

# Maintenance Utilization in Retro Commissioning

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## Synopsis

Commissioning and retro commissioning have both been shown to be cost effective measures to implement in any building. One of the areas often neglected in the commissioning process is the use of onsite personnel or the inclusion of people that will be responsible for the building after it is commissioned. Whether this is a small or a large organization, with new construction or during a remodel there are advantages for utilizing them. Maintaining the quality that is received during the commissioning project is important. In order to do so, the people that will be responsible for the building after it is commissioned need to be an integral part of the project. This paper summarizes the benefits to the commissioning agent, contractors and the building owner for including the maintenance organization. It discusses the roles of the maintenance personnel in the commissioning process, how they may best assist and what benefits they will receive. A brief discussion on the importance of documenting the systems, maintenance's role in recording and how this applies to the persistence and best operation of the building and systems, is included.

## About the Author

Al Turnbull is an employee of The Boeing Company in Seattle, Washington. He has worked for over 18 years in the Plant Engineering Department of the Facilities Division. During this time he has been responsible for design, programming, training, acceptance of, and in the commissioning of buildings and systems.

Prior to his employment with Boeing he worked for several years for a leading controls manufacturer where he was responsible for design, installation, service and training of site personnel. He has been involved in private, institutional, commercial, and government projects.

## Introduction

“... commissioning of existing buildings -also known as retro commissioning-... goes beyond the quick-fix solutions to systematically optimize building systems so that they operate efficiently and effectively,... it also identifies and solves problems that have developed during the building’s life”<sup>[3]</sup>

There are several schools of thought on what are the best methods to use in commissioning a building. All of them are intended to ensure the proper operation of the building’s various systems. Whichever style is chosen, the “Operations and Maintenance” staff or organization will at some point be involved, even if the specifications may only call for training. However, if we are to satisfy the long term goals of the owner and increase the usefulness of commissioning, we need to include the maintenance and operations personnel or their organization(s) to a much greater extent. There are many benefits to the building owner and his staff beyond the successful completion of a commissioning project. The agent needs to be able to identify, quantify and demonstrate these to the owner. Sustaining the quality received during commissioning is an important aspect of any project. In order to do so, the people that will be responsible for the building after it is commissioned should be included as part of the process.

You will also find many benefits for the commissioning agent by including the maintenance organization during the retro commissioning of the building or systems. Whether this 'group' happens to be a single individual or part of a large team, there are many areas where they can be involved in the project. To successfully do so, the commissioning agent and owner must be able to explain their own roles as well as define the roles of the O & M personnel. As owners or vendors we need to be aware of their expertise, their backgrounds and training, and be conscious of the assumptions the O & M group may be working under. We need ways to help convey the design intent to the people that work in the field, and methods to explain how they may best assist. In addition, the provider should be able to explain and demonstrate the benefits that affect the O & M staff and how this applies to the persistence of savings and best operation of the building.

## Dollars and Sense

*“There are material differences between our results for existing buildings and new construction. This can be seen in the “bottom-line” results per unit floor area – a six-fold greater median energy savings and four-fold lower commissioning costs for existing buildings”<sup>[1]</sup>*

This quote came from a meta-analysis of building commissioning conducted for the U. S. Department of Energy by a group of authors from Lawrence Berkeley National Laboratory, Portland Energy Conservation Inc. and the Energy System Laboratory, Texas A & M University. The study examined 175 projects that included 224 buildings, located in 21 different states. Of the total count in the study, 150 of the buildings existed prior to undergoing commissioning, and thus went through a retro commissioning effort.

The key findings in this study were that, while the commissioning process in new buildings was cost effective, the payback periods for retro commissioning were substantially less. The analysis demonstrated the economic benefit of doing a retro commissioning project because of the reduction in energy usage and a project could be justified on that basis alone.

However, they went on to say, “Perhaps the largest caveat in any cost-benefit analysis for commissioning is that energy savings are only one of many quantifiable and non-quantifiable impacts... Non-energy (NEIs) impacts include: changes in maintenance costs, changes in equipment lifetime, improved productivity... and improved indoor air quality.” and “In cases where NEIs have been estimated, they are significant – often more so than energy savings.”<sup>[1]</sup>

For existing buildings, it was found from the analysis that the prevalence of measures were done to correct deficiencies in the area of “operations and control”. For new buildings, approximately 2/3 of the deficiencies noted were related to the overall HVAC system ...and the deficiencies found exceeded those in existing buildings by a factor of six.<sup>[1]</sup>

Also the analysis found that: electricity savings were more ‘shallow’ and were most likely to persist. Heating and cooling systems had ‘deeper’ savings, but were least likely to persist. In one study, they found most of the increase in energy use was caused by equipment failure or operator changes because of other problems that did not adversely affect the building comfort.<sup>[1]</sup>

The implications from this are the areas that may change the quickest, or have the most effect, are in places where the operations or maintenance personnel have the most impact. It is important to point out that when changes are made in the operation of a building, it is typically done to correct some other, less obvious, problem. And that the types of deficiencies found in buildings that had not been previously commissioned were less in the spots that maintenance personnel would have typically made adjustments or initiated repairs. It is important to remember the type of problems found were typically not a direct result of lack of maintenance, but of the overall operation of the systems or changes “that did not adversely affect the building comfort”.<sup>[1]</sup>

Other studies as well as this analysis indicate typical three to four year persistence from the items that were implemented during the project(s). In cases where there is an adequate maintenance routine the savings were most often extended.

An additional factor to remember that can be stressed to the owner is that in cases where the O & M staff is actively involved in the process, they will look for other opportunities. And where the process was properly executed it has “...inspired a more creative approach to building operations and maintenance that might not have previously existed.”<sup>[5]</sup> It also increases the staff members’ awareness of energy efficiency and can, if promoted properly, enlist their aid in meeting the energy or environmental goals of the company.

## Other Benefits:

### **Overall:**

Though the dollar savings demonstrated are usually related to energy, there are many other benefits. Many of these are not obvious and typically are not quantified. Often the reason for starting the retro commissioning project was not related to energy savings, but to correct some other concern in the building's operation. But since the energy savings can be estimated and tracked it becomes the justification. It is also one of the methods used to identify when a follow-up or a re-commissioning effort should take place.

In many projects, the original design intent is the target of the retro commissioning effort. Although changes in the building's function or remodels will change that goal. Also, the original design documentation may not be available or, for some other reason, may be outdated. If this is the case then the owner and the commissioning agent will need to define the specifics of what they are trying to achieve during the retro commissioning project.

### **For the O & M staff:**

If we are to effectively incorporate the use of the maintenance and operations personnel we need to be able to explain to them why they should be included, and how they may benefit from the retro commissioning effort. They may perceive this as a 'make work exercise' or see it creating additional workload. The agent should explain to the staff (and to the owner) that in order to retain the benefits over time they may have to expand the existing preventative maintenance plans or develop new ones. This may appear at first glance to add additional workload, but it has been found that incorporating changes into their routine actually *decreases* the workload.

When the project is started and the O & M staff are brought onboard, bring them in as part of the 'team' that is going to 'optimize' the building. As it was pointed out earlier; I consider it important to remind your team that in new construction the number of problems identified during commissioning of the HVAC and control systems were considerably higher than the deficiencies found in the commissioning of existing building systems. Also, many of the corrections made in a building by the operations or maintenance staff are to correct other problems, many of which may be hidden.

One of the aspects of commissioning an existing building is the knowledge of what the effects of retro commissioning on the various systems and on the overall building operation will be. Part of the process is to identify and document each of the individual systems. It is also important to document how the systems interact and how the operation of one piece of equipment will influence another. The commissioning agent should point out to the O & M personnel that part of the agent's responsibility is to help identify how the various systems operate and to document how they may interact.

“...reduced equipment breakdown was the largest perceived non-energy benefit...” “Extended equipment lifetime was reported in one-third of the cases, and improved thermal comfort in one-fifth of the cases.”<sup>[1]</sup>

These improvements in a properly operating building can result in significant dollar savings. What retro commissioning brings to the staff, with its analysis of the system and the corrections it initiates, allows staff members to concentrate on why they were hired in the first place, and frees them to fill the role of preventative maintenance agents rather than being ‘fire fighters’. As less of their time is spent on nuisance and emergency calls, more time is available for looking at the overall operation.

The training received during the different phases is often cited as one of the primary benefits from a project.<sup>[5]</sup> During construction of a new project, this is an item that is usually specified, and is provided by the various vendors or contractors. It is important there because it is the introduction to the systems and may be the first time a team member may see the equipment. It should not be discounted during retro commissioning as the O & M personnel may not know how a system is supposed to function; they might be new to the building or may never have been trained on the equipment. If it is appropriate during a retro commissioning project a vendor can be brought in to help establish how a system or item is designed to work. Training the O & M staff before the work starts or as it progresses, though it may not have been specified as part of the project, can be an added and productive benefit for the contractor and the owner’s staff. This can help in the understanding of the equipment or system and can increase the efficiency of the data collection. In cases where this training must be purchased or is well outside the original scope, a proposal can be made to the owner or his representative with the benefits pointed out.

Another benefit from maintenance participation is the ability to incorporate new troubleshooting or testing methods into their normal activities.<sup>[3]</sup> It provides them the opportunity to witness new ideas and different ways to approach a problem. In some cases they may be exposed to or be able to obtain new equipment.

A complete set of compiled documents should be provided at the end of the project. Sections of it, as they are put together, can be of help during each phase. When the manual is complete this will help the owner to maintain and operate the building correctly after the project is over. It is very important to document the operating parameters, setpoints, sequences and schedules once they are determined. These are also a challenge to maintain over time, and anything that can be done to help is appreciated. Also it is not unusual for a control or operational change to be made due to a misunderstanding of an energy management control sequence. All of these can have a major impact on the energy costs of the building.

An item that is not recognized by the maintenance personnel and should be stressed to them as well as the owner is benchmarking. Once the retro commissioning project is finished there is a point from which to determine how efficiently the building is operating and can be used to indicate when it is appropriate to inspect, investigate, or possibly recommission the building or a system.

As the team goes through the building, the information they have collected can also be used to help determine which items need replacing or upgrading. The operations and maintenance personnel can use the information to assist in determining budgets, replacement costs and capital improvements.

### **For the Vendor:**

*“The most cost effective projects have at least one in-house staff person assigned to the project.”<sup>[3]</sup>*

There are many reasons for the commissioning agent to utilize the onsite personnel. Not only does it help in demonstrating the savings over time, but can have an immediate impact on the cost of the project. The O & M staff knows the building and its systems. They know where the equipment is and they have access to all the sections of a building. There may be special procedures or protective equipment required to enter an area. The O & M staff would be familiar with and have the training and equipment to enter those areas. They have the ability to get information from other employees that the vendor may not be aware of or have access to. They know where the problems occur and where service calls are made. They may also have logs and service records that can be used to determine where to concentrate efforts or will point out problems in the system’s operation. They may have additional equipment available to them that the contractor may not. At the start of the effort the O & M staff can conduct the surveys of each system and determine what equipment may be at the end of its life and may need replacing. They also have access to supplies and parts that may be required. And as the project progresses the maintenance group can make repairs and improvements as needed.

Something that I feel is not stressed enough is the documentation. It is important to obtain as much of the original information as possible. This not only helps in locating and understanding the system, but can uncover some of the assumptions or criteria that dictated the design and determined the type of equipment. The O & M staff may be able assist the provider in obtaining or locating the needed information. Many times they have sources that are separate from the building files. Or they may have copies of the original documentation where the originals have been removed or destroyed. The team can also be enlisted to help in compiling information about the equipment. It may be possible for them to chase down the data sheets and manuals for the various parts of the systems. They can also collect all the name plate data and help with field measurements. As they assist in the process they will also be documenting it for themselves. Quite often the information compiled is new and contains additional information about the system and building. Complete information not only helps the vendor, but is important for operations as well as for maintenance.

## **Teamwork**

In order to effectively use the operations and maintenance group they need to feel they have a reason to be working on the project. Remember they are being brought in as part of a team. This point as well as the benefits mentioned earlier can be stressed. We need to assure them that this is not a fault finding mission but a method to improve the operation of a building. Emphasize

the fact that this is a cost effective approach to increasing efficiency, lowering energy bills, and improving working conditions.

Any team needs clear definitions of the goals they are trying to achieve. They also need clearly defined roles for each of its members. During the planning phase, determine what each group is going to do and when the team is formed explain what it is they are expected to accomplish and how it was planned. Establish lines of communication and then be sure they are used and maintained. Have the team help to decide where the best opportunities lie and then assign responsibilities based on those recommendations. During the investigation have them help to develop the list of points to measured and their priorities.

Be sure to remind them that in retro commissioning the main emphasis is on improving and optimization and not a justification for capital improvements or adding new technology, though these may be some of the outcomes.

Develop an honest relationship. Explain to them what information is important and why. Keep them informed at each step. Don't place them in a position where they may not be willing to bring up the history of the equipment. They are a valuable resource, and have a great deal of information that will help make the project a success.

Additionally there is another area where the 'team members' can be of benefit to each other. We each bring individual ideas, different training, unique knowledge and additional resources to any task. These items can enhance the overall project by presenting a different approach or method that may not have been considered.

And at the hand off of the project go over the recommendations and show them how to sustain the improvements.

Most of what has been presented in the paper is written around having an onsite O & M organization. Some of the items mentioned are not presented well for the owners that may contract out for maintenance. In those cases where the systems are under service contract it would be appropriate to bring in the vendor for a few hours to go over the systems and discuss the service calls or work orders. Having the owner hire them for the day can be a cost effective approach to understanding the systems and increasing the commissioning agent's efficiency.

## **Conclusions**

Studies of retro commissioning projects have demonstrated energy saving paybacks ranging from a few months to a few years, always well within the normal persistence of the measures implemented, and typically have exceeded the potential savings estimated at the beginning of the effort. For the savings to continue it is important to realize the impact maintenance and operations has on the proper functioning of the buildings systems. Bringing that group in early on in the project and having them actively involved will help them as well as the building owner. In addition they can supply quite a bit of direct support for the commissioning agent. And the best benefit for a commissioning agent is a successfully completed project.

Consider the benefits of retro commissioning:

- Energy savings of 5% to 20%
- Paybacks under two years
- Lower operating costs
- Increased building value

And the benefits of improved O & M practices as a result:

- Extended equipment life
- Healthier work environments
- Improved building comfort
- Maintenance training
- Better documentation
- Operations improvements

In addition to the above list there is the overall awareness of how the systems affect the building and its occupants and what the maintenance and operations importance is in a properly operating building.

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