

LEED Commissioning

for New and Existing Buildings

Repetition among many LEED programs makes their expanding commissioning requirements easier to understand

The U.S. Green Building Council (USGBC) operates 10 Leadership in Energy and Environmental Design (LEED) Green Building Rating Systems. Eight of those systems—LEED for New Construction (LEED-NC), LEED for Existing Buildings (LEED-EB), LEED for Commercial Interiors (LEED-CI), LEED for Core & Shell (LEED-CS), LEED for Schools, LEED for Retail—New Construction, LEED for Retail—Commercial Interiors, and LEED for Healthcare—require commissioning. The other two—LEED for Homes and LEED for Neighborhood Development—do not. This article will compare and contrast the eight that do.

With the exception of LEED-EB, which differs substantially from the other programs in its commissioning requirements and, thus, will be discussed separately, seven of the eight programs are based on the original LEED-NC program.

The fact that LEED-NC, LEED-CI, LEED-CS, LEED for Schools, LEED for Healthcare, LEED for Retail—New Construction, and LEED for Retail—Commercial Interiors are virtually identical is probably the most important thing to remember.

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LEED COMMISSIONING REQUIREMENTS

For LEED-NC, fundamental commissioning is a prerequisite, and an additional point can be obtained for enhanced commissioning.

Fundamental-commissioning requirements.

The fundamental-commissioning requirements for the LEED-NC, LEED-CI, LEED-CS, LEED for Schools, LEED for Healthcare, LEED for Retail—New Construction, and LEED for Retail—Commercial Interiors are:

- Designate a commissioning authority (CxA) who is independent of the project's design and construction management to lead the commissioning process.
- Develop and implement a commissioning plan that describes the equipment, team members, schedule, and commissioning tasks involved in the project.
- Document the owner's project requirements (OPRs), and develop a basis of design (BOD). The CxA will review these documents and, if needed, facilitate changes.
- Develop commissioning specifications that inform the contractors of their responsibilities, and incorporate

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LEED for New Construction (LEED-NC)	LEED for Existing Buildings (LEED-EB)	LEED for Commercial Interiors (LEED-CI)	LEED for Core & Shell (LEED-CS)
The commissioning authority (CxA) shall be independent of the project's design and construction management, but may be an employee of the firms providing those services. The CxA may be an employee or consultant of the owner. For projects smaller than 50,000 gross sq ft, the CxA may be a person on the design or construction team who has the required experience.		The CxA should not be directly responsible for project design or construction management.	The CxA shall be independent of the project's design and construction management, although he or she may be an employee of the firms providing those services. The CxA may be a qualified employee or consultant of the owner. For projects smaller than 50,000 gross sq ft, the CxA may be a person on the design or construction team who has the required experience.
The owner shall document the owner's project requirements (OPRs). The design team shall develop the basis of design (BOD). The CxA shall review these documents for clarity and completeness. The owner and the design team shall be responsible for updates to their respective documents.	Develop a comprehensive building-operation plan that meets the requirements of current building usage and addresses the heating, cooling, humidity-control, lighting, safety, and building-automation systems.	Clearly document the OPRs and BOD for the building's energy-related systems. Updates to these documents shall be made by the design team during design and construction.	The owner shall document the OPRs. The design team shall develop the BOD. The CxA shall review these documents for clarity and completeness. The owner and the design team shall be responsible for updates to their respective documents.
Develop commissioning requirements and incorporate them into construction documents.		Develop commissioning requirements and incorporate them into construction documents.	Develop commissioning requirements and incorporate them into construction documents.
Develop and implement a commissioning plan.	Prepare a commissioning plan for carrying out the testing of all building systems to verify that they are working according to the specifications of the building-operation plan.	Develop and utilize a commissioning plan.	Develop and implement a commissioning plan.
Verify the installation and performance of the systems to be commissioned.	Implement the commissioning plan, documenting all results.	Verify that the installation and performance of energy-consuming systems meet the OPRs and BOD.	Verify the installation and performance of the systems to be commissioned.
	Repair or upgrade all system components not working according to the specifications of the building-operation plan.		
	Test all building components that require repair or upgrade to verify they are working according to the specifications of the building-operation plan, or submit a five-year plan to execute the previously mentioned steps.		
Complete a summary commissioning report.		Complete a commissioning report.	Complete a summary commissioning report.

Comparison of fundamental-commissioning requirements for eight LEED programs.

those specifications into bid documents.

- Verify the installation and performance of the equipment included in the commissioning scope.
- Complete a summary commissioning report that includes an issues list, test sheets, and an executive summary.

Enhanced-commissioning requirements.

The requirements for enhanced commissioning are:

- Hire a CxA who is not an employee of the

design or construction firms.

- Review design documents as well as the OPRs and BOD.
- Review contractor submittals for compliance with the OPRs and BOD.
- Develop a systems manual that contains the information required to recommission the building.
- Verify training of operation-and-maintenance (O&M) personnel and tenant-space occupants.

- Return to the site 10 months after project completion, meet with the O&M staff, and conduct a post-occupancy review and plan.

Program differences. There are a few differences among the commissioning requirements of LEED-NC, LEED-CI, LEED-CS, LEED for Schools, LEED for Healthcare, LEED for Retail–New Construction, and LEED for Retail–Commercial Interiors. The fact that the programs are virtually identi-

LEED for Schools	LEED for Retail–New Construction	LEED for Retail–Commercial Interiors	LEED for Healthcare
The CxA shall be independent of the project’s design and construction management, although he or she may be an employee of the firms providing those services. The CxA may be a qualified employee or consultant of the owner. For projects smaller than 50,000 gross sq ft, the CxA may be a person on the design or construction team who has the required experience.	The CxA shall be independent of the project’s design and construction management, although he or she may be an employee of the firms providing those services. The CxA may be a qualified employee or consultant of the owner. For projects smaller than 50,000 gross sq ft, the CxA may be a person on the design or construction team who has the required experience.	The CxA shall not be directly responsible for project design or construction management. For projects smaller than 50,000 gross sq ft, the CxA may be a person on the design or construction team who has the required experience.	The CxA shall be independent of the project’s design and construction management, although he or she may be an employee of the firms providing those services. The CxA may be a qualified employee or consultant of the owner. For projects smaller than 50,000 gross sq ft, the CxA may be a person on the design or construction team who has the required experience.
The owner shall document the OPRs. The design team shall develop the BOD. The CxA shall review these documents for clarity and completeness. The owner and the design team shall be responsible for updates to their respective documents.	The owner shall document the OPRs. The design team shall develop the BOD. The CxA shall review these documents for clarity and completeness. The owner and the design team shall be responsible for updates to their respective documents.	Clearly document the OPRs and BOD for energy-related systems. Updates to these documents shall be made by the design team during design and construction.	The owner shall document the OPRs. The design team shall develop the BOD. The CxA shall review these documents for clarity and completeness. The owner and the design team shall be responsible for updates to their respective documents.
Develop commissioning requirements and incorporate them into construction documents.	Develop commissioning requirements and incorporate them into construction documents.	Develop commissioning requirements and incorporate them into construction documents.	Develop commissioning requirements and incorporate them into construction documents.
Develop and implement a commissioning plan.	Develop and implement a commissioning plan.	Develop and utilize a commissioning plan.	Develop and implement a commissioning plan.
Verify the installation and performance of systems to be commissioned.	Verify the installation and performance of systems to be commissioned.	Verify that the installation and performance of energy-consuming systems meet the OPRs and BOD.	Verify the installation and performance of systems to be commissioned.
Complete a summary commissioning report.	Complete a summary commissioning report.	Complete a commissioning report.	Complete a summary commissioning report.

cal is probably the most important thing to remember, although LEED reference guides should be consulted before preparing fees for any such work. The few differences include:

- The enhanced-commissioning option of LEED for Healthcare, which is in the public-comment phase and likely to be rolled out this year, is the most notable exception. This is the only program that offers two possible points for enhanced commissioning. The

requirements for the first point are identical to the LEED-NC enhanced-commissioning requirements. LEED for Healthcare also offers a second point for envelope commissioning, including wall mockups, envelope design review, and a series of planned and documented field inspections.

- All programs allow a “streamlined” commissioning approach, by which a design team may provide commissioning for projects less than 50,000 sq ft.¹

LEED-EB

Because it focuses on the achievement of sustainability during operation, rather than construction, LEED-EB varies significantly from the other LEED programs. Because existing-building commissioning takes place in the absence of plans and specifications, a bid process and construction contractors make new-building procedures inapplicable.

Following are LEED-EB commissioning

LEED for New Construction (LEED-NC)	LEED for Existing Buildings (LEED-EB)	LEED for Commercial Interiors (LEED-CI)	LEED for Core & Shell (LEED-CS)
<p>1) Prior to the start of the construction-documents phase, designate an independent commissioning authority (CxA) to lead, review, and oversee the completion of all commissioning-process activities. The CxA shall, at a minimum, perform tasks 2, 3, and 6 below. Other team members may perform tasks 4 and 5.</p> <p>a) The CxA shall have documented CxA experience from at least two building projects.</p> <p>b) The CxA:</p> <ul style="list-style-type: none"> i) Shall be independent of design and construction work. ii) Shall not be an employee of the design firm, although he or she may be contracted through it. iii) Shall not be an employee of, or contracted through, a contractor or construction manager holding construction contracts. iv) Can be a qualified employee or consultant of the owner. <p>c) The CxA shall report results, findings, and recommendations</p>	<p>Verify and ensure that fundamental building elements and systems are installed, calibrated, and operating as intended so they can deliver functional and efficient performance. Carry out comprehensive commissioning, including the following procedures:</p> <ul style="list-style-type: none"> 1) Develop a comprehensive building-operation plan that meets the requirements of current building usage and addresses the heating, cooling, humidity-control, lighting, safety, and building-automation systems. 2) Prepare a commissioning plan for carrying out the testing of all building systems to verify they are working according to the specifications of the building-operation plan. 3) Implement the commissioning plan, documenting all results. 4) Repair or upgrade all system components not working according to the specifications of the building-operation plan. 5) Test all building components that required repair or upgrade to 	<p>Verify and ensure that fundamental building elements and systems are installed, calibrated, and operating as intended. Requirements of these sections are incorporated into LEED-CI by reference to the LEED-NC program.</p> <ul style="list-style-type: none"> 1) The CxA must review the design of all energy-related systems prior to the completion of design development. 2) The CxA is responsible for reviewing contractor submittals for all energy-related systems. 3) Develop or review a single manual containing the information required for recommissioning energy-related systems. 4) Verify that the requirements for training operating personnel and tenant-space occupants are met. 5) Have a contract, including a plan for resolution of outstanding commissioning-related issues, in place eight to 10 months after final acceptance to review with O&M staff and occupants. 	<p>1) Prior to the start of the construction-documents phase, designate an independent CxA to lead, review, and oversee the completion of all commissioning-process activities. The CxA shall, at a minimum, perform tasks 2, 3, and 6. Other team members may perform tasks 4 and 5.</p> <p>a) The CxA shall have documented CxA experience from at least two building projects.</p> <p>b) The CxA:</p> <ul style="list-style-type: none"> i) Shall be independent of design and construction work. ii) Shall not be an employee of the design firm, although he or she may be contracted through it. iii) Shall not be an employee of, or contracted through, a contractor or construction manager holding construction contracts. iv) Can be a qualified employee or consultant of the owner. <p>c) The CxA shall report results, findings, and recommendations directly to the owner.</p> <p>2) The CxA shall conduct, at a</p>

Comparison of enhanced-commissioning requirements.

- requirements:
- Develop a comprehensive building-operation plan (BOP) accurately defining the present-day requirements of the building and its ancillary systems.
 - Prepare a plan for carrying out

Coming Soon: Changes to LEED-EB Program

In 2006, the USGBC conducted comment periods and public voting on a new LEED-EB program, which eventually will replace the current Version 2.0 program. As this article goes to press, LEED for Existing Buildings: Operations and Maintenance (LEED-EB: O&M) has passed public ballot and is being prepared for general use.

The USGBC has indicated that the reference guide, online submittal templates, and registration for the new program will be available in spring 2008. In the meantime, the USGBC recommends that projects be registered under Version 2.0. Projects will be able to switch to the new program for free when it is ready. The ratings systems for the current and new programs can be downloaded at no charge from the USGBC's Website at www.usgbc.org/DisplayPage.aspx?CMSPageID=221.

The energy-efficiency requirements for LEED-EB: O&M have increased significantly. The new program requires an energy audit that meets the requirements of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Level I

walk-through assessment. Commissioning requirements are:

- **Energy & Atmosphere Credit 2.1: Existing Building Commissioning—Investigation and Analysis (2 points).** Requires either an ASHRAE Level II energy audit or an existing-building commissioning plan, a breakdown of energy use, and lists of occupant problems and capital improvements.
- **Energy & Atmosphere Credit 2.2: Existing Building Commissioning—Implementation (2 points).** Requires the implementation of low-cost/no-cost projects from Credit 2.1, including the demonstration of savings from those measures and staff training. Also, the building-operating plan must be updated.
- **Energy & Atmosphere Credit 2.3: Existing Building Commissioning—Ongoing Commissioning (2 points).** Requires a continuous commissioning program with a cycle of less than 24 months. At least half of that work must be completed prior to application for the LEED-EB: O&M program. The building-operating plan must be updated.

LEED for Schools	LEED for Retail–New Construction	LEED for Retail–Commercial Interiors	LEED for Healthcare	
<p>1) Prior to the start of the construction-documents phase, designate an independent CxA to lead, review, and oversee the completion of all commissioning-process activities. The CxA shall, at a minimum, perform tasks 2, 3, and 6. Other team members may perform tasks 4 and 5.</p> <p>a) The CxA shall have documented CxA experience from at least two building projects.</p> <p>b) The CxA: <ul style="list-style-type: none"> i) Shall be independent of design and construction work. ii) Shall not be an employee of the design firm, although he or she may be contracted through it. iii) Shall not be an employee of, or contracted through, a contractor or construction manager holding construction contracts. </p>	<p>1) Prior to the start of the construction-documents phase, designate an independent CxA to lead, review, and oversee the completion of all commissioning-process activities. The CxA shall, at a minimum, perform tasks 2, 3, and 6. Other team members may perform tasks 4 and 5.</p> <p>a) The CxA shall have documented CxA experience from at least two building projects.</p> <p>b) The CxA: <ul style="list-style-type: none"> i) Shall be independent of design and construction work. ii) Shall not be an employee of the design firm, although he or she may be contracted through it. iii) Shall not be an employee of, or contracted through, a contractor or construction manager holding construction contracts. </p>	<p>1) Prior to the start of the construction-documents phase, designate an independent CxA to lead, review, and oversee the completion of all commissioning-process activities. The CxA shall, at a minimum, perform tasks 2, 3, and 6. Other team members may perform tasks 4 and 5.</p> <p>a) The CxA shall have documented CxA experience from at least two building projects.</p> <p>b) The CxA: <ul style="list-style-type: none"> i) Shall be independent of design and construction work. ii) Shall not be an employee of the design firm, although he or she may be contracted through it. iii) Shall not be an employee of, or contracted through, a contractor or construction manager holding construction contracts. </p>	<p>Option 1: 1) Prior to the start of the construction-documents phase, designate an independent CxA to lead, review, and oversee the completion of all commissioning-process activities. The CxA shall, at a minimum, perform tasks 2, 3, and 6. Other team members may perform tasks 4 and 5.</p> <p>a) The CxA shall have documented CxA experience from at least two building projects.</p> <p>b) The CxA: <ul style="list-style-type: none"> i) Shall be independent of design and construction work. ii) Shall not be an employee of the design firm, although he or she may be contracted through it. iii) Shall not be an employee of, or contracted through, a contractor or construction manager holding construction </p>	<p>Option 2: (This option earns one point in addition to Option 1. Option 2 cannot be completed without Option 1.) Commission the building-thermal-envelope systems in accordance with the requirements of Option 1.</p> <p>In support of the process requirements in Option 1, the following sequence of steps should be taken to ensure an effective building-thermal-envelope commissioning process, typically including (but not limited to):</p> <ul style="list-style-type: none"> • A startup meeting. Coordinate with the entire green-building project team on goals and objectives of the process. • Conduct building-thermal-envelope design review. • Develop thermal-envelope commissioning work plan and schedule. • Develop coordinated documentation plan. • Functional performance test and inspection procedures ascertained (reference standards).

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the testing of all building systems to confirm correct operation and/or define required remedial work.

- Implement and document the tasks in the above plan.
- Repair and/or upgrade all systems and components found to be deficient during the commissioning process.
- Retest all building components after changes are made to ensure optimal operation.

A five-year plan for the continuous improvement of all aspects of the previously mentioned items may be submitted instead. Document continuous improvement through the five-year period. Implement all low-cost/no-cost items in the first two years of the program.

As OPRs are to the new-building commissioning process, a BOP is the heart of the existing-building commissioning process. A BOP may become apparent largely in the day-to-day operation of a building. However, parts of

building operation may have diverged significantly from the design. If they have changed slowly, the O&M staff may barely be aware of the change and/or the effect of the change on the success of the building’s mission.

A commissioning plan for an existing building includes on-site monitoring of conditions, rather than the checking of newly installed equipment. In an existing building, a CxA is more likely to be required to make minor repairs over the course of commissioning, while in a new building, a CxA is forbidden to alter newly installed systems. LEED-EB requires a CxA to visually confirm the correct

operation of manual and automatic systems at the beginning of the commissioning process. Trendlogs that verify this operation must be provided. Further tests of all aspects of mechanical- and electrical-system operation either can be one-time tests (for new buildings) or tests based on trendlogs showing operation over a few days to a few weeks.

The commissioning process for existing buildings almost certainly will involve operation by the O&M staff. In new buildings, the O&M staff may not be available for much of the commissioning process.

For all programs, it is advisable to purchase the respective LEED reference guide before making the first commissioning proposal.

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LEED for New Construction (LEED-NC)	LEED for Existing Buildings (LEED-EB)	LEED for Commercial Interiors (LEED-CI)	LEED for Core & Shell (LEED-CS)
<p>directly to the owner.</p> <p>2) The CxA shall conduct, at a minimum, one commissioning design review of the owner's project requirements (OPRs), basis of design (BOD), and design documents prior to the midconstruction-documents phase and back-check the review comments in the subsequent design submission.</p> <p>3) The CxA shall review contractor submittals applicable to the systems being commissioned for compliance with the OPRs and BOD. This review shall be concurrent with architecture/engineering (A/E) reviews and submitted to the design team and owner.</p> <p>4) Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems.</p> <p>5) Verify that the requirements for training operating personnel and building occupants are completed.</p> <p>6) Ensure the involvement of the CxA in reviewing building operation with operations-and-maintenance (O&M) staff and occupants within 10 months of substantial completion. Include a plan for the resolution of outstanding commissioning-related issues.</p>	<p>verify they are working according to the specifications of the building-operation plan, or submit a one- to five-year plan for continuous improvement related to requirements 1 through 5. During the implementation of the continuous-improvement plan, demonstrate continuous improvement on a yearly basis until all requirements are met. All low- and no-cost measures must be implemented within the first two years of the program.</p>		<p>minimum, one commissioning design review of the OPRs, BOD, and design documents prior to the midconstruction-documents phase and back-check the review comments in the subsequent design submission.</p> <p>3) The CxA shall review contractor submittals applicable to the systems being commissioned for compliance with the OPRs and BOD. This review shall be concurrent with A/E reviews and submitted to the design team and owner.</p> <p>4) Develop a systems manual that provides future operating-staff members the information needed to understand and optimally operate the commissioned systems.</p> <p>5) Verify that requirements for training operating personnel and building occupants are met.</p> <p>6) Ensure the involvement of the CxA in reviewing building operation with O&M-staff members and occupants within 10 months of substantial completion. Include a plan for the resolution of outstanding commissioning-related issues.</p>

Comparison of enhanced-commissioning requirements (continued).

SUMMARY

Eight of the current 10 LEED programs require commissioning as a mandatory prerequisite. Five of these programs—LEED-NC, LEED-EB, LEED-CI, LEED-CS, and LEED for

Schools—have similar requirements for fundamental and enhanced commissioning. LEED for Healthcare has similar commissioning requirements, but offers two enhanced-commissioning points for commissioning a building envelope.

LEED for Retail—New Construction and

LEED for Retail—Commercial Interiors, which are in pilot or comment phases, parallel the commissioning requirements of the LEED-NC, LEED-CS and LEED-CI programs.

The LEED-EB program differs substantially from the other seven programs in

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<p>iv) Can be a qualified employee or consultant of the owner.</p> <p>c) The CxA shall report results, findings, and recommendations directly to the owner.</p> <p>2) The CxA shall conduct, at a minimum, one commissioning design review of the OPRs, BOD, and design documents prior to the midconstruction-documents phase and back-check the review comments in the subsequent design submission.</p> <p>3) The CxA shall review contractor submittals applicable to the systems being commissioned for compliance with the OPRs and BOD. This review shall be concurrent with A/E reviews and submitted to the design team and the owner.</p> <p>4) Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems.</p> <p>5) Verify that the requirements for training operating personnel and building occupants are met.</p> <p>6) Ensure the involvement of the CxA in reviewing building operation with O&M staff and occupants within 10 months of substantial completion. Include a plan for the resolution of outstanding commissioning-related issues.</p>	<p>iv) Can be a qualified employee or consultant of the owner.</p> <p>c) The CxA shall report results, findings, and recommendations directly to the owner.</p> <p>2) The CxA shall conduct, at a minimum, one commissioning design review of the OPRs, BOD, and design documents prior to the midconstruction-documents phase and back-check the review comments in the subsequent design submission.</p> <p>3) The CxA shall review contractor submittals applicable to the systems being commissioned for compliance with the OPRs and BOD. This review shall be concurrent with A/E reviews and submitted to the design team and owner.</p> <p>4) Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems.</p> <p>5) Verify that the requirements for training operating personnel and building occupants are met.</p> <p>6) Ensure the involvement of the CxA in reviewing building operation with O&M staff and occupants within 10 months of substantial completion. Include a plan for the resolution of outstanding commissioning-related issues.</p>	<p>iv) Can be a qualified employee or consultant of the owner.</p> <p>c) The CxA shall report results, findings, and recommendations directly to the owner.</p> <p>2) The CxA shall conduct, at a minimum, one commissioning design review of the OPRs, BOD, and design documents prior to the midconstruction-documents phase and back-check the review comments in the subsequent design submission.</p> <p>3) The CxA shall review contractor submittals applicable to the systems being commissioned for compliance with the OPRs and BOD. This review shall be concurrent with A/E reviews and submitted to the design team and owner.</p> <p>4) Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems.</p> <p>5) Verify that the requirements for training operating personnel and building occupants are met.</p> <p>6) Ensure the involvement of the CxA in reviewing building operation with O&M staff and occupants within 10 months of substantial completion. Include a plan for the resolution of outstanding commissioning-related issues.</p>	<p>contracts.</p> <p>iv) Can be a qualified employee or consultant of the owner.</p> <p>c) The CxA shall report results, findings, and recommendations directly to the owner.</p> <p>2) The CxA shall conduct, at a minimum, one commissioning design review of the OPRs, BOD, and design documents prior to the midconstruction-documents phase and back-check the review comments in the subsequent design submission.</p> <p>3) The CxA shall review contractor submittals applicable to the systems being commissioned for compliance with the OPRs and BOD. This review shall be concurrent with A/E reviews and submitted to the design team and owner.</p> <p>4) Develop a systems manual that provides future operating staff the information needed to understand and optimally operate the commissioned systems.</p> <p>5) Verify that the requirements for training operating personnel and building occupants are met.</p> <p>6) Ensure the involvement of the CxA in reviewing building operation with O&M staff and occupants within 10 months of substantial completion. Include a plan for the resolution of outstanding commissioning-related issues.</p>	<ul style="list-style-type: none"> • Review thermal-envelope components and assemblies mockups when relevant. • Conduct scheduled field inspections per work plan. Document the inspections. • Inspect corrections of defects encountered during inspections. • Prepare final report. <p>The building thermal envelope entails all exterior-wall assemblies separating a building’s conditioned spaces from outdoor ambient conditions, including roof assemblies, vapor barriers, diffusion retarders, air-barrier systems, rain-screen layers, flashings, cladding and siding, windows, curtain-wall assemblies, doors, thermal bridges, and utility penetrations for piping, electrical-conduit, duct-bank, and other entry points that create routing for HVAC-system components.</p> <p>Commissioning of the building envelope should be in accordance with American Society of Heating, Refrigerating and Air-Conditioning Engineers Guideline 0-2005, <i>The Commissioning Process</i>, and National Institute of Building Sciences Guideline 3-2006, <i>Exterior Enclosure Technical Requirements for the Commissioning Process</i>.</p>

terms of commissioning requirements. It substitutes existing-building goals, minor repairs by the CxA, trendlogging for the OPR, and contractor-executed repairs of new programs.

For all programs, it is advisable to purchase the respective LEED reference guide before making the first com-

missioning proposal. (These guides are not to be confused with the ratings systems, which are abbreviated greatly and can be downloaded at no cost from the USGBC Website, www.usgbc.org.)

REFERENCE

1) U.S. Green Building Council. *Who can be the commissioning authority.* (n.d.). Retrieved from <https://www.usgbc.org/ShowFile.aspx?DocumentID=1262>.

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HVACR systems (mechanical and passive) and associated controls.	Heating, cooling, humidity, and building-automation systems.	HVACR systems (mechanical and passive) and associated controls.	HVACR systems (mechanical and passive) and associated controls.	HVACR systems (mechanical and passive) and associated controls.	HVACR systems (mechanical and passive) and associated controls.	HVACR systems (mechanical and passive) and associated controls.
Lighting and daylighting controls.	Lighting system.	Lighting and daylighting controls.	Lighting and daylighting controls.	Lighting and daylighting controls.	Lighting controls, including daylighting.	Lighting and daylighting controls.
Domestic hot-water systems.	Safety systems.	Domestic hot-water systems.	Domestic hot-water systems.	Domestic hot-water systems.	Domestic hot-water systems.	Domestic hot-water systems.
Renewable-energy (wind, solar, etc.) systems.		Renewable-energy (wind, solar, etc.) systems.	Renewable-energy (wind, solar, etc.) systems.	Renewable-energy (wind, solar, etc.) systems.	Renewable-energy (photovoltaic, wind, solar, etc.) systems.	Renewable-energy (wind, solar, etc.) systems.

Systems to be included in the commissioning scope.

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