

## RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR)

**Title:** Utilization of Random Sampling Techniques in Performing Building Commissioning

**Research Category:** Operation and Maintenance Tools

**Research Classification:** Applied

**TC/TG Priority:**

**Estimated Cost:** \$75,000

**Other Interested TC/TGs:** 1.7, 1.8

**Possible Co-Funding Organizations:**

**Handbook Chapters and Guidelines to be Affected by Results of this Project:**

HVAC Applications Chapter 42 “Building Commissioning”

ASHRAE Guideline 0-2005

ASHRAE Guideline 1-1996

### **State-of-the-Art (Background):**

Some commissioning providers use random statistical sampling techniques in order to reduce the costs of commissioning—with the understanding that the intent of commissioning is to confirm the quality of the building *process*, not of every component in the building. Others feel that owners expect that the building will be working correctly after commissioning, which requires review and testing of every component. Most, however, practice something in between: essentially a weighted random sampling technique that takes into account the criticality of the components and their likelihood of failure, as well as the cost of testing.

The justifications for these approaches are often based either on theory or expediency, neither of which is likely to result in the best approach. ASHRAE Guidelines 0 and 1 provide recommended sampling rates for XXX, but no justification for these numbers based on solid data.

### **Advancement to the State-of-the-Art:**

There is a need for research to identify the costs and benefits of these techniques as well as the best application of these techniques—in what situations should they be used or not used, and how. There is also a need for tools to support decision making between the commissioning provider and the building owner, to select the appropriate sampling method during each phase of the commissioning project, to provide an acceptable remaining risk of failure at an acceptable cost.

### **Justification of Value to ASHRAE:**

One of the biggest barriers to the uptake of commissioning is the high cost—or perceived high cost—of the process. Owners are often interested in engaging in a quality assurance process, but want to do so at a minimum cost. On the other hand, most commissioning processes that appear in ASHRAE guidelines and elsewhere are complete, ideal processes, and there is no guidance on how to short-cut the process and still achieve acceptable results. Commissioning agents are then faced with attempting to provide the best service they can at a minimum cost, without the firm basis for determining the best approach.

**Objective:**

The objectives of this project are to:

- survey the use of sampling techniques used in the building industry—e.g., concrete, steel, building enclosures, etc.—as well as the sampling rates utilized by other industries—e.g., pharmaceutical, modular buildings, etc. develop a tool for commissioning providers to use with owners to help them determine the required sampling rates for a particular project, weighing the cost against the risk of failure,
- develop a model that uses statistical techniques to estimate the probability of failure of a particular system or component, given an estimated failure rate without commissioning, and the sample rate used for the testing during different phases of the commissioning process,
- develop a set of estimated failure rates that are suitable for use right away for several key systems or components,
- apply the tool to develop recommended sampling rates or weights to use for several key systems or components in different applications, and
- develop a research roadmap to develop additional input assumptions to expand the breadth of applicability of the tool.

While the statistical model and optimization are expected to be straightforward, the input assumptions (estimated failure rates with and without commissioning) are not. There are several different approaches to developing inputs that will be provided for by the ASHRAE Research contractor:

- made by the user (commissioning provider and the owner),
- provided by the contractor, based on a methods such as literature search, interviews, and engineering judgment, and
- provided by the contractor, based on evaluation field data collection from real building and commissioning projects.

The contractor will develop the statistical model, and an initial set of input assumptions or data, for three different systems or components (chosen to address some of the most important failures, and most common targets for sampling). It is expected that about 75% of the assumptions will be based on literature, interviews, and engineering judgment, and 25% will be based on field data collection.