to the owner at the completion of design. This informs the owner of the maintenance and service life decisions that have been made before construction begins. The owner is then required to retain the document during the life of the building. The intent is that this will inform the owner regarding inspection and maintenance procedures that need to be followed.

Transportation Management Plan

Traffic congestion is a major contributor to poor air quality, and programs that encourage the use of transit, ridesharing, bicycling rather than driving alone can be part of the solution. Standard 189.1-2009 requires all building projects to develop a transportation management plan, which includes as a minimum, preferred parking for carpools and vanpools with parking facilities as well as a plan for bicycle transportation. Owners of the building project who occupy or partially occupy the build must provide employee benefits that either incentivize use of mass transit, initiate telework or flexible work schedule programs, or initiate ridesharing or carpool matching programs.

Summary

Section 10 of Standard 189.1 goes beyond design into construction and operation of the building. This provides for enhanced practices during construction, but more importantly, during the life of the building. ■

Advertisers Index/Reader Service Information

Two fast and easy ways to get additional information on products and services in this issue:

1. Visit the Web address below the advertiser's name for the ad in this issue.
2. Go to www.ashrae.org/freeinfo to search for products by category or company name. Plus, link directly to advertisers' Web sites or request information by e-mail, fax or mail.

Company	Page
AAON, Inc.	S21
info.hotims.com/30916-53	
ASHRAE Standard 189.1	S50
info.hotims.com/30916-88	
CALMAC	S33
info.hotims.com/30916-54	
Captive Aire	S45
info.hotims.com/30916-55	
Energy Conservatory	S49
info.hotims.com/30916-56	
Greenheck Fan Corp.	S19
info.hotims.com/30916-57	
ITT Bell & Gossett	S25
info.hotims.com/30916-58	
Jackson Systems LLC	S42
info.hotims.com/30916-59	
KMC Controls	S8
info.hotims.com/30916-60	
Lennox	S51
info.hotims.com/30916-61	
Metal-Fab	S27
info.hotims.com/30916-62	
Mitsubishi Electric & Electronics USA Inc.	S2
info.hotims.com/30916-63	
Multistack, LLC	S39
info.hotims.com/30916-64	
Munters Corp., Dehumidification Div.	S52
info.hotims.com/30916-65	
Price	S13
info.hotims.com/30916-66	
Raypak	S15
info.hotims.com/30916-67	
Ruskin	S36-S37
info.hotims.com/30916-68	
Semco	S9
info.hotims.com/30916-69	
Siemens Building Technology	S7
info.hotims.com/30916-80	
TITUS	S31
info.hotims.com/30916-70	
Viconics	S5
info.hotims.com/30916-71	
Viega LLC	S29
info.hotims.com/30916-83	
Yaskawa Electric America	S43
info.hotims.com/30916-72	

For information on advertising in the ASHRAE Journal, contact Greg Martin at 678-539-1174 or gmartin@ashrae.org.