Commissioning In Energy Savings Performance Contracts

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ABSTRACT

Energy savings performance contracts (PCs) using the international measurement and verification (M&V) protocols are increasing in number. For these projects to be successful, they must incorporate an appropriate quality assurance and quality control component. M&V protocols call for commissioning on all projects.

The most appropriate commissioning process used for PC projects is likely to differ significantly from the commissioning process used in a typical non-PC new construction or major renovation project. In the extreme, PC contractors have felt that there is no need for an outside commissioning authority and process. On the other hand, owners are interested in more than just the energy savings. They want to ensure that all installed equipment and interfaced systems are working as intended in all modes of operation, regardless of energy impact. How can the non-energy issues be dealt with in performance contracts? Normally, if M&V is more rigorous, the commissioning rigor could be reduced and vice versa, but how is this distribution best made? Both M&V and commissioning have some common data needs. How can these needs best be coordinated?

This paper investigates the above, and other important issues related to PCs. It provides specific guidance on how to incorporate and integrate commissioning into various types of PC contracts and for various types of buildings and equipment. The information in this paper can assist both owners and contractors in planning and conducting appropriate and efficient commissioning in their PC projects.

Background

Commissioning new equipment is defined as "the process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained to perform in conformity with the design intent." (ASHRAE, 1996) A similar definition is given in The International Performance Measurement and Verification Protocol (IPMVP, 1997): "A process for achieving, verifying and doucmenting the performance of buildings to meet the operational needs of the building within the capabilities of the design, and to meet the design documentation and the owner's functional criteria, including preparation of operator personnel." (IPMVP, 1997, p. 145) This is achieved ideally by beginning in the design phase with design intent development and documentation, and continuing through construction, acceptance and the warranty period with actual testing and documentation of operation and performance.

Energy savings performance contract projects (PCs) are services and products provided by a contractor having specific levels of performance attached to them. Often payment for the service is benchmarked and dependent on how well the levels of

performance are met over time, based on actual measurement and verification. Services include engineering analysis; project management; and providing: equipment, installation, operation and maintenance. The focus of the project is to obtain utility bill savings from energy and peak demand reductions and to use those savings to pay for the improvements causing those savings.

For any PC to be successful, an appropriate quality assurance and quality control component needs to be part of the process. In addition, PCs require a measurement and verification (M&V) component to assess the energy performance of the installed systems. The International Performance Measurement and Verification Protocol (IPMVP) has become the standard for M&V. Commissioning has proven to be a useful process for ensuring quality in the design and construction of mechanical and control systems (Reference here) and is a standard requirement in all M&V options of the IPMVP.

Paper Organization. This paper provides a description of the basic commissioning and PC process, then discusses the issues surrounding commissioning and M&V and finally to provides specific guidance for integrating commissioning into performance contract projects.

Commissioning and Performance Contract Objectives and Process

M&V is not a replacement for commissioning and commissioning is not a replacement for M&V. Commissioning's primary objective is to ensure that equipment *functions* well according to the specifications and has the *potential* to save energy. M&V seeks to *quantify the savings* of the installed equipment. PCs ultimately seek to ensure that the systems *save the energy* they were estimated to. These are important distinctions. Meeting the commissioning objectives does not mean the PC goals will be met. For example, a variable speed drive installation may function flawlessly, but not save the energy expected because the original savings estimates or the post savings calculations (M&V) were inaccurate. Conversely, a variable speed drive on paper may save the energy predicted, but not actually be functioning well, as the pre- or post-savings estimates (M&V) were inaccurate. Good M&V and commissioning are both important in a PC.

Commissioning

For new equipment, typical commissioning objectives and methods during the design phase are:

- Ensure that the design intent is clearly documented—*by providing formats, coordinating its development and reviewing content.*
- Ensure that commissioning requirements, functional and performance criteria, operations and maintenance (O&M) documentation and training are completely specified in the bid documents—*by coordinating their development, providing content and reviewing the documents.*
- Contribute to the design documents—*through focused design reviews.*

Typical commissioning during the construction phase is intended to achieve the following specific objectives:

- Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors—*by submittal review, construction observation and review of start-up and checkout.*
- Verify and document proper function and performance of equipment and systems—*through documented functional and performance testing.*
- Verify that O&M documentation left on site is complete—*through documentation review.*
- Verify that the Owner's operating personnel are adequately trained—*through review of training plans and verifying training completion.*

Commissioning often extends into the contractors normal one year warranty period. The objectives of commissioning during warranty are to:

- Ensure that system meet the design intent during peak seasonal conditions—*through conducting required seasonal or deferred testing*
- Bring to closure outstanding functional and performance issues—*by reviewing and addressing outstanding issues.*

Energy Savings Performance Contracts

The primary objectives and activities for typical PCs are:

- Determine if the candidate building holds sufficient likelihood of success (savings will pay for capital and financing costs over an acceptable time horizon)—*by performing a preliminary building assessment and identifying primary savings sources.*
- Develop a comprehensive list (with savings estimates and costs) of utility (energy, water, waste, etc.) and operations and maintenance (O&M) cost reduction measures—*through a detailed "investment grade" audit and energy study.*
- Develop an acceptable contract with the owner.
- Develop project details—*through engineering analysis and design for the measures.*
- Install and set up equipment and systems and ensure full functionality and performance—*through a traditional design-build program with contractor's providing their own quality control and assurance.*
- Verify energy savings (M&V)—*through engineering calculations, spot measurements, short or long-term monitoring, bill analysis and/or building simulation.*

M&V Options. There are four verification of energy savings or M&V options described in the IPMVP (IPMVP, 1997). More than one option may be used on any given project.

Option A. Verify functionality. Spot measurement. Stipulate savings assumptions. Verify that the measure can generate savings. Key performance factors (lighting wattage or chiller efficiency) are determined with spot or short-term measurement and operational

factors (lighting operating hours or cooling ton-hours) are stipulated based on analysis of historical data or spot/short-term measurements and agreement with the owner. Performance factors and proper operation may be measured or checked annually. Savings are calculated using spot or short-term measurements, computer simulations, and/or historical data.

Option B. Verify functionality. Whole-building simulation or end-use calculations from short-term measurements over life of contract. Savings are determined after project completion by short-term or continuous measurements taken throughout the term of the contract at the *device or system level.* Both performance and operations factors are monitored.

Option C. Verify functionality. Whole building energy use tracking over time. After project completion, savings are determined at the "whole-building" or facility level using current year and historical utility meter or sub-meter data. Savings are calculated using a range of methods from simple comparison to multivariate regression.

Option D. Verify functionality. Calibrated whole-building simulation informed from short-term measurement. Savings are determined through simulation of facility components and/or the whole facility. Simulations are calibrated with hourly or monthly utility billing data and/or end use metering.

Ideally, an independent party should perform the M&V to ensure the highest objectivity. However, in practice many PC contractors perform their own M&V in order to reduce overall project costs and keep the project viable. This scenario puts the owner at more risk. This risk can be mitigated to some degree if the technical and commissioning specifications are more rigorous, and if the owner has staff or a consultant who can technically evaluate and review the M&V work performed by the PC contractor.

Commissioning in M&V Protocols

The IPMVP references commissioning over 13 times. The protocol highly recommends commissioning for all PCs for the following tasks: (IPMVP, p. 25; 135-6)

- Documenting design assumptions
- Documenting energy conservation measure design intent
- Installation verification
- Functional performance testing
- Adjusting measures to meet actual needs

The IPMVP (protocol) definition of commissioning also suggests that operator training "preparation of operator personnel" can be enhanced through commissioning.

The protocol (p. 108) recommends using ASHRAE Guideline 1-1996 *The HVAC Commissioning Process* as a guide. The protocol also suggests that M&V data can be used for commissioning (p. 41) and that commissioning can help installers do a better job and reduce owner risk (p. 113). The protocol suggests that the performance contractor normally would do the commissioning, but that the owner may engage an independent third party (p. 26). Equally specific references to commissioning are found in the Federal Energy Management Program (FEMP) M&V Guidelines where commissioning is recommended for all M&V options.

M&V and System Type

Installed systems have been classified in the M&V protocols into simple and complex. Simple systems are characterized by constant load, constant operating hours or static measures, such as lighting efficiency, some motors, windows and insulation. Complex measures have variable load or variable operating hours, such as lighting schedule controls, steam traps, variable speed drives, variable air volume retrofits, boiler or chiller replacement, packaged rooftop replacement and outdoor air control. The recommended M&V rigor goes up as the installed systems become more complex.

Why Commission With M&V?

Understanding why commissioning is important even when the project has M&V requires discussion on risk relative to the performance of energy and non-energy related measures.

Risk, M&V and Commissioning

Commissioning ensures that systems are installed and operating as intended and subsequently reduces the uncertainty whether the owner will be receiving all they paid for. The risk the owner assumes decreases as more commissioning and M&V are applied to any given measure. However, increased effort in these areas also increases project costs.

There is an appropriate level of M&V and commissioning for each measure, dependent on the owner's aversion to risk and the types of measures installed. Generally, with more M&V commissioning may be less rigorous and the more rigorous the commissioning, the less the need for M&V. However, there is never a point when either some M&V or commissioning is not needed in a PC.

Performance Contractor and Commissioning

It may be asked, "Why not just let the performance contractor perform the commissioning? Won't they just have to pay for poor performance, if they don't commission well?" In practical application, if initially the predicted savings are not realized (partly or solely because the system was not commissioned well) the contractor may be inclined to use any latitude available in true-up and savings analysis assumptions they have to minimize the short-fall of savings. In summary, if the contractor poorly commissions the project and the energy components of the systems don't function as well as they could, the owner may never know, predicted and/or maximum savings may never be realized and the contractor is unlikely to be adversely affected. The non-energy problems are likely to be left with the owner.

The focus of the contractor is to install the equipment so they can get paid for the installation (where a significant amount of markup exists) and to install it well enough to realize the predicted energy savings. Many projects have stipulated savings where there is even less motivation to install the equipment well. Some contractors think they already commission their projects when they do start-up checkout, traditional testing, adjusting and balancing or controls calibrations.

PC contractors have felt that there is no need for an outside commissioning authority and process. On the other hand, owners are interested in more than just the energy savings. They want to ensure that all installed equipment and interfaced systems are working as intended in all modes of operation, regardless of energy impact. Some major performance contractors have reported they are paying out true-up fees to customers for projects whose performance was lower than estimated. Investigation into these problem projects by PC contractor forensic staff has revealed that in many cases poor performance was caused by poor quality control during design, installation and setup. They believe that a commissioning process could have prevented many of the problems they are now paying for. On the positive side, integrating the appropriate portions of the traditional commissioning process into PCs can result in an improved project. (Fiedler 1998)

As has been found in commissioning traditional facilities, commissioning can be a real benefit to contractors. Commissioning will result in better customer satisfaction, more referrals, fewer callbacks and improved energy performance and payments—all contributing to greater profitability. So why aren't they all doing it? One supposition is that the people responsible for executing quality assurance and control (designers during design and site technicians during construction) are not informed that their designs and installations are faulty. Upper management in the PC company apparently has been more focused on being creative in energy analysis and baselining than on quality control of design and installations.

Integrating Commissioning into PCs

The previous sections of this paper have provided the background in the subject of commissioning and PCs. This section provides specific guidance for incorporating commissioning into PCs. A few salient issues are discussed prior to providing a full table of recommendations.

Managing vs. Executing Commissioning

When referring to participants in the commissioning process, it is important to accurately reflect their true activities. Some commissioning guidelines refer to the party managing the commissioning as the commissioning agent, authority or provider, while others reserve that term for the party executing the in-field commissioning. In PCs when the performance contractor is executing the commissioning field work, there should always be someone working as or with the owner who manages that commissioning. An independent commissioning provider hired by the owner manages and may also execute some of the field commissioning.

Specifications and Design Documents

Many PCs will be design-build where there are traditionally limited specifications and design documents provided to the owner. The owner needs to communicate from the onset what they require regarding project specifications and design documents. It is recommended that design narratives be required for all systems and that detailed specifications and drawings be provided prior to construction. This design information will be invaluable to those performing commissioning, M&V and the long-term operation of the facility. This information is critical for any substantive commissioning design reviews. If the

project schedule or other conditions are likely to not allow detailed specifications and design documentation, the owner can include the specific language desired in the specifications, right in the owner/contractor contract.

Financing Commissioning and Conflicts of Interest

Commissioning costs can impact the first costs of the project and therefore may be seen as a cost to minimize or eliminate. It is critical to incorporate only the amount of commissioning appropriate and to be creative in the way it is managed and financed.

The cost of commissioning can be added into the total project cost and financing package. This is generally the most desirable option for owners from a financing view and for some owners that are cash constrained, it may be the only option. For projects where commissioning will be financed, the commissioning provider will have to be contracted to and paid by the performance contractor and therefore is not truly "independent," though the owner may retain the right to select the commissioning provider they feel comfortable with.

A conflict of interest exists with any project where commissioning is conducted by a party involved in the design or construction of the project. This conflict should be specifically addressed to minimize the potential problems. For such projects, the owner should ensure that more detailed commissioning specifications are written so that there is no question as to the commissioning tasks required, including the level of testing and documentation rigor required and the specific performance targets (EER, kw/ton, capacity, space temperature range, etc.).

Methods for dealing with conflicts of interest during planning are for the owner to clearly state their commissioning desires and objectives prior to the PC being developed. One option is for the owner to select an independent commissioning provider before hand and require that the performance contractor use this entity to do the commissioning work. The owner may have the commissioning provider assist in developing the commissioning scope of work. Another option is for the owner to develop some strict qualification criteria for the commissioning provider and require the performance contractor to contract to another firm for the commissioning work who meets those criteria and that the owner has approval authority of the commissioning firm.

The owner then requires that during design and construction the commissioning individual provide all findings, issues and reports as they are identified directly to both the owner and to the performance contractor, so the owner has full knowledge of all findings and issues. This reporting mechanism is also recommended for all commissioning that is done by the performance contractor, with reports from the individual staff of the contractor doing the commissioning going simultaneously to their own supervisor and to the owner. When the commissioning provider is under contract to the performance contractor, it is advised that the level of technical expertise and the time commitment to the project of the owner's technical representative be greater.

M&V and Non-Energy Components

Most PCs are focused on the energy consumption of the equipment or systems they are installing, since that is what their payments are tied to. However, there are many operational and performance issues that are important to the owner—possibly even more than energy—that are not energy-related, e.g., alarm annunciation, chiller system flow safeties, air

handler low temperature limit and high duct pressure safeties, pipe cleaning and water treatment, compressor staging and loading, equipment interfaces with fire-alarms and emergency power, building automation system graphics features, isolations valves for maintenance, manual control, operation of lead/lag controls, building pressurization, indoor environmental quality (see section below), O&M and as-built documentation, staff training, etc.

These features may be of little importance to the performance contractor and subsequently may receive inadequate attention and verification of proper operation. Even though the contractor may be involved with the project for some years, if these non-energy issues are not identified before the typical one year warranty, any assistance with these types of issues will cost the owner more money. Ensuring that non-energy issues are adequately addressed in the project is one of the primary reasons for incorporating commissioning into every PC.

Indoor Environmental Quality Verification

One area where significant overlap may exist between the M&V and commissioning is the verification that indoor environmental quality (IEQ) meets project targets (either improved performance or no degradation from pre-project levels). Generally, commissioning providers are intimately familiar with the issues surrounding IEQ. Performance contractors, having historically been focused on energy, are less likely to be "experts" in the IEQ arena. That makes the traditional commissioning provider on the project the natural candidate to assist if not conduct any IEQ verification for either the owner or performance contractor. An IEQ appendix to the IPMVP provides excellent guidance on verifying IEQ performance. (IPMVP 1999 Appendix). Owners should read Section 8.6 and Table 8.2 during planning and include as part of the contract documents the IEQ issues they want verified and assign a party the responsibility to perform the verification.

Simple Systems

For simple systems it is generally recommended that the performance contractor execute the field commissioning work with oversight by a technical representative of the owner. For simple systems, there is less risk for the owner, as savings are relatively easy to calculate with higher confidence than for complex measures. Commissioning is also easier for simple systems and the commissioning effort can be verified by less technical staff which allows the owner to more easily and confidently manage the commissioning executed by a the performance contractor. However, more detailed specifications and independent design and contract setup review is warranted. This scenario requires that the owner has or engages a technical representative that can manage the technical quality assurance on the project. The owner or their representative should provide clear direction to the performance contractor in the contract documents regarding what non-energy issues and features are to be verified.

The owner may be able to reduce their level of oversight, review and verification of the commissioning effort by the performance contractor as the M&V becomes more rigorous from Stipulated (IPMVP Option A) to more rigorous Performance (Options B, C; D) for a any given measure.

Complex Systems

It is generally recommended that with complex systems, commissioning oversight or management be handled by an independent commissioning provider hired directly by the owner. However, the performance contractor may do the bulk of the field commissioning work. This scenario, with an independent commissioning provider and the contractor doing much of the field work, still requires detailed and clear specifications and commissioning requirements in the contract documents. The owner's own technical staff may be able to perform the commissioning oversight function without an independent commissioning provider, if they have the technical and managerial skills and sufficient time.

As with a given simple system, the owner may be able to reduce the independent commissioning provider's level of oversight, review and verification by transferring some of the effort to the performance contractor as the M&V becomes more rigorous from Stipulated (IPMVP Option A) to more rigorous Performance (Options B, C; D). The owner or their representative should provide clear direction to the performance contractor in the contract documents regarding what non-energy issues and features are to be verified.

Projects of Mixed System Types

PCs with a mix of complex and simple measures could have the commissioning managed by the independent commissioning provider, with the simple system commissioning work primarily conducted by the performance contractor, as described above and as listed in Table 1. In such situations, careful communication protocol is required to reduce the number of misunderstandings or disagreements as to scope and accountability. The independent commissioning provider normally will not have authority over the performance contractor, increasing the need for good communication and coordination.

Table of Guidelines

Both the management and suggested commissioning rigor by outside (non-PC contractor) parties is a function of the system or equipment type and the M&V option selected. Subsequently, this section provides guidance organized by system type and M&V type. However, it should be recognized that the M&V option selected may also be a function of the type of commissioning chosen.

In Table 1, the typical commissioning activities have been divided up into 15 tasks. Details about these tasks can be found in various commissioning guidelines (ASHRAE, 1996). With each task, the suggested scenario for managing and executing the work is provided for Simple Systems and Complex Systems and two categories of M&V: *Stipulated* (IPMVP Option A) and *Performance* (IPMVP Options B, C; D). These categorizations (Stipulated and Performance) are the authors' and are not described this way in the IPMVP. Table 1 provides a summary of guidelines for incorporating commissioning into PCs.

Table 1. Incorporating Commissioning into ESPC

Simple Systems Commissioning

Project Tasks	Simple Systems (constant load, constant operating hours; static measures: lighting efficiency, some motors, windows, insulation)	
	Stipulated (Option A)	**Performance (Option B, C; D)**
General management and overview	• Cx provided by ESCO. Detailed oversight by OTR. Use detailed specifications. • Initial contract setup needs independent review.	• Cx provided by ESCO with less oversight by OTR than Option A. • Initial contract setup needs independent review.
Scoping assessment	• Performed by ESCO • OTR needs to do walk-through	• Performed by ESCO • OTR needs to do walk-through
Investment grade audit, baseline and proposal (incl. Spot measurement) and simulation	• Performed by ESCO • ICP review the baseline & audit • ICP provide commissioning requirements for ESCO proposal	• Performed by ESCO • ICP or OTR review the baseline and audit
Contract development	• Performed by ESCO • ICP or OTR review to ensure Cx is required, and to review other issues, if needed (M&V)	• Performed by ESCO • ICP or OTR review to ensure Cx is required, and to review other issues, if needed (M&V)
Design and specification review (verify design intent, Cx, IEQ, training & O&Ms in specs)	• Performed by ICP	• Performed by OTR (or ICP)
Submittal review (match to specifications, ensure clear sequences)	• Performed by OTR (or ICP)	• Performed by OTR (or ICP)
Construction observation & installation verification	• Performed by OTR (or ICP)	• Performed by OTR (or ICP)
Pre-functional checklists and start-up	• Performed by ESCO, with spot checking by OTR (or ICP)	• Performed by ESCO, with spot checking by OTR (or ICP)
Functional testing	• Tests written and performed by ESCO; witnessed by OTR or ICP	• Tests written and performed by ESCO; witnessed by OTR (or ICP). Tests less rigorous than Option A.
Trending and datalogging for initial functional performance	• When needed, provided and analyzed by ESCO. Reviewed by OTR or ICP.	• When needed, provided and analyzed by ESCO. Review optional by OTR or ICP.
Initial spot efficiency performance testing for M&V (lighting Watts, EER, kW/ton, boiler effic.)	• If needed, performed by ESCO	• If needed, performed by ESCO
Facility staff training	• Performed by ESCO • Approved by OTR (or ICP)	• Performed by ESCO • Approved by OTR (or ICP)
O&M documentation review	• Performed by OTR (or ICP)	• Performed by OTR (or ICP)

Project Tasks	Simple Systems (constant load, constant operating hours; static measures: lighting efficiency, some motors, windows, insulation)	
	Stipulated (Option A)	**Performance (Option B, C; D)**
One year warranty period activities (optimization, outstanding punch)	• Optimization by ESCO • Punch by OTR (or ICP)	• Optimization by ESCO • Punch by OTR (or ICP)
Ongoing monitoring, M&V, IEQ, annual efficiency check, bill analysis, savings.	• Not applicable	• Data and analysis by ESCO or independent M&V contractor • Review by ICP or other consultant

Complex Systems Commissioning

Project Tasks	Complex Systems (variable load or variable operating hours: lighting schedule controls, steam traps, VFDs, occupancy sensors, VAV retrofits, boiler, chiller and packaged rooftop replacement, outside air control)	
	Stipulated (Option A)	**Performance (Option B, C; D)**
General management and overview	• Cx oversight provided by ICP. ESCO or ICP do bulk of work. More detailed oversight by ICP, than with Options B; C.	• Cx oversight provided by ICP. ESCO or ICP do bulk of work.
Scoping assessment	• Performed by ESCO • ICP needs to do walk-through	• Performed by ESCO • ICP needs to do walk-through
Investment grade audit, baseline and proposal (incl. spot measurement) and simulation	• Performed by ESCO • ICP review the baseline and audit	• Performed by ESCO • ICP review the baseline and audit
Contract development	• Performed by ESCO • ICP review to ensure Cx is required, and to review other issues, if needed (M&V)	• Performed by ESCO • ICP review to ensure Cx is required, and to review other issues, if needed (M&V)
Design and specification review (verify design intent, Cx, IEQ, training & O&Ms in specs)	• Performed by ICP	• Performed by ICP
Submittal review (match to specifications, ensure clear sequences)	• Performed by ICP	• Performed by ICP
Construction observation & installation verification	• Performed by ICP	• Performed by ICP
Pre-functional checklists and start-up	• Performed by ESCO, with spot checking by ICP (or OTR)	• Performed by ESCO, with spot checks by ICP (or OTR)
Functional testing	• Tests written by ICP (or ESCO); approved by ICP. Execution by ICP (or ESCO); approved by ICP. If ESCO executes, ICP witnesses, as needed.	• Tests written by ICP (or ESCO); approved by ICP. Execution by ICP (or ESCO); approved by ICP. If ESCO executes, ICP witnesses, as needed. Less rigorous than Option A.

	Complex Systems (variable load or variable operating hours: lighting schedule controls, steam traps, VFDs, occupancy sensors, VAV retrofits, boiler, chiller and packaged rooftop replacement, outside air control)	
Project Tasks	**Stipulated (Option A)**	**Performance (Option B, C; D)**
Trending and datalogging for initial functional performance	• Data provided by ESCO. Analysis by ESCO (or ICP); approved by ICP.	• Data provided by ESCO. Analysis by ESCO(or ICP); approved by ICP. Less rigorous than Option A.
Initial spot efficiency performance testing for M&V (lighting Watts, EER, kW/ton, boiler effic.)	• Tests written by ICP (or ESCO); approved by ICP. Execution by ICP (or ESCO); approved by ICP. If ESCO executes, ICP witnesses, as needed.	• Tests written by ICP (or ESCO); approved by ICP. Execution by ICP (or ESCO); approved by ICP. If ESCO executes, ICP witnesses, as needed.
Facility staff training	• Performed by ESCO • Approved by ICP	• Performed by ESCO • Approved by ICP
O&M documentation review	• Performed by OTR (or ICP)	• Performed by OTR (or ICP)
One year warranty period activities (optimization, outstanding punch)	• Optimization by ESCO • Punch by OTR (or ICP)	• Optimization by ESCO • Punch by OTR (or ICP)
Ongoing monitoring, M&V, IEQ, annual efficiency check, bill analysis, savings.	• Not applicable	• Data and analysis by ESCO or independent M&V contractor • Review by ICP or other consultant

Cx = commissioning, **ESCO =** energy services company (performance contractor), **IAQ** = indoor air quality, **ICP =** independent commissioning provider (ideally hired by the Owner, otherwise another commissioning firm hired by the ESCO, approved by the Owner with parallel reporting to owner and contractor of all findings), **OTR =** owner's technical representative. May or may not be on the owner's staff. This person need not have extensive engineering skills, but does need to have technical skills and understanding of the technologies being considered and an understanding of M&V, **VAV** = variable air volume, **VFD** =variable frequency drive.

Summary and Conclusions

Systematic quality assurance procedures are good business practice for inclusion in performance contract projects for both the performance contractors and owners. Commissioning, as a quality assurance process will result in better customer satisfaction, more referrals, fewer callbacks and improved energy performance and payments—all contributing to greater profitability for the contractor and owner. Commissioning is a recommended component of all performance contracts by the IPMVP. In traditional projects without a performance contract, commissioning has most often been performed by a party independent from the contractor. Though this preferred "independent" scenario may be difficult to always achieve, other acceptable scenarios exist where the commissioning provider is under contract to the performance contractor with conflict of interest management procedures in place.

Project scenarios using stipulated savings M&V with simple systems require the least rigorous commissioning and are recommended to be commissioned by the performance contractor with approval and oversight by the owner's technical representative. For a given simple measure or system, using more rigorous M&V, generally, less commissioning oversight by the owner is needed. For a given complex system, especially when savings are

stipulated, commissioning should be conducted by an independent commissioning provider, when possible. When this is not possible, requiring the performance contractor to contract with an owner-selected or at minimum owner-approved commissioning provider is recommended. In these cases, reporting of all findings of the commissioning provider should be done directly to both the owner and the contractor.

References

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[IPMVP] International Performance Measurement and Verification Protocol, December 1997. Site visited http://www.ipmvp.org.

[IPMVP] International Performance Measurement and Verification Protocol, 1999, Appendix. *Indoor Environmental Quality: Introduction, Linkage to Energy Conservation, and Measurement and Verification.* This was intended to be an appendix to the 1999 IPMVP which has not been released, as yet. The appendix is found on the IPMVP website above.