G|PRO
Green Professional Building Skills Training

CONSTRUCTION MANAGEMENT

TEST YOURSELF QUESTIONS: Answer Key

CHAPTER 1: Construction Management and Green Building

1. **How does the sustainability concept of integration affect the construction process and the CM/GC's role?**

   The sustainability concept of integration affects the construction process by interconnecting all the building's finished components and systems; the construction process is not separate from the finished product. The CM/GC must following existing best practices and understand and incorporate the green elements discussed throughout this manual. He or she may also have to help owners understand and negotiate the trade-offs among the many interrelated sustainable measures available to a project, and proceed to build as green as possible in a manner consistent with the construction documents and the OPR (*see pages 2-4*).

CHAPTER 2: Pre-Con Services: Sustainability Planning in the Design Phase

1. **What is the CM/GC's role on the Sustainability Team (ST)?**

   The CM/GC's role on the Sustainability Team will vary depending on whether the project is pursuing LEED certification. The CM/GC will engage as a member of the Sustainability Team and coordinate the activities and involvement of his or her group or company. The CM/GC may also collaborate with all other team members in creating sustainability goals, determining targeted credits, developing the sustainability management plan and quality control plan, and guiding the project beyond pre-con (*see page 5-6*).

2. **How is the CM/GC involved in identifying sustainability goals and target LEED credits?**

   The CM/GC may or may not be part of developing the project's sustainability goals, depending on when he or she first becomes involved. Sustainability goals should be informed by the owner's big-picture ideas on what the sustainability priorities are and what the project is expected to accomplish. When identifying target LEED credits, the CM/GC reviews the schematic plans and specifications with the A/E team and advises what the impact of the sustainability measures will be on construction costs and schedules. He or she provides estimates to evaluate the A/E team's proposed product selection, and may consider alternative sustainable measures. Finally, the CM/GC reviews specifications and confirms the constructability, availability, and cost with material and equipment suppliers, vendors, and manufacturers (*see pages 6-7*).

3. **Why and how do you conduct and evaluate a simple payback analysis?**

   A simple payback analysis is conducted to compare the first costs of an improvement to the savings that will result from the improvement. It is conducted by first calculating the base capital investment by subtracting any available tax credits, subsidies, or fiscal incentives from the raw construction costs. This is the net capital investment. Then, engineering estimates are used to determine the anticipated operating savings. The net capital investment is then divided by the

anticipated operating savings to calculate how long it will take to recoup the capital investment. This duration is called the payback period (*see page 8*).

4. **What is the CM/GC's role in analyzing sustainability incentives?**
   The CM/GC's role in a Sustainability Funding Opportunities Analysis is to assist the A/E and provide valuable input. The CM/GC may help conduct a thorough review of incentives and rebates specific to each project, which identifies all funding options. He or she will then map them to the proposed green measures and use the determined funding potential as part of the payback analysis process. Incentive programs may have application deadlines, eligibility requirements, tax issues, and other complex criteria that the CM/GC may need to help manage. Coordination is necessary between the various parties working on tracking and documentation requirements, and others will often call on the CM/GC for information and documentation (*see page 11*).

CHAPTER 3: Sustainability Management Plan

1. **What elements should you include in your Sustainability Management Plan?**
   The Sustainability Management Plan should include LEED credit information, CM/GC action steps by project phase (including the design/pre-con phase, the bid and award phase, mobilization phase, shop drawings and submittals phase, construction phase, and Cx and close-out phase), and a list of the trades affected. The SMP should also determine what documentation is required from the trades, and identify the necessary sustainable work practices that will be employed on the project. Your SMP should also include all items that impact the schedule, purchasing, or coordination. Overall, the SMP identifies who is going to do what and when on a green project *(see pages 12-14)*.

2. **When updating your Sustainability Management Plan, what critical elements need to be confirmed?**
   The plan must be updated to address any changes in scope that arose from the pre-con evaluations and assessment *(see page 13)*.

CHAPTER 4: Trade Bid and Award: Incorporating Sustainability Strategies

1. **What should the CM/GC consider when selecting green subcontractors?**
   The CM/GC should consider whether a subcontractor has prior experience with green work, is certified or trained in green building practices, is open to identifying alternative projects that are more green, or has an interest in learning about green work if they have no previous experience in the field. For sustainability reasons, the CM/GC should also consider where the subcontractors' operations are located (*see pages 16-17).*

2. **What are the unique elements of bid documents on a green project?**
   The unique elements of bid documents on a green project are:
   1. An overview explaining the project's sustainability mission must be included as the first paragraph in the scope of work.
   2. If a LEED project, the LEED credit scorecard should be provided with a narrative explaining what documentation and work-practices will be required of the contractors to

attain the various credits. Here you should include template letters which subcontractors will be required to submit to the CM/GC.

3. Individual scopes of work should be customized to ensure that they include the appropriate green language and identify each trade's associated LEED credits. Ensure that the language contained in all cross-referenced specifications is consistent and accurately includes green elements.

(*see page 17*)

3. How does the vetting of green bids differ from standard practice?

The vetting of green bids is similar to standard practice, but the discussion will now include the sustainability goals, green construction elements, and any special circumstances and methods of installation. Following the structure of your established Sustainability Management Plan, verify that subcontractors have included:

- Additional time required for flush-out and testing.
- Recognition of schedule impacts as a result of additional commissioning.
- Acquisition of local materials.
- Logistical concerns related to sustainable efforts with construction and demolition waste management, the erosion and sedimentation plan, etc.
- Confirmation that vendors can achieve recycled content percentages for key materials such as steel and concrete, and that concrete suppliers can achieve regional content requirements.

(*see page 18*)

CHAPTER 5: Mobilization

1. What is the intent of each of the four core sustainable construction activity areas?

The intent of each of the four core sustainable construction activity areas is:

1. **Construction Activity Pollution Prevention (CAPP):** The intent is to reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust generation.
2. **Construction Waste Management (CWM):** The intent is to divert construction and demolition debris from disposal in landfills and incinerators.
3. **Construction Indoor Air Quality (CIAQ):** The intent is to reduce indoor air quality problems resulting from the construction or renovation process.
4. **Commissioning (Cx):** The intent is to "verify that the building's energy-related systems are installed, calibrated, and perform according to the OPR, basis of design (BOD), and construction documents (CDs)."

(*see pages 20-23*)

2. What are the CM/GC's primary compliance considerations for each core area?

1. **CAPP:** Develop your ESC Plan specific to on-site issues and conditions; become familiar with the EPA's National Pollutant Discharge Elimination System (NPDES) and NYS Department of Environmental Conservation State Pollutant Discharge Elimination System (DEC SPDES) regulations and anticipate inspections from these agencies; inform subcontractors of their responsibilities; communicate ongoing developments and respond to comments and concerns; conduct daily and weekly walk-through inspections using your checklist, and keep logbooks of your inspection notes; document mitigation procedures in

action, with photos; keep a log of problems, related incidents, and the solutions that are implemented for reporting to the LEED consultant and to relevant regulatory agencies.

2. **CWM:** Develop your CWM plan based on the project's diversion goals; select a waste management subcontractor that is capable of meeting your plan's requirements and has the resources to follow LEED standards; consider space restrictions on your site and determine whether you will use an off-site or on-site sorting procedure; monitor subcontractors' activities to ensure they are following the plan; motivate subcontractors to minimize waste through efficient use of materials and pre-planning; obtain weekly tallies from the hauler documenting percentages of materials diverted; provide documentation to the LEED consultant at project close-out.
3. **CIAQ:** Develop your CIAQ plan based on the project's goals and the specific pollution sources to be expected; become familiar with and develop strategies to respond to any local regulations aimed at mitigating pollutants; be aware that the owner's CxA and the sustainability manager will require documentation of materials' composition and installation procedures to verify conformance with LEED IAQ regulations; work with subcontractors to develop creative solutions to implement procedures for ensuring proper ventilation during installations that use materials with VOCs; ensure that proper precautions are taken to protect HVAC equipment while stored on-site and, if operating, prior to occupancy; if flush-out purging is part of your project plan, allow time in the schedule, coordinate with your HVAC subcontractor, and document the process for LEED and the CxA; if using the air-test option, obtain test (or re-test) data to provide at project close-out.
4. **Cx:** Secure a copy of the project's Cx Plan from the CxA and understand the CM/GC's related responsibilities; monitor the work and ensure that equipment installed by your mechanical subcontractors conforms with the project's green specifications; manage required LEED submittals that verify conformance with project specifications; ensure that your specialty contractors understand and take responsibility for conducting field installation verification and operational performance testing checklists; coordinate pre-functional and functional start-up field testing with your subcontractors and the CxA as required; coordinate subcontractor and CxA involvement in developing O&M manuals; develop and coordinate delivery of training to owner's O&M staff on commissioned equipment.

(*see pages 20-23*)

CHAPTER 6: Preparing Your Trades – Project Goals and Requirements

1. **Why is it important to train your trades on project goals and requirements?**

   Design choices and construction details in one area of the building can have a profound impact on the success of a green measure in another area. Tasks performed by one trade can affect the success of work done by another trade, so inter-trade coordination is essential. Thus, ensuring that all trades understand this is key to a successful green project. Ignorance of the project goals and requirements could jeopardize the successful installation and operation of sustainable project elements *(see page 25).*

2. **What are the primary green training issues for the various trades?**

   1. **Carpentry and Millwork contractor:** Confirm which materials may or may not be used; use rapidly renewable materials; create procedures for using and documenting FSC-certified lumber; establish and attain a VOC cap for sealants; conform with and manage the Waste Reduction Plan; store materials properly.

2. **Painting contractor:** Consider benefits of using low- or non- VOC emitting paints, primers, sealants, etc.; establish and attain a VOC cap; provide MSDS documentation requirements; conform with and manage the waste-reduction plan; store materials properly; review required air-sealing coordination measures, comply with federal requirements for lead abatement.
3. **Plumbing and mechanical contractor:** Explain new product types and technologies; review piping procedures and routes that may be unfamiliar; consider sequence of installation procedures; properly install HVAC controls; prepare IAQ control plan; protect stored and installed materials from dust and moisture; train owner on how to use new systems.
4. **Electrician:** Explain new product types and technologies; teach the importance of properly installed lighting/dimming controls; comply with IAQ plan; discuss how the commissioning process will affect their work; explain how air sealing methods may need to be coordinated with their wall and ceiling penetrations.
5. **Labor services and waste management:** Provide directions about which materials can be co-mingled and which are to be separated on the job site; establish a plan for multiple containers or bins for on-site sorting; keep track during all pickups, and stay diligent about what material is going where; store materials properly.

(see pages 30-31)

3. Which sustainable strategies can be classified as construction process activities?

The construction process-specific issues that all trades need to understand are encompassed within the four core activity areas for sustainable construction: Construction Activity Pollution Prevention (CAPP), Construction Waste Management (CWM), Construction Indoor Air Quality (CIAQ) and Commissioning (Cx) *(see page 24-25).*

4. What green issues must the CM/GC track in each work area as the project proceeds?

1. **Excavation/demolition:** Monitor and confirm compliance with the Erosion and Sedimentation Control plan (ESC); ensure the use of low-sulfur fuel for on-site heavy equipment and vehicles.
2. **Formwork:** Confirm whether specifications require FSC wood; consider use of reusable formwork; confirm compliance with IAQ plan requirements; watch out for formwork layout complications related to underground or in-slab sustainable elements, such as geothermal systems or radiant slabs.
3. **Foundation:** Conitor and control concrete washout.
4. **Steel:** Keep track of recycled content.
5. **Concrete:** Recycled content, regional content.
6. **Envelope:** Confirm specification requirements and testing procedures for sustainable envelope, façade, and roof systems; verify sealing of joints, overlaps, corners, cutouts, and penetrations for both energy efficiency and water control, while ensuring VOC compliance; comply with site-specific Construction Waste Management Plan.

(see pages 29-30)

CHAPTER 7: Shop Drawings and Submittals

1. Is the shop drawing submittal process different on a green job? If so, how?

The shop drawing submittal and approval process on a green project should be fully integrated with your standard procedures. Project architects and engineers should have incorporated all of the green requirements into the plans and specifications *(see page 32).*

2. **What types of additional documentation are required from the CM/GC and your subs?**
    1. Subcontractors and vendors will be required to fill out compliance sheets and submit certification letters with product submittals.
    2. The CM/GC is required to track and verify that all green specification items and work practices have been satisfied. It is essential to have a proper paper trail.

    (see page 33)

3. **What products require additional documentation to verify sustainable specification conformance?**
    - **Water Efficiency:** Verification of WaterSense labeling on selected products.
    - **Energy and Atmosphere:** Verification of ENERGY STAR labeling on selected products.
    - **Materials and Resources:** Verification of the geographical area where a material was extracted, processed, and/or manufactured; verification of the quantity of pre- and post-consumer recycled content used; verification of FSC-certified wood products; verification of rapidly renewable content in materials, such as bamboo.

    (see page 33)

CHAPTER 8: Rough-In, Finishes and Fit-Out

1. **What green design elements require CM/GC tracking and verification at rough-in?**

    The green design elements that require CM/GC tracking and verification at rough-in are HVAC and Controls, Plumbing and Pipefitting, Electrical, Indoor Air Quality Plan, and Construction Waste Management (*see pages 34-35*).

2. **How do you use your Quality Control Plan to be sure that you are catching all the issues?**

    The QCP outlines the tracking and oversight necessary for each installation, and can be used as a guide as the CM/GC continues to verify a variety of green components, such as ensuring that installers are providing the specified products and are adhering to proper installation procedures (*see page 34-35*).

3. **What are the primary green issue areas the CM/GC must watch out for at the finishes and fit-out stage?**

    Indoor Air Quality:
    1. Review the sequence of installation in conjunction with floor-by-floor site logistics. When possible, schedule high-polluting activities or installation of materials that off-gas before installing absorbent materials.
    2. Ensure on-site storage of porous and fabric-based materials provides proper protection from moisture and pollutants.
    3. Provide ductwork protection per SMACNA standards at each supply and return, and make sure all joints are properly sealed with mastic and tightly fastened to the trunk line.
    4. Confirm all openings in piping or ductwork are sealed after installation and until start-up.
    5. Confirm VOC-emitting finishes meet green specifications.
    6. If formaldehyde-based MDF or particleboard is used, ensure all exposed edges of cabinets, undersides of all countertops, shelving, etc., are sealed prior to installation with low VOC paint.
    7. Ensure the proper ventilation and isolation of work areas when pollutants are unavoidable.

8. Coordinate and monitor building flush-out or air quality testing with subcontractors and the CxA.

MEP and Life Safety Systems:

1. Confirm HVAC system controls and BMS meet product specifications, set points, and SMACNA requirements.
2. Ensure electrical fixtures, lighting and daylighting controls, occupancy sensors, and PV or other renewable systems are installed in accordance with the project specifications.
3. Be sure hot and cold pipes are properly insulated to reduce heat loss or gain.
4. Confirm installed plumbing fixtures meet low-use specs.

(*see pages 35-36*)

CHAPTER 9: Commissioning and Close-Out

1. **Which building systems require the CM/GC's involvement in the commissioning process?**

   The buildings systems that require the CM/GC's involvement in the commissioning process are:

   - Heating, ventilation, air conditioning, and refrigeration (HVAC&R) systems (mechanical and passive) and associated controls
   - Plumbing (pumps, boilers, and domestic hot water)
   - Lighting and daylighting controls
   - Greywater and blackwater recycling systems
   - Fire-protection systems and controls
   - Renewable energy systems (i.e., wind, solar, etc.)

   Additional systems and procedures that may be included:

   - Building envelope
   - Water treatment
   - Stormwater management
   - IT infrastructure

   (*see page 40*)

2. **How is the CM/GC's role different with Enhanced as opposed to Fundamental Commissioning?**

   On projects that include Enhanced Commissioning, requirements are expanded to include additional documentation of the commissioning review process, review of contractor submittals, verification that operation personnel are trained, and review of systems operation after occupancy (*see page 38-39*).

3. **What is the CM/GC's role in commissioning at the various stages of construction?**

   The CM/GC is responsible for coordinating the trades, ensuring that the contractors' installations meet specifications, and supplying documentation to the Commissioning Agent. When properly done, the CxA will identify the CM/GC's role and provide specific direction on how he or she is involved. The brief ways the CM/GC's role intersects that of the CxA are:

   - **Design Review:** Assist in value engineering (VE) by providing cost-effective alternative solutions, provide support developing the commissioning plan, provide relevant submittals and shop drawings for review.
   - **Construction Inspections and Performance Testing:** Arrange for installation inspections prior to closing, arrange with subcontractor for pre-functional and start-up inspections and tests for HVAC&R systems and BMS/control programming, arrange with subcontractor for testing of lighting controls and hot water systems, ensure

subcontractors complete CxA and CM/GC-identified punch lists and corrective work, coordinate with CxA on final testing and acceptance procedures.

- **O&M Training Supervision and Turnover:** Assist in the development of O&M manuals to ensure optimal future operation of relevant systems, develop and deliver operations training program on commissioned systems for the owner's O&M staff, system troubleshooting.

(*see page 38*)

4. **What types of green-related documentation must the CM/GC provide at project close-out?**

   The CM/GC must provide the required documentation from the subcontractors at project close out, especially material reporting templates required for LEED, such as the master LEED credit matrix created at the job's outset (*see page 42*).

CHAPTER 10: Measurement and Verification

1. **Describe the different options available for M&V in the IPMVP published by EVO.**

   The different options available for M&V in the IPMVP published by EVO are:

   - **Option A. Retrofit Isolation: Key-Parameter Measurement:** This option is used for a retrofit of a single system such as lighting that is simple enough to permit spot checking of a few parameters and comparison to the engineering estimates.
   - **Option B. Retrofit Isolation: All-Parameter Measurement:** This option also applies to retrofits of particular systems, but in this case, energy use of the retrofit system must be made during the reporting period. This option must be used in retrofit situations where the system will operate in a variable and unpredictable manner.
   - **Option C. Whole Facility:** Savings is determined by measuring either energy use at the level of the entire facility or at some level lower than the entire facility but greater than individual systems. The typical case is one in which the facility energy use can be measured both before the retrofit and for a comparable period after the retrofit.
   - **Option D. Calibrated Simulation:** This option is used in cases such as new construction, where baseline data is not available, and is based on computerized building simulations.

   (*see pages 45-46*)

2. **Describe how energy efficiency is predicted and measured in the construction of a new building versus a retrofit.**

   In a retrofit, energy efficiency is measured using utility meters and additional meters on particular pieces of equipment. The consumption of electricity, water, gas, and fuel oil, or heating output can be measured over some reasonable historical period. Usually one or two years can be easily measured by simply reviewing the utility bills for that period. Then, the new equipment is installed and consumption is observed using the same meters for a succeeding year or two. The change in consumption will give an accurate measurement of the savings.

   In a new building, energy efficiency is measured by comparing the energy and water consumption of the new building to what the consumption would have been had the building been constructed using standard techniques, without any efficient devices or fixtures. Designers construct a computer model of the building, a large collection of equations representing all the energy flows in the building, which mimics the actual performance of the building on an hour-by-hour basis and can estimate the annual use of fuel, electricity, and water. The fuel, electricity,

and water use of the “standard” or “base-case” building can be estimated. The designers then prepare a second version of the computer model, one that includes all the efficiency features, and use it to estimate in advance how much fuel, electricity, and water will be used in the new building. The difference between usages in the two models will equal the projected energy savings well before construction is complete (*see page 44-45*).

3. **Describe the value of a Post-Occupancy Review and Assessment.**

   A Post-Occupancy Review and Assessment is a good business practice to discuss the pitfalls, successes, and methods to streamline and optimize processes. Goals of the Sustainability Management Plan should be reviewed to determine what changes were made and why. Some of the benefits of engaging in a Post-Occupancy Review and Assessment are:

   1. Documentation of best practices and innovations for future application.
   2. The exchange of individual learning in a manner that benefits the whole group.
   3. An increase in understanding others’ motivations, rationales, and perspectives.
   4. Greater job satisfaction due to a forum for giving and receiving constructive feedback.

   (*see pages 47-48*)