

RESEARCH TOPIC ACCEPTANCE REQUEST

TITLE:

Costs and Benefits of Building Commissioning

TC/TG:

TC 9.9 Building Commissioning

Research Category:

Operation and Maintenance Tools, (High-Risk, Innovative and Emerging Technologies)

Research Classification:

Basic and Applied

TC/TG Priority:

1

Other Interested TC/TGs:

TC 1.8 (Owning and Operating Costs)

Possible Co-funding Organizations:

NYSERDA, BOMA, USGBC

Estimated Cost:

N/A

Handbook Chapters to be Affected By Results of this Project:

Applications Handbook Chapters on Building Commissioning, and on Owning and Operating Costs

State-of-the-Art (Background):

Building commissioning saves significant amounts of energy in new commercial buildings. This finding has been reported time and again in the technical literature, and is well accepted by those in the industry. However, this has not been demonstrated in a way

that is persuasive to building owners, and there have been no broad and definitive studies that attempt to provide statistical rigor to addressing this question.

It has been documented in multiple studies that the lack of information on the value of commissioning has been the primary factor that has kept building owners from choosing to have their buildings commissioned. The fact that commissioning is not a standard practice today is resulting in millions of dollars wasted in energy and maintenance costs. By removing barriers to commissioning for the most significant circumstances, ASHRAE will help its members to increase the use of this practice in the most beneficial cases.

Advancement to the State-of-the-Art (Justification):

Because there is such a lack of information on the benefits of commissioning, there is a need for ASHRAE-sponsored research to provide this hard information. There are three possible approaches to determining the costs and benefits from commissioning.

- *Before-and-after study.* A baseline is established before commissioning, and the effects of commissioning can be estimated from the improvement in performance after the commissioning. It is not possible to engage in this type of research for commissioning of new buildings, because no baseline is available.
- *Controlled side-by-side study.* Two similar facilities are studied in detail: one that has been commissioned, and another that has not. The difference in performance can be attributed to commissioning only if there are no other differences between the buildings. In practice, this is almost impossible to achieve because even very similar buildings can have significant differences, making it impossible to estimate commissioning benefits. Even if one could conduct such a carefully controlled experiment, the ability to generalize its results to the broader population of buildings is limited.
- *Large sample study.* A large number of buildings are surveyed, and any statistically significant difference between commissioned and uncommissioned buildings' performance can be attributed to commissioning. Since there are so many other differences between buildings that affect performance, it may be difficult to discern commissioning savings from other differences. This problem can be minimized by attempting to collect other information that may explain differences in performance. However, the more variables one uses to explain commissioning benefits and other unrelated savings, the larger the sample size that is needed to collect statistically significant data representing a broad array of building types.

While all three methods have distinct drawbacks, the third is the only method that will provide the information that is so sorely needed, and it is the approach that is proposed for this project. This project will identify the most appropriate variables to collect, conduct a statistical evaluation in order to establish the most appropriate sample size, and design a survey instrument to collect the necessary data. Since it would be a massive undertaking to attempt to collect this data from a sample of all US buildings, the contractors will select one of the most important sub-sectors. For this population, the

contractor will conduct a survey to collect the necessary data from an appropriate sample of buildings, and report on the nature and magnitude of savings that can be discerned from the data with statistical significance. Not only will this data collection activity provide data on the costs and benefits of commissioning for one subsector, but it will provide a test of the survey instrument and process, and fold that feedback into a final version of the instrument.

With the preliminary statistical analysis and tested survey instrument completed, it is anticipated that a future phase of research will be able to build upon this study by tackling a much larger number of additional subsectors, to provide more broadly applicable information on commissioning costs and benefits.

Justification and Value to ASHRAE

Since many ASHRAE members are involved in one way or another with commissioning, it would be a great benefit to them to have information to share with their clients regarding its value. This project will provide concrete statistical information on the costs and benefits of commissioning in one important building subsector, and will provide the basis for data collection for other subsectors in subsequent phases of research (to be funded by ASHRAE or others). By identifying the most significant and measurable variables to collect, it will influence research done by others, to ensure that comparable data are collected. The list of variables to collect could be incorporated into an ASHRAE guideline for measurement of costs and benefits of commissioning, and published in the ASHRAE handbook chapter on building commissioning.

Objective:

The objectives of this research project are:

- Conduct interviews and literature review to determine the need for information on costs and benefits of commissioning, including why this information is needed, which party is in need of this information, what level of certainty is required, in what format this information would be most useful, and in which sectors is this information most needed.
- Identify and analyze data that have already been collected across the country on commissioning activities, costs, and impacts in order to begin to understand the type of data that have been collected, the range and nature of reported costs and commissioning impacts, and the variables that might be significant in evaluating costs and benefits.
- Evaluate the most appropriate (significant and measurable) variables to serve as:
 - stratification variables (e.g., building type, ownership, geographical region);
 - proxies for costs and benefits (e.g., energy costs, O&M costs, construction costs, design costs, complaint calls, call backs, occurrence of certain types of problems);

- explanatory of savings (e.g., type of construction, stage of the building when commissioning was done, type of system); or
- confounding savings (e.g., existence of a data center or electric heat, weekly operating hours, other energy conservation measures).

Of course, the larger the number of variables that are included in a statistical model, the larger the sample size needed to represent a broad array of subsectors. The contractor will recommend the most appropriate balance between including important variables and keeping the sample sizes manageable.

- Establish the stratified sample sizes needed to report costs and benefits from commissioning with a stated level of significance and uncertainty. This could include reviewing datasets such as CBECS to identify the expected variation in owning and operating costs for the population by sector, building type, major equipment types, or other explanatory or confounding variables. The result will be a matrix showing the possible variables for stratification, the variation in population energy-use intensities (EUIs) within each of these cells, and the sample size required to discern the effects of commissioning. For example, one cell might represent privately owned office buildings in the northwest with central systems, electric heat, a full time energy manager, and no data center.
- Review these results with the Project Monitoring Subcommittee to evaluate whether a statistically significant survey is feasible, before continuing with the remainder of the project.
- Create a survey instrument to collect the necessary data from each site. This must include consideration of the most appropriate wording to use, and must balance the need for detailed information with the limited time that any individual will be able to spend on completing the survey. The contractor will also create any other process specification necessary to clearly communicate how the survey is to be conducted.
- Identify one cell in the matrix defined earlier which is most important (importance established in the first task). Collect data from the required number of buildings using the instrument defined in the previous task. Report on commissioning costs and benefits for this stratified sample.
- Evaluate the process of collecting the data, the appropriateness of the variables collected for identifying savings and costs, and the survey format. Make any necessary improvements.