Green Dorms:
Lessons Learned from Commissioning
LEED Certified Campus Housing

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Synopsis

An increasing number of private and public universities are adopting USGBC LEED®-NC certification as policy for all new campus construction projects. Increasing student enrollments are also creating housing shortages on many of the same university campuses. The result is a growing number of new campus student housing projects pursuing LEED-NC certification – each of which requires fundamental building systems commissioning to meet a LEED-NC prerequisite.

CTG Energetics, Inc. has completed or is the process of providing commissioning and LEED consulting services for seven campus housing projects at six different private and public universities in California. This paper discusses our experience with commissioning of campus housing projects pursuing LEED-NC certification.

In our experience LEED campus housing presents unique commissioning challenges including:

- Lean project budgets;
- Hard project deadlines;
- Unsophisticated and repeated building systems;
- Integration of building systems with campus chilled and hot water loops;
- Integration of building systems controls with campus controls systems;

The paper will provide lessons learned to assist other commissioning providers as well as college and university officials in implementing successful commissioning processes for student housing projects pursuing LEED certification.

About the Author

Erik Ring, PE, is the Managing Director at CTG Energetics, Inc., an Irvine, CA consulting firm specializing in sustainability, LEED certification, energy analysis, and commissioning services for a variety of building projects. Mr. Ring's experience includes consulting, commissioning, and design for numerous projects involving high performance MEP and renewable energy systems. In addition to managing CTG's commissioning and energy services consulting team, Mr. Ring is a LEED Accredited Professional, a member of the LEED Energy & Atmosphere Technical Advisory Group and a former board member of the USGBC Los Angeles Chapter.

Introduction: The Demand for Green Student Housing

Student enrollment at colleges and universities across the United States continues to swell and is projected to skyrocket over the next several years. Many institutions of higher education are adding new campus housing, renovating existing housing, or replacing outdated dormitories in order to meet the demands of rising enrollments. Newer student housing projects tend to be filled with amenities such as kitchens, study rooms, "living/learning" communities, extensive information technology infrastructure, an emphasis on single rooms and privacy, and a focus on safety and security. New construction and renovation of student housing has accounting for approximately 17% of the $80 billion spent by American colleges and universities on construction projects from 2000 to 2004[1].

Many colleges and universities are also putting an emphasis on "going green" with all of their capital improvement projects, including campus housing. Increasing awareness of and demand for green building practices has lead to numerous "green" student housing projects. Over the last several years numerous colleges have built "eco-dorms" that put an emphasis on resource efficiency and healthy living, while catering to environmentally conscious students. Many of these projects have achieved (or are planning on achieving) certification under the US Green Building Council's Leadership in Energy and Environment Design for New Construction (LEED-NC) which includes "Fundamental Building Systems Commissioning" as a requirement[2].

Since LEED-NC was released in March 2000, approximately 200 colleges and universities have joined the US Green Building Council and many have set LEED-NC certification as a campus standard for all new construction. As of February 2006, colleges and universities who have completed LEED-NC certified student housing projects[3], include:

- Carnegie Mellon University
- Duke University
- Furman University
- Harvard University
- Harvey Mudd College
- Lewis & Clark College
- Portland State University
- University of South Carolina

Since LEED registered projects (those somewhere in the process of planning design and construction) currently outnumber LEED certified projects approximately 4 to 1, it is reasonable to predict that dozens of new campus housing projects are currently being designed and constructed to meet LEED-NC criteria.

Campus student housing projects have unique traits that present challenges for campus administrators, facilities staff, designers, builders, and commissioning authorities working together to produce LEED-NC certified projects. Over the last two years, CTG has completed commissioning and/or LEED consulting services for seven campus housing projects at six

different private and public colleges and universities, all located in California. This paper discusses our experience with commissioning campus housing projects pursuing LEED certification and the unique challenges associated with commissioning this building type.

Unique Challenges to Commissioning LEED Student Housing

1. Lean Project Budgets

Although the quality of campus student housing is generally improving with an emphasis on providing residents with increased amenities, privacy, and security, at many institutions new student housing must compete financially with off-campus market rate housing. New student housing projects must also compete for funding with other campus capital improvement projects, such as adding new classrooms and labs, which may be viewed as more central to the mission of institution. Further, student housing is notoriously abused by its (young, transient, and often fun-loving) residents. Campus administrators are reticent to overspend on campus housing facilities that will likely require significant renovation in only 5 to 10 years.

As a result of these and other factors, campus housing projects are typically built on somewhat lean project budgets. Since 2000, construction budgets for campus housing have averaged $114 to $150/sf[4], which is typical of apartment construction[5] but does not afford exorbitant consulting fees, premium materials, or complicated systems.

A lean project budget coupled with ambitious LEED goals may complicate a commissioning agent's role in the project. First the commissioning authority's fee is likely to be scrutinized and negotiated more carefully for a $10M campus housing project (the average size of a campus housing project in 2004) than for a $100M research laboratory facility. Explicitly defining the scope of services requested of the commissioning authority (along with associated the fee), and what if any commissioning activities can be performed by the campus facilities staff, is an important first step in developing a successful commissioning process.

The design and construction teams are often contending with their own fee and budget limitations and may not feel that they are able to devote additional effort to supporting commissioning. Often designers and builders of campus student housing are experienced and well-versed in building this type of construction and may have designed and built other housing projects for the university, but have never had to contend with LEED requirements including commissioning.

Finally, many campus housing projects employ a design-build process for the mechanical, electrical, and plumbing systems, as a way to keep costs in check. In our experience, a design-build process, with the installing contractor also serving as the designer, will generally yield less design documentation and less thorough construction submittals than a design-bid-build process. This further complicates the commissioning authority's role of ensuring that the installed systems meet the Owner's Project Requirements and the Design Intent, as prepared by the design team.

2. Hard Project Deadlines

For most new building construction projects on a college or university campus, the academic calendar will dictate project start and completion dates. For campus housing, the student housing department will typically reserve rooms and collect deposits from students months in advance of the beginning of a new academic term. Student housing construction projects do not have the luxury, therefore, to deliver the finished building to the campus late, even by a week or a day, since the campus has made housing commitments to dozens or hundreds of students. Colleges and universities generally do not or can not have contingency plans for where to house students if the construction is delayed, and often include significant contractor penalties for late delivery of a student housing project.

If the construction process for a student housing project is scheduled appropriately to include adequate time for commissioning and if there are no significant delays, then the hard deadline of an impending academic year should not pose a challenge for building commissioning. In the real world, however, many construction projects operate on tight schedules where even minor delays can result in a significant effort to finish and deliver the building on time (and avoid contractor penalties). If the building is barely finished (or not quite finished) in time for students to move in on a pre-planned date, the ability to perform a thorough commissioning inspections and testing can be compromised. Generally it is inconvenient at best (or impossible at worst) to enter a student room in order to test the systems serving that room once that room has been occupied. And unlike classroom buildings or administrative offices, there are no "off-hours" to perform testing without inconveniencing occupants in a student housing building.

Commissioning inspections and testing for campus housing projects generally has a narrow window between substantial completion and occupancy. For best success, campus staff, construction teams, and commissioning agents must work closely to coordinate and schedule commissioning activities on campus housing projects. Any systems that require testing or inspections in the student rooms and restrooms should be evaluated first. Systems located in mechanical rooms, central plants, and common areas can be inspected even after occupancy with far less intrusion and inconvenience to the student residents.

3. Unsophisticated and Repeated Building Systems;

The systems to be commissioned in a student housing project, even a project pursuing green building goals and LEED certification, are generally unsophisticated with relatively few modes of operation and little in the way of field mounted controls and accessories. The relative simplicity of the building MEP systems in student housing is related to the building type but can also be tied to the lean project budgets discussed earlier.

Student housing tends to include interior lighting with manual switches only, as scheduled lighting controls, occupancy sensors, and automated dimming systems are all inappropriate for a residential setting. Exterior lighting systems are generally controlled by time clocks or photocell controllers. HVAC systems tend to be small distributed systems such as fan coil units, split system DX units, or even PTAC units. We have commissioned three student housing projects in coastal areas of Southern California that included heating systems but no mechanical cooling.

Operable windows (natural ventilation) are a given for the student housing projects we have commissioned in California, and forced mechanical ventilation is uncommon. Ceiling-mounted restroom exhaust fans controlled via wall switches are typical. Domestic hot water systems in student housing are large in capacity but otherwise simple in operation and controls. Only one of seven LEED student housing projects that we have consulted to has included a rooftop photovoltaic system, and none of pursued solar water heating solutions or other on-site generation strategies.

The commissioning inspections and testing appropriate for four-pipe fan coil units, ceiling mounted exhaust fans, residential kitchen hoods, manual lighting controls, and other systems typically found in student housing are not as involved as sophisticated lighting controls, chilled water plants, or air handling units found in other campus LEED buildings. To some degree this changes the nature of commissioning from a highly technical exercise to a coordination and quality control exercise – insuring that many simple systems are designed and installed correctly rather than evaluating the operation a few complex systems.

Further, the MEP systems in student housing projects are typically repeated, housing unit-by-housing unit. This leads to a lot of repetition in the inspection and testing protocols. The repetition of common systems also means that for any deficiency it is important for the commissioning authority to assess whether the issue is unique to that particular installation or common for every housing unit.

4. Integration of building systems with campus central chilled and hot water loops;

Where the campus has central chilled water and/or hot water distribution, new student housing may be connected to the campus central plant for space heating, space cooling, and domestic water heating. This makes campus housing somewhat unique from other multi-family housing projects, which are unlikely to use chilled and hot water for heating and cooling. The interconnection between the campus chilled and hot water loops and the student housing project is a key area where commissioning can help to maintain quality control of the building mechanical and domestic hot water systems.

In our experience the design team will necessarily look to the campus for operating conditions of the campus chilled and hot water loops, and design standards for the point-of-connection between the building and the campus loops. In addition to setting design temperatures and hours of availability, the campus facilities staff often has distinct opinions on the types of heat exchangers, control valves, piping, etc. that should be connected to the campus central loop.

Unfortunately, campus facilities staff are often “out of the loop” in the early stage of design, where the architect and engineers may be working only with campus housing administrators. The commissioning authority can play a critical role in facilitating communication of campus design standards to the design team (as part of the Owner’s Project Requirements) and reviewing the progress of the design to make sure that the interconnections with the campus chilled and hot water loops meet the design intent.

Finally the boundaries for the scope-of-work for the connection of the housing project to the campus chilled and hot water loops must be explicitly understood between all parties. Often the campus facilities staff will have preferred contractors for any expansion or connection to the campus hot and chilled water loops and will want this work performed separately from the general project mechanical, plumbing and piping installation. Again the commissioning authority should play a coordination role in insuring that the campus, the design team, and the contractors have a clear understanding in who will implement each aspect of the final system.

5. Integration of building systems controls with campus controls systems and occupant control;

Most colleges and universities have distributed digital controls (DDC) standards and protocols for the entire campus building stock. Campuses typically require that all new construction projects will implement the preferred controls system and integrate that system with the larger campus controls system. DDC control further differentiates university student housing from other types of multi-family housing, which typically include local controls only. We have experienced numerous complications, however, in applying campus standard DDC control systems to student housing projects, which can affect the commissioning process.

First, due to the simplicity of the systems typical found in student housing, networked DDC controls are often overly-complex and prohibitively expensive. Projects may initially consider but eventually balk at providing networked DDC controllers for dozens (or hundreds) of fan coil units and restroom exhaust fans serving student housing. There is generally limited value, but significant expense, to installing full DDC control at every possible MEP system included a student housing project.

Further, housing projects inherently require manual control and occupant override of HVAC and lighting controls that may be uncommon in other campus buildings. For example, in a classroom building the campus facilities staff will likely schedule the HVAC systems and dictate room temperature setpoints, via the campus DDC system, with little or no occupant override capability. In student housing, however, HVAC, lighting, and domestic hot water must be available at all times, and occupants will expect some degree of manual control over the lighting and HVAC system settings.

We have seen examples of campus facilities staff applying “campus standard” controls, sequences of operation, and setpoints to student housing – neglecting unique needs of student housing. For example, split-system HVAC unit in a student apartment where the campus standard temperature sensor and controller allow occupants to adjust the room temperature setpoint over a fixed range, but not to turn the unit on and off. This resulted in (energy conscious) students complaining that even on pleasant days when they would like to open all the windows, there is no way to turn off the air-conditioning in their LEED certified dormitory. Balancing central campus control with occupant overrides is a key controls design issue that is often overlooked in student housing projects.

Finally, whether the DDC controls will be specified and installed by the contractor or by campus facilities staff can have significant impacts on the commissioning process. The campus facilities

staff often elects to install the DDC controls, after the contractor has completed installation of the building systems. Unfortunately in our experience, it is much more difficult to achieve good controls submittals, points lists, sequences of operation, etc., when the campus is performing their own controls installation than when a controls sub-contractor is required to submit this information as part of the specifications. Having a mechanical contractor install the equipment, with the campus installs the DDC controls at a later date, can yield coordination problems that the commissioning authority will likely be called upon to help resolve.

For example, in one student housing project, DDC controllers, installed to operate 3-ton split system heat pumps, were powered from 24v-dc transformers integral to the split system fan coil units. The factory-provided transformers, intended to power local electronic thermostats only, caused the DDC controllers to automatically reset every time the compressor firing caused a small voltage interruption. The result was dozens of networked DDC controllers in the student housing project resetting and readdressing themselves every few minutes, which resulted in significant instability across the entire campus DDC system. This was the unanticipated and unintended consequence of merging simple residential HVAC equipment with a sophisticated campus DDC control system. Both the campus and the mechanical contractor blamed one another for the problem until, through commissioning the problem was diagnoses. We recommended that new independent control power transformers be installed for the DDC controllers in the building and this solved the problem.

Conclusions: Making LEED Student Housing Work

Although LEED-NC was not developed with housing projects in mind, we have seen a rash of college and university student housing projects pursuing LEED-NC certification and anticipate that we will provide commissioning and consulting services to more of these projects in the years to come. In our experience, student housing projects (even LEED certified green student housing projects) include relative simple technical solutions but can have tricky budget, scheduling and coordination issues which impact commissioning of the building. The key to successful commissioning in student housing projects is insuring that the campus, the design team, and installing contractors have a clear understanding of the technical requirements necessary to make the building function properly, and then assisting them in coordinating and executing their responsibilities.

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[1] Based on data from *American School and University* "16th Annual Residence Hall Construction Report." June 2005.
[2] More information about USGBC and LEED can be found at http://www.usgbc.org.
[3] Based on data from http://www.usgbc.org.
[4] Based on data from *American School and University* "16th Annual Residence Hall Construction Report." June 2005.
[5] US national average, 2005, construction cost for a 4-7 story apartment building is $102 – 153/sf, per www.RSMeans.com.