EDUCATION COMMITTEE

HOUSING RESEARCH CENTRE

2015 Malaysia University-Industry Green Building Collaboration (2015 MU-IGBC) Symposium

- Theme A -

Delivery Process and Performance Evaluation

Topic : Building Commissioning

By: Ir. Soong Peng Soon – GBI Commissioning Specialist

What is Commissioning & Verification to Green Building Project?

Commissioning is a quality assurance process that ensure building systems are designed, installed and performing to the **Owner's Project Requirements**

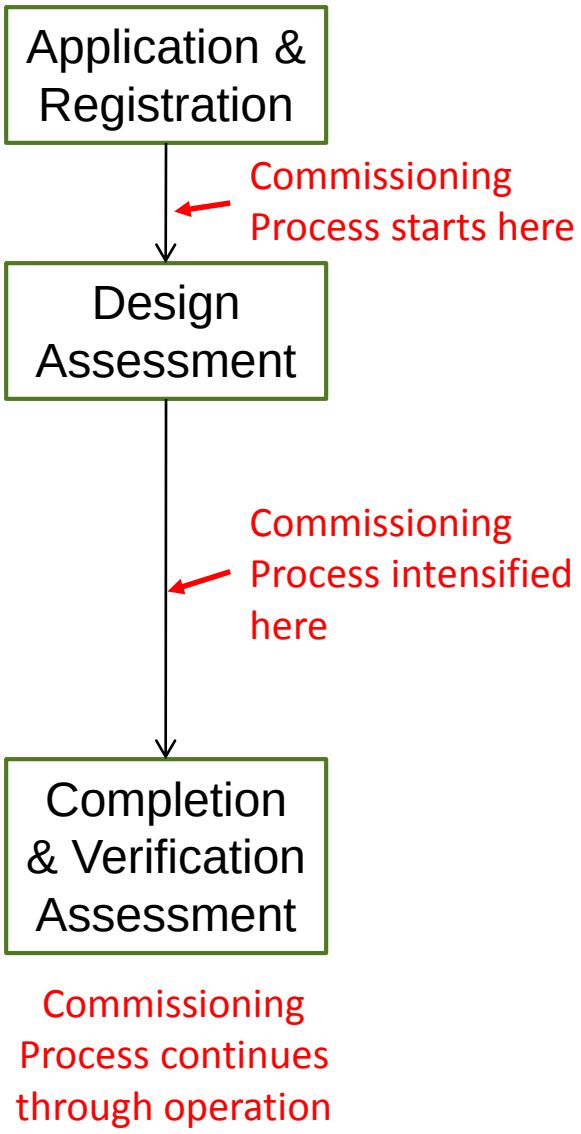
It enhances the delivery of a project & focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's Project Requirements. Owner must get the value out of their effort & investment into green inititiatives upon turnover.

Commissioning is an ongoing process (ideally, spanning from pre-design into occupancy)

It is NOT a "construction event"

It is NOT a short-term "inspection task"

It is NOT just a "punch list" for clearance at the end of construction



Role of Commissioning Service Provider (CxS)

- Document the Owner's Project Requirements (OPR) and develop the Basis of Design (BOD)
- Review the Owner's project requirements and the basis of design for clarity and completeness prior to the approval of contractor submittals of any commissioned equipment or systems
- Develop and implement a commissioning plan
- Develop and incorporate commissioning requirements into the construction contract documents.
- Conduct at least one commissioning deign review of the Owner's project requirements, basis of design, and design documents prior to mid-construction documents phase and back-check the review comments in the subsequent design submission
- Review contractor submittals applicable to the systems being commissioned for compliance with the Owner's project requirements and basis of design

What Commissioning Service Provider (CxS) will do…

- Verify the Installation and Performance of the Systems to be Commissioned
- Develop a systems manual that gives future operating staff the information needed to understand and optimally operate the commissioned systems
- Verify that the requirements for training operating personnel and building occupants have been completed
- Complete a summary commissioning report
- Reviewing building operation within 12 months (or up at least 50% occupancy) after substantial completion with O&M staff and occupants. Include a plan for resolving outstanding issues

Green Building Index (NRNC Tool)

GBI COMMISSIONING SPECIALIST (CxS)

INTRODUCTION

The GBI rating system recognizes the need to address typical shortfalls of the building industry where it relates to the need for proper design and commissioning of a building's energy related system. Whilst the GBI (v1.0) does not mandate the appointment of a CxS, owners are urged to consider such an appointment to enhance the performance of their buildings in the long run. As a matter of fact, the GBIAP has repeatedly highlighted that buildings targeting for GBI Gold rating and above, should realistically engage the services of a CxS. The commissioning process begins early in the Design phase of a building project and continues through Construction and warranty period. GBI encourages commissioning of both dynamic and static elements that impact energy & water efficiency and elements that impact IEQ. Commissioning should be performed on features and systems, including all HVAC systems and their controls, ductwork, pipework, renewable and alternative energy technologies, lighting controls and day-lighting systems, waste heat recovery, and advanced technologies; such as UFAD, chilled slab cooling, chilled beams, thermal storage, heat recovery system, and so forth.

Water commissioning includes irrigation systems, plumbing fixtures, and plumbing infrastructure. Energy commissioning covers HVAC system, lighting, and energy-generation equipment. Commissioning activities that affect Indoor Environmental Quality (IEQ) include acoustics, temperature and humidity controls, ventilation systems, monitoring equipment, occupant controls, and day-lighting systems. It is important that the scope of commissioning incorporates both dynamic and static elements in the design, and not merely the mechanical and electrical systems. Commissioning plumbing fixtures involves just the fixtures that are used to reduce water use, while the plumbing-infrastructure requirement applies to such things as rain-water or gray-water recovery systems. Innovative waste-water technologies should also be commissioned.

The CxS is expected to be well-qualified for the managerial and technical aspects of the project and exhibit experience in construction management, design, engineering, hands-on field experience with equipment and troubleshooting, energy efficiency, and operations & maintenance.

In a nutshell, the CxS must ensure that the building's energy related systems are designed and installed to achieve proper commissioning so as to realize their full potential and intent.

ROLE OF THE CxS

GBI requires the CxS to be an independent, third-party expert who serves as an objective advocate of the owner, directs the commissioning process, and presents final recommendations to the owner regarding the performance of commissioned building systems.

The design reviews and submittal reviews must be performed by a firm other than the design firm. It is the function of the CxS to introduce standards and strategies early in the design process and ensure implementation of selected design measures by seeing that clearly stated target requirements are included in the construction documents. A knowledgeable CxS on a team can greatly facilitate the design process through collaborative design reviews. These reviews can help minimize costs and maximize GBI rating by ensuring that the requirements can be met.

Essentially, the CxS examines the information needed to make high-quality decisions at each stage, and seeks to understand the mechanisms of decision making. Specifically, it relates to building delivery and operations processes, performance metrics and evaluation, and the economics and financial attributes of sustainable design.

Green Building Commissioning related items
These involved knowledge in many fields

greenbuildingindex

EE1	MINIMUM EE PERFORMANCE
EE2	LIGHTING ZONING
EE3	ELECTRICAL SUB-METERING & TENANT SUB-METERING
EE4	ADVANCED EE PERFORMANCE
EE5	ADVANCED EE PERFORMANCE
EE8	EE VERIFICATION
EE9	SUSTAINABLE MAINTENANCE
EQ1	MINIMUM IAQ PERFORMANCE
EQ3	CARBON DIOXIDE MONITORING AND CONTROL
EQ5	MOULD PREVENTION
EQ6	THERMAL COMFORT: DESIGN & CONTROLLABILITY OF SYSTEMS
EQ7	AIR CHANGE EFFECTIVENESS
EQ8	DAYLIGHTING
EQ9	DAYLIGHT GLARE CONTROL
EQ10	ELECTRIC LIGHTING LEVELS
EQ13	INTERNAL NOISE LEVELS
EQ14	IAQ BEFORE & DURING OCCUPANCY
EQ15	POST OCCUPANCY COMFORT SURVEY: VERIFICATION
SM13	BUILDING USER MANUAL
WE1	RAINWATER HARVESTING
WE2	WATER RECYCLING
WE3	WATER EFFICIENT - IRRIGATION/LANDSCAPING
WE4	WATER EFFICIENT FITTINGS
WE5	METERING & LEAK DETECTION SYSTEM
IN1	INNOVATION IN DESIGN & ENVIRONMENTAL DESIGN INITIATIVES

Conventional Building Commissioning was started for requirement of air-conditioning & ventilation systems, initially focusing on adjusting & balancing for ducting, piping, equipment & accessories. The measurement & verification usually involves the conventional technologies of:

- Pressure & temperature measurement
- Measurement & airflow & water flow
- Instantaneous reading on power consumption
- Simple noise measurement
- Other simple & straight forward evaluations.

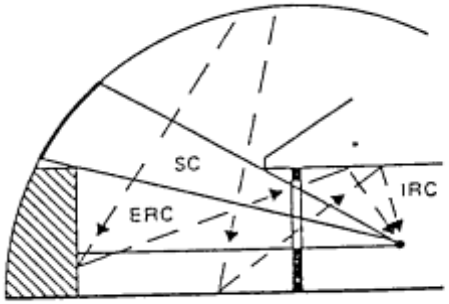
Green Building Commissioning includes more expertise in other building systems. The list of specialties expands as the green building rating system evolves and raising the bar. Many conventional "Commissioning Specialist" were caught unprepared when move into this new definition of Green Building Commissioning. For example, extra expertise shall be needed in:

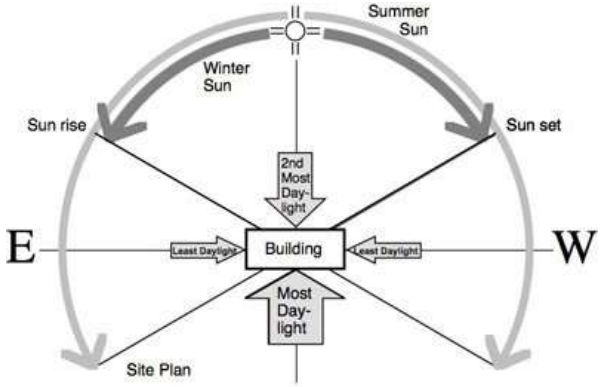
- Building Enclosure
- Daylight & glare research
- Advanced illumination research on special & new lighting options
- Indoor environmental health analysis & human comfort research
- Rain fall analysis, vegetation, water treatment research
- Energy use analysis & data acquisition hardware & software.
- Reflectance & emissivity of material surface
- Etc. & etc.

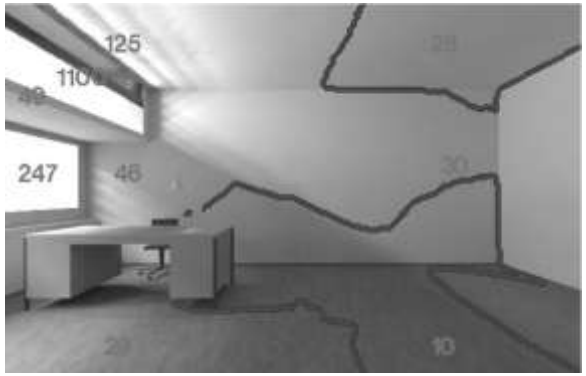
Essentially, Commissioning Specialist for Green Building can be a team rather than a single individual.

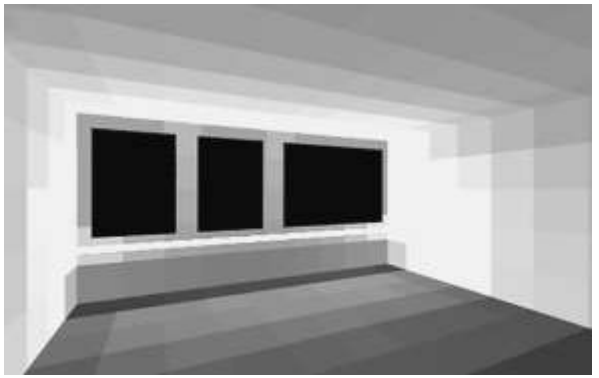
Examples of expertise not common in conventional commissioning and may be assisted by research in higher learning institutions

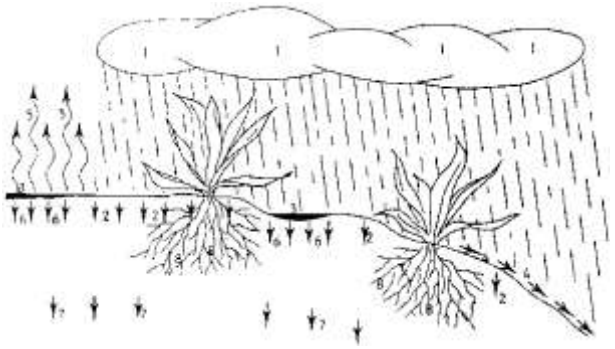
Daylight harvesting, sun path analysis, rainfall study, vegetation study, heat island effect, etc.

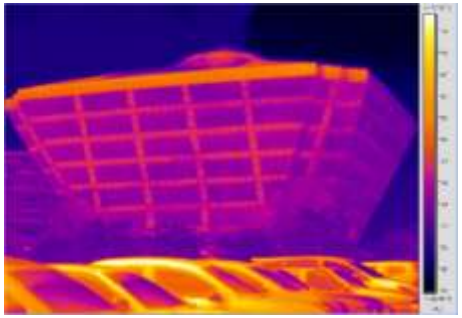












Examples of expertise not common in conventional commissioning and may be assisted by research in higher learning institutions

Energy use verification & rating is still much debatable subject in industry. Much efforts have been poured into finding the best building modeling software to predict energy use and on the monitoring hardware & software to acquire data on actual energy use.
And, as we used more electronic to save energy intelligently, we bring in other problem such as harmonics, which is relatively new topic, currently only actively being researched in universities:

It is embarrassed that some analysis in USA suggests that:
"Green buildings perform no better, and in fact perform worse, than non-green buildings. Many recommended actions, especially those selected by users, have little to no effect. Too few of its standards are results-driven, with high pay-back in areas other than environmental stewardship. Its rewards are self-serving, and used more often by a narrow group of elite users rather than a broad population."

Probably, these green buildings were not properly commissioned and Owner's Objectives had not been met.

Examples of expertise not common in conventional commissioning and may be assisted by research in higher learning institutions

Indoor air quality, measurement & tracing of gases have been research topics in universities, which are emphasized in green buildings:

When constructing cost-effective buildings, it is easy to forget that the success or failure of a project may rest on its indoor environmental quality (IEQ). Healthy, comfortable employees are often more satisfied and productive. Unfortunately, this simple truth is often lost, for it is easier to focus on the first-cost of a project than it is to determine the value of increased user productivity and health. Facilities should be constructed with an appreciation of the importance of providing high-quality, interior environments for all users.

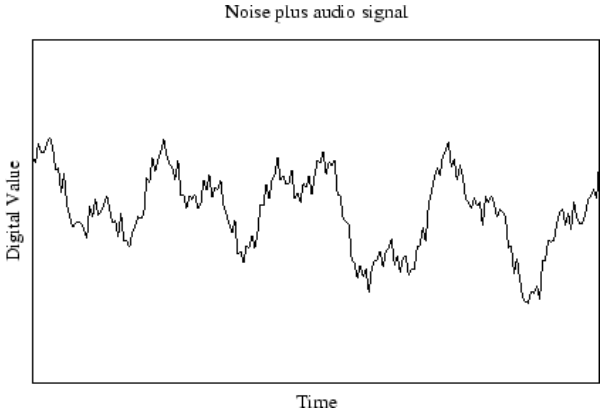
For example, list of Volatile Organic Compound (VOC) is unfamiliar to common construction:

Compounds (10.6eV lamp)

Acetaldehyde
Acetic Acid
Acetic Anhydride
Acetone
Acrolein
Acrylic Acid
Allyl Alcohol
Allyl Chloride
Ammonia
Amyl Acetate
Amyl Alcohol
Aniline
Anisole
Arsine
Benzene
Benzonitrile
Benzyl Alcohol
Benzyl Chloride
Benzyl Formate
Biphenyl
Bromine
Bromobenzene
2-Bromoethyl Methyl Ether
Bromoform
Bromopropane, 1-
Butadiene
Butadiene diepoxide, 1,3-
Butane
Butanol, 1-
Butanol, t-
Butene, 1-
Butoxyethanol, 2-
Butyl Acetate, n-
Butyl Acrylate, n-
Butylamine, n-
Butyl Hydroperoxide, t-
Butyl Mercaptan
Carbon Disulfide
Chloro- 1,3-butadiene, 2-
Chlorobenzene
Chloroethyl Ether, 2-
Chloroethyl Methyl Ether, 2-
Chloropicrin
Chlorotoluene, o-
Crotonaldehyde
Cumene
Cyclohexane
Cyclohexanone
Cyclohexene
Cyclohexylamine
Decane
Diacetone Alcohol
Dibromochloromethane
Dibromoethane, 1,2-
Dichlorobenzene, o-
Dichloroethene, 1,1-
Dichloroethene, c-1,2-
Dichloroethene, t-1,2-
Dichloro-1-propene, 1,3-
Dichloro-1-propene, 2,3-
Dichlorvos
Dicyclopentadiene
Diesel Fuel #1
Diesel Fuel #2
Diethylamine
Diethylaminopropylamine, 3-
Diethylmaleate
Diisopropylamine
Diketene
Dimethylacetamide, N, N-
Dimethylamine
Dimethyl Carbonate
Dimethyl Disulfide
Dimethylethylamine
Dimethylformamide, N, N-
Dimethylhydrazine, 1, 1-
Dimethyl Methylphosphonate
Dimethyl Sulfate
Dimethyl Sulfoxide
Dioxane, 1, 4-
DS-108F Wipe Solvent
Epichlorohydrin
Ethanol
Ethanolamine
Ethene
Ethoxyethanol, 2-
Ethyl Acetate
Ethyl Acrylate
Ethylamine
Ethylbenzene
Ethylene Glycol
Ehtylene Oxide
Ethyl Ether
Ehtyl 3-Ethoxypropionate
Ethyl Hexyl Acrylate, 2-
Ethyl (S)-(-)lactate
Ethyl Mercaptan
Ethyl Sulfide
Furfuryl Alcohol
Gasoline #1
Gasoline #2, 92 Octane
Glutaraldehyde
Heptane, n-
Hexamethyldisilazane, 1, 1, 1, 3, 3, 3-
Hexane, n-
Hexanol, 1-
Hexene, 1-
Hydrazine
Hydrgen Sulfide
Iodine
Iodomethane
Isoamyl Acetate
Isobutane
Isobutanol
Isobutylene
Isobutyl Acetate
Isoflurane
Isooctane
Isopar E Solvent
Isopar G Solvent
Isopar K Solvent
Isopar L Solvent
Isopar M Solvent
Isopentane
Isoprene
Isopropyl Ether
Jet Fuel JP-4
Jet Fuel JP-5
Jet Fuel JP-8
Kerosene
Limonene, D-
Mesitylene
Methoxyethanol, 2-
Methoxyethoxyethanol, 2-
Methyl Acetate
Methyl Acrylate
Methylamine
Methyl Bromide
Methyl t-butyl Ether
Methylcyclohexane
Methyl Ether
Methyl Ethyl Ketone
Methylhydrazine
Methyl Isobutyl Ketone
Methyl Isocyanate
Methyl Isothiocyanate
Methyl Mercaptan
Methyl Methacrylate
Methyl-1, 5-Pentane-Diamine, 2-
Methyl Propyl Ketone
Methyl-2-Pyrrolidinone, N-
Methyl Salicylate
Methylstyrene, α-
Methyl Sulfide
Mineral Spirits
Mustard
Naphthalene
Nitric Oxide
Nitrobenzene
Nitrogen Dioxide
Nonane
Octane, n-
Pentane
Peracetic/Acetic Acid Mix
Perchloroethene
PGME
PGMEA
Phenol
Phosphine
Photocopier Toner
Picoline, 3-
Pinene, α-
Pinene, β-
Piperylene, Isomer Mix
Propanol, n-
Propene
Propionaldehyde
Propyl Acetate, n-
Propylene Carbonate
Propylene Glycol
Propylene Oxide
Propyleneimine
Propyl Mercaptan, 2-
Pyridine
Pyrrolidine
RR7300 (PGME/PGMEA)
Sarin
Styrene
Tabun
Tetraethyllead
Tetraethyl Orthosilicate
Tetrafluoroethene
Tetrahydrofuran
Tetramethyl Orthosilicate
Therminol VP-1
Toluene
Trichlorobenzene, 1, 2, 4-
Trichloroethene
Triethylamine
Triethyl Borate
Triethyl Phosphate
Trimethylamine
Trimethyl Borate
Trimethyl Phosphate
Turpentine
Undecane
Vinyl Actetate
Vinyl Bromide
Vinyl Chloride
Vinyl-2-Pyrrolidinone, 1-NVP, N-Vinylpyrrolidone, 1-Ethenyl-2-Pyrrolidinone
Xylene, m-
Xylene, o-
Xylene, p-

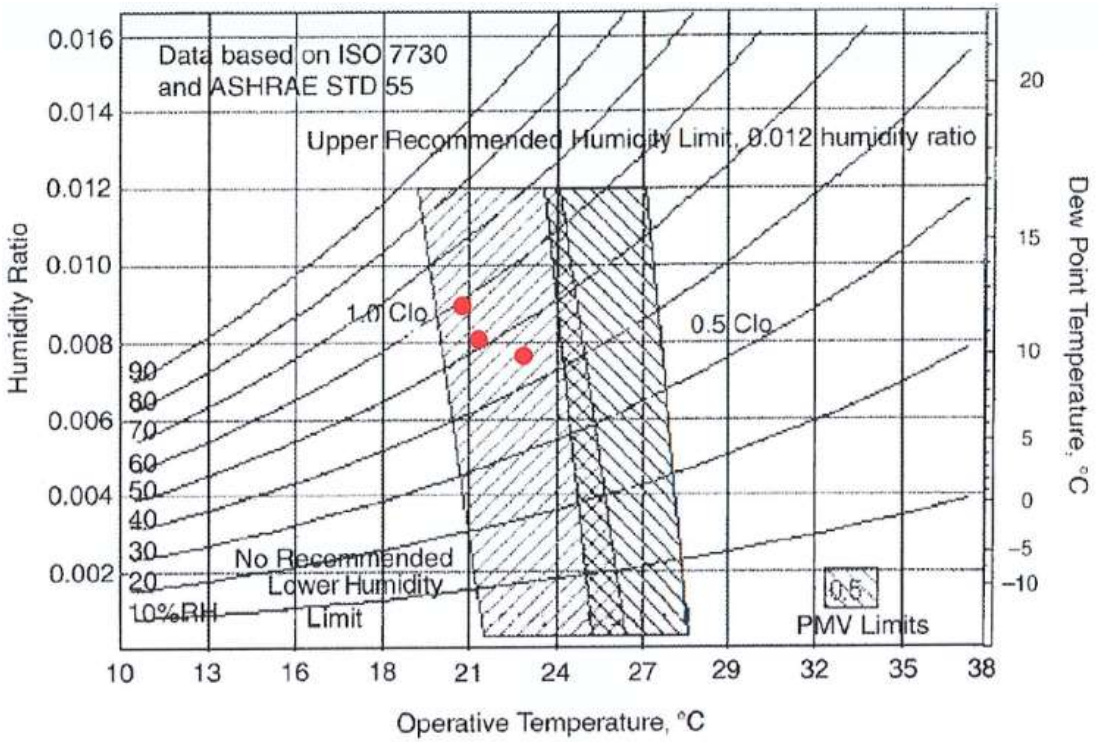
Examples of expertise not common in conventional commissioning and may be assisted by research in higher learning institutions

Effect of noise to occupants is as important as other parameters and the effective methods & decision to eliminate unwanted noise & vibration is still a subject of research:



Examples of expertise not common in conventional commissioning and may be assisted by research in higher learning institutions

Human Response to temperature, humidity, wind speed and radiant temperature is still much a subject of research:



Summary: Commissioning is a crucial delivery and performance evaluation process

Commissioning need facts & figures, methodology that guide us in devising a better commissioning & verification plan for green buildings. These basic information may be available from research in institution of higher learning. Normal entities in construction industry may not have the time, resources and specialist to research into these.

Input from Commissioning can be useful for decision makers throughout the project development process from inception to completion, and beyond to occupancy. Recommendation from Commissioning Specialist can help to make high-quality decisions at each stage. Eventually Commissioning Specialist summarizes performance metrics and evaluation criteria for relevant green building features in a Commissioning Report.

Recommendations from commissioning can also be used as guide for justifiable technical viability, economics and financial attributes of sustainable design. The ability to foresee practical operation & verification problem is very important as this has impact to the commercial accountability.

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Commissioning Process Certifications:

General Information

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University of Wisconsin

Certifications for Commissioning Process Professionals

Certification for Educational Achievement

- Qualified Commissioning Process Provider (QCxP℠) or (QCP℠)

Certifications for Educational Achievement Plus Documented Experience

- Commissioning Process Authority Professional (CxAP℠) or (CAP℠)
- Commissioning Process Manager (CxM℠ or CXM℠)
- Commissioning Process Technical Service Provider (CxTS℠) or (CTS℠)
- Green Commissioning Process Provider (GCxP)℠, (GCP)℠

Introduction

Background

The University of Wisconsin–Madison initiated the development of a certification program for individuals involved in the Commissioning Process (CxP) in 2001, with a formal program launched in February 2003. The purpose of this program is to provide in-depth training and professional recognition, establishing a benchmark for commissioning professionals and supporting providers. The knowledge and experience demonstrated through the completion of the certification requirements are critical for success in implementing the Commissioning Process, which reduces the cost and improves the quality of constructed projects and existing buildings. Building owners may use these certifications when hiring internal commissioning managers and staff, and when engaging the professional services of others to implement the Commissioning Process on their new building and facility projects, rehab of existing buildings and facilities, and on-going operational improvements and functional enhancement of existing facilities. These certifications can be used as one standard upon which to judge the expected performance of a commissioning authority, Commissioning Process manager, or providers of related Commissioning Process services. A primary objective of the program is to establish a rigorous, independently evaluated level of accomplishment, so that any individual who receives a University of Wisconsin – Madison certification will be capable of providing value to projects using the principles of the Commissioning Process.

THANK YOU

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