



Spelman College

New Residence Hall Project No. 06193

Atlanta, Georgia 30314

FINAL REPORT

Prepared By:



AFFILIATED ENGINEERS

**3007 SW Williston Road
Gainesville, FL 32608
Telephone: 352-376-5500
Facsimile: 352-375-3479**

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Executive Summary

The Spelman College Residence Hall project consists of a 300 bed residence hall, a dining hall with a 175 seating capacity, several apartments for visiting faculty and trustees, and inside parking for 100 automobiles. Designed to compliment the other campus structures, the project also creates a new campus open space that is related to the rest of the campus and its historic quadrangle. The building utilizes campus chilled and hot water.

Spelman College has adopted the use of the commissioning (Cx) process on this construction project in order to ensure that all systems are fully functional and provide a comfortable, safe, energy efficient environment. Spelman College has utilized the services of Brookwood Program Management firm to oversee the project from the Owner's perspective. Included in the scope of Cx for this project are the mechanical, electrical and building envelope systems.

The building will be a LEED 2.2 certified building. This Cx final report addresses the fundamental building systems Cx requirements for LEED certification. The Cx provider was independent of the design team and the construction management team and provided an independent review of the Basis of Design, Design Intent and Construction Documents. The Cx requirements and documentation were integrated into the construction project in the form of a Cx specification, Cx plan, prefunctional checklists and functional performance tests. Verifying prefunctional checklists, witnessing of functional performance testing and post-occupancy facility review are all also included in the Cx scope for this project. Also included is the development of a system and energy management manual. It will be developed during the first year of occupancy.

Affiliated Engineers Inc. (AEI) and Spelman/Brookwood project managers coordinated the functional testing process with the contractor, New South Construction Company, and the sub-contractors. Substantial effort was made during the acceptance phase of the project to scheduling testing activities concurrently with the final construction tasks to minimize the impact on the final delivery date of the project. AEI provided prefunctional checklists and functional performance tests that were written to complement the design sequences of operations. The sub-contractors who were directly responsible for the installation or operation of specific elements of the project provided the manpower to demonstrate that the respective systems met the intent of the design documents and were fully functional. The design professionals provided

support so that issues which required modifications to the original design were designed and implemented.

In general, the functional testing processes produced satisfactory results for the commissioned systems. The sequences of operation for the HVAC system performed as expected and the final adjustments were made to the systems to improve component performance such as loop tuning, final calibrations, etc. Once equipment and system testing was complete, overall operation was verified by AEI and monitoring by the Building Automation System (BAS) during steady-state operation.

At the time of this report, some items still remain open and should be addressed. These items have been included in the main report along with reconciled issues and are indicated as open herein. The more significant issues included:

1. The chilled water piping design would allow low return water temperature to return to the central plant. The system was redesigned to prevent this from occurring. **This issue is closed.**
2. The hot water system would allow low return water temperature to return to the central plant. Domestic hot water heaters are provided with three way valves. The system was modified to prevent bypass of the heaters and increase the return water temperature. **This issue is closed.**

The training program was coordinated by the construction manager directly with the College's facilities management group. Likewise, operations and maintenance manuals were transmitted directly to the College.

The Cx process was successful on two major counts:

1. Many noted issues were identified and corrected during the course of the testing process. Unquestionably, many of these issues would have impacted the operation of the facility in terms of excessive energy consumption, future downtime, or life safety.
2. Opportunities were identified that should require further consideration and are summarized such that action may be taken at the appropriate time.

General Cx Process

Project Team

The entire project team was instrumental in the success of the project. The team members who had specific involvement in the “formal” Cx process were:

Owner – Spelman College

Design Professional (A/E)

Architect –Facility Design Group, Inc.

Mechanical Electrical Piping Engineer – Facility Design Group, Inc.

Program Manager

Brookwood Program Management

Builder

New South Construction Co.

Sub-contractors

- Schumate Mechanical. - Mechanical Contractor (MC)
- Fitzgerald Plumbing. - Piping/ Plumbing Contractor (PC)
- Inglett & Stubbs, Inc. - Electrical Contractor (EC)
- WJE - Test Adjust Balance Contractor (TAB)
- Siemens Building Technologies - Controls Contractor (CC)

Cx Provider (CxP)

- Mechanical Electrical Piping (MEP) – Affiliated Engineers, Inc.
- Building Envelope – Stafford Consulting Engineers

Cx Plan Summary

This section provides a general overview of the Cx process as it was proposed in the project manual. The project team embraced opportunities to improve and streamline the Cx process to the extent possible, in order to focus on delivering fully functional systems through an iterative, collaborative and efficient process.

1. Cx Plan. The Cx Plan, provided as part of the bid documents, is binding on the Contractor. The Cx plan provides guidance in the execution of the Cx process. Just after the initial Cx scoping meeting, the Cx agent (CA) will update the plan that is then considered the "final" plan, though it will continue to evolve and expand as the project progresses. The project specifications will take precedence over the Cx Plan.
2. Cx Process. The following narrative provides a brief overview of the typical Cx tasks during construction and the general order in which they occur.
3. Cx during construction begins with a scoping meeting conducted by the CA where the Cx process is reviewed with the Cx team members.
4. Additional meetings will be required, throughout construction phase, scheduled by the CA with necessary parties attending to plan, scope, coordinate, resolve problems and schedule future activities.
5. Equipment documentation is submitted to the CA during normal submittals, including detailed start-up procedures.
6. The CA works with the Subs in developing startup plans and startup documentation formats, including providing the sub-contractors with pre-functional checklists to be completed, during the startup process.
7. In general, the checkout and performance verification proceeds from simple to complex, from component level to equipment to systems and intersystem levels with pre-functional checklists being completed before functional test.
8. The Subs, under their own direction, execute and document the pre-functional checklists and perform startup and initial checkout. The CA documents that the checklists and startup were completed according to the approved plans. This may include the CA witnessing start-up of selected equipment.
9. The CA develops specific equipment and system functional performance test procedures. The Subs review the procedures.
10. The procedures are executed by the Subs, under the direction of, and documented by the CA.
11. Items of non-compliance in material, installation, performance and/or setup are corrected at the sub-contractor's expense and the systems re-tested.
12. The CA reviews the Operation and Maintenance (O&M) documentation for completeness.
13. The CA reviews, pre-approves and coordinates the training provided by the Subs and verifies that it was completed.

14. Deferred testing is conducted, as specified or required.

The mechanism for communicating issues was the “continuous punch list” maintained by the construction manager. Upon the identification of an issue, AEI provided the issue in PDF format to Brookwood who would then pursue resolution. Issue tracking was therefore extremely simple and multiple issues lists were not maintained.

Scheduling was closely coordinated between the AEI and the builders. A scheduling-meeting was held early in the project which included Spelman, Brookwood, New South, the sub-contractors and AEI. During this meeting, each of the completion activities for a system were identified and coordinated to ensure a smooth work flow between the Contractor and CA.

Because of the rapid construction schedule and quality of sub-contractors, the start-up process was executed during the completion of prefunctional checklists by the contractors independently of the Cx provider. Prefunctional checklists were subsequently back-checked prior to the functional testing process.

The project team worked to eliminate wasted time during the functional testing process to minimize the liability for retesting. When minor issues were identified during the testing process they were corrected during the course of the test. Very limited “re-testing” occurred therefore the project experienced very few delays and no additional costs as a result of reconciliation efforts of AEI, New South and sub-contractors.

Training was coordinated directly with the College and executed following the completion of system acceptance. AEI has not received training plans from the contractors and has not reviewed this information.

The systems were revisited during the opposite season and issues (if any) are included in the “Results” section of this report.

The system and energy management manual required for the LEED enhanced Cx point will be pursued following completion of all project submittals of O&M manuals.

LEED Participation

This project fulfills the requirements for LEED certification as outlined in the LEED Green Building Rating System™ Version 2.2 for Prerequisite 1: Fundamental Building Systems Cx. Documentation can be found in the appendix of this report.

Fundamental Building Systems Commissioning

	Activity/ Requirement	Status
1.	Completed Owner's Project Requirements (OPR) and Basis of Design (BOD) documentation.	Complete
2.	Incorporate Commissioning requirements into construction documents.	Complete
3.	Develop and utilize a Cx plan.	Complete
4.	Verify installation, functional performance, training and documentation.	Complete
5.	Complete a Cx report.	Complete

Enhanced Commissioning

	Activity/ Requirement	Status
1.	Complete one Cx Design Review of the OPR, BOD and design documents prior to mid-construction phase and back-check the review comments following design submission.	Complete
2.	Review submittals applicable to systems being Cx'd for compliance to OPR and BOD.	Complete
3.	System manual prepared for project.	Working
4.	Operating personnel and building occupants have been trained in operation and maintenance of the cx'd systems.	Complete
5.	Review building operations w/in 10 months after substantial completion and a plan for resolution for outstanding issues have been completed.	Working

Building Envelope

Testing of the building envelope was conducted by Stafford Consultants. The building envelope reports are included herein and can be found in the appendix.

Results

Refer to Appendix D, Functional Testing Action List, for a comprehensive listing of all the issues identified during functional performance testing.

Mechanical Systems

Campus Chilled and Heating Water Entrance System

Testing of the campus chilled and heating water systems included the following; Start / Stop of the pumps, BAS speed control through the VFD's, Pump rotation schedule, pump failure alarms, differential pressure control, pump lead / lag sequence, high temperature conditions and low differential pressure alarm.

Issues discovered during testing include:

1. Condensate leaking from chilled water piping and accumulating at the base of pump. Signs of corrosion were evident on pump frame. The leak was corrected and no longer leaks. **This issue is closed.**

Fan Coil Units

Testing of the fan coil units included operation of heating, cooling modes, occupied and unoccupied modes, static pressure control, filter monitoring, safety sensors used for control and startup and shutdown of the Fan Coil Unit.

Issues discovered during testing include:

1. The primary drain overflow on Fan Coil Units 817, 830, 836, 730, 734, 737, 710, 735, 746, 738, 748, 740, 705,725 does not drain into the secondary drain. The drains have been fixed and now drain to the secondary drain pan. **This issue is closed.**
2. Many FCU's had filters that were inaccessible or had limited accessibility due to by water piping, ceiling hangers, piping hangers, etc. AEI recommended providing adequate accessibility for filters. The Owner and Contractor have reviewed the installation and all filter access's are satisfactorily. **This issue is closed.**
3. The drain line for FCU 749 went uphill. The drain line has been fixed and now drains downhill. **This issue is closed.**

4. Hot water & chilled water pipes were resting on FP water pipes. Noted in room 639. Hot water return pipe was leaking at union down stream of valve. The pipes have been properly supported. **This issue is closed.**
5. Sensors were out of calibration noted on FCUs but not limited to: Room Temp Sensors: FCUs – 836, 639, 634, 833, 717, 648, 647, 637, 540, 523, 415, 446, 450. Discharge Air Temp Sensors: 736,747,634,833,717,610,525,540,523,550,547,543,446,439. The sensors have been replaced or calibrated. **This issue is closed.**
6. Discharge air sensor probe length is short in comparison to internally lined duct insulation. Discharge air temperature does not accurately read temp. Temperature differentials observed were over 7 F in most cases. The sensors have been corrected. **This issue is closed.**
7. When float switch was activated, chilled and hot water control valve did not return to close position. The current sequence relies on field level controller comm with room level or fan coil unit controller to close both valves. If fails valve will not close. The program has been corrected to close valves. **This issue is closed.**

Variable Air Volume Systems

Testing of the variable air volume rooms included temperature control, volume control, occupied and unoccupied modes of operation.

Issues discovered during testing include:

1. VAV box control loop was not tuned optimally. Even after several minutes air flow values did not reach set point. The loops have been tuned to reach setpoint quicker. **This issue is closed.**
2. VAV box has incremental control for heating loop. Sequence of operation calls for modulating control damper to minimum position before opening hot water valve. Control loop opened hot water valve before modulating control damper to minimum position. The program has been corrected to prevent overlap of cooling and heating. **This issue is closed.**
3. VAV – 206, 203, 202: Had high discharge air temperature. Upon further investigation Siemens found that actuator was disconnected from control valve. The actuator has been replaced and works properly. **This issue is closed.**

Air Handling System

Testing of the air handling system included operation of heating, cooling and outside air controls, static pressure control, filter monitoring, safety sensors used for control, startup and shutdown of the air handling unit (AHU). Modes tested include failure modes of the air handler and manual/automatic control of the VFD'S, Occupied and Unoccupied control.

Issues discovered during testing include:

1. RTU made excessive noise that could be heard on Level 2. The noise has been corrected by the Contractor. **This issue is closed.**
2. The static pressure loop was not functional. The loop has been corrected and functional. **This issue is closed.**
3. Due to lack of space between heating and cooling coils, freezestat was located after the cooling coil. The freezestat location may not allow for protection of cooling coil from freezing. **This issue is open.**

Energy Recovery Units

Testing of the energy recovery units included operation of heating, cooling, static pressure control, filter monitoring, safety sensors used for control, startup and shutdown of the energy recovery unit (ERU). Modes tested include failure modes of the ERU and manual/automatic control of the VFD'S, Occupied and Unoccupied control.

Issues discovered during testing include:

1. ERU-1 relief air fan trips the overload after ~1 minute. The relief fan operates correctly and does not trip. **This issue is closed.**
2. ERU-1 heat wheel has a large gap in the purge area - larger than expected. The gap has been corrected to limit leakage air. **This issue is closed.**
3. The control valves are exposed to weather and require weatherproof covers. Weatherproof covers have been added to the valves. **This issue is closed.**
4. Roof - ERU 2 chilled water leaking by roof entrance. The leak has been fixed. **This issue is closed.**
5. Roof - ERU's are noisy (possibly too much air). The units have been slowed down and noise issue has been corrected. **This issue is open.**

Mechanical and Electrical Rooms

Testing of the mechanical and electrical space ventilation system included operation of cooling controls. Modes tested include failure modes of heaters and start / stop functions.

Issues discovered during testing include:

1. Boiler Room - Control wiring for water meter was not in conduit. Wire has been placed in conduit. **This issue is open.**

Toilet/Laundry Exhaust

Testing of the toilet/laundry exhaust included operation of cooling controls. Modes tested include failure modes of the air handler and manual/automatic control of the VFD'S, Occupied and Unoccupied control.

Issues discovered during testing include:

1. Exhaust Fan EF-5 missing current switch to provide feedback to BAS. The BAS now monitors the EF. **This issue is closed.**
2. Exhaust Fan EF-5/MAU-2 can be started individually from Graphics. EF-5 and MAU- 2 are interlocked and should not have the capability to be operated individually. The program has been corrected. **This issue is closed.**

Electrical Systems

Pad Mounted Primary Transformer

Testing of the pad mounted primary transformer included closing/opening disconnects and grounding (Hi Pot) testing.

Issues discovered during testing include:

1. No major issues were discovered during testing of the system.

Primary and Secondary Line Conductors

Testing of the primary and secondary line conductors included insulation testing of the primary and secondary conductors.

Issues discovered during testing include:

1. No major issues were discovered during functional testing.

Main Service Entrance Switchboards/Digital Meters

Testing of the main service entrance switchboards and digital meters included testing all devices, resistance testing and operation of all attached devices.

Issues discovered during testing include:

1. No major issues were discovered during functional testing.

Transient Voltage Suppression System

Testing of the main service transient voltage suppression system included verifying the system was operational and breakers closed.

Issues discovered during testing include:

1. No major issues were discovered during functional testing.

Emergency Power System

Testing of the emergency power system included testing of the generator and automatic transfer switches, operation of attached devices.

Issues discovered during testing include:

1. No major issues were discovered during functional testing.

Panel Boards

Testing of the panelboards included testing all devices, insulation testing and operation of all attached devices.

Issues discovered during testing include:

1. The penetrations on rated walls needed further work. Several walls had holes above the ductwork and the walls were sealed. Many areas had electrical penetrations not completely sealed. **This issue is closed.**

Grounding System

Testing of the grounding system included ground testing of the system.

Issues discovered during testing include:

1. No major issues were discovered during testing.

Lighting Control System

Testing of the lighting control system included testing motion sensing devices and operation of lighting fixtures, included timers and overrides.

Issues discovered during testing include:

1. The light fixtures in the garage without restrikes are missing the smaller light bulbs. The lights have been installed. **This issue is closed.**

Fire Alarm System

Testing of the fire alarm system included testing all devices and operation of all attached devices.

Issues discovered during testing include:

1. Magnetic Locks did not release on doors scheduled to allow exit. The fire alarm system has been provided to release the doors. **This issue is closed.**

Security System

Testing of the security system included testing all devices and operation of all attached devices.

Issues discovered during testing include:

1. Door hardware was not fully integrated with card readers. Door hardware is now integrated properly to the card reader. **This issue is closed.**
2. 2nd and 8th floor north - PTZ cameras were offline due to communication problems. The cameras are online and work properly. **This issue is open.**
3. Door 216A - Card Access exit was not working during normal operation. **This issue is open.**
4. Door 225A - Door was missing Fire Alarm interface. **This issue is open.**
5. Not all workstation reporting descriptions matched construction documents. **This issue is open.**

Building Automation System

Testing of the Building Automation system included alarms, point to point verifications, and sequences.

Issues discovered during testing are:

1. Mechanical Room - VFDs were not connected to the BAS network. The VFD's are now integrated to the BAS. **This issue is closed.**
2. All Levels - Fan Speed for FCU's in common areas were not present on graphics (High or Med speed). Fan speed is present on graphics. **This issue is closed.**

Plumbing Systems

Domestic Water System

Testing of the domestic water systems (booster pumps, backflow, suites and laundry, kitchen) included lavatories, urinals and showers.

Issues discovered during testing include:

1. Room 508 - The kitchen hot and cold lines were piped backwards. The piping has been corrected. **This issue is closed.**
2. Room 334 – The sink and bathtub hot water valves were turned on for more than 1 minute and no hot water was received. The room now receives hot water in a timely fashion. **This issue is closed.**

Kitchen Waste

Testing of the kitchen waste systems included lavatories, urinals and showers.

Issues discovered during testing include:

1. Room 603 - Toilet did not flushing. The toilet was repaired and flushes properly. **This issue is closed.**
2. Room 302 – There was no water to the kitchen. Water has been turned on to the Kitchen. **This issue is closed.**
3. Room 719 – There was no water to the shower, bath or sink. Water has been turned on to room 719. **This issue is closed.**

Fire Protection System

Testing of the fire protection system included the fire pump, jockey pump, sprinkler system and security system integration.

Issues discovered during testing include:

1. The seventh floor sprinkler armovers in the corridor do not have support. These appear over two feet. Verify with NFPA 13 code requirements for expected floor pressure if these require support. The pipes are now properly supported. **This issue is closed.**
2. In FCU 736 room the sprinkler west of the FCU is ~4' long with no support. The sprinkler is now properly supported. **This issue is closed.**
3. Lower Levels of Buildings-Section of fire alarm system not functioning. Correct systems and verify operation. (Completed) Repair was made during visit and proper functioning of the system was observed after repair was made. **This issue is closed.**
4. Mechanical Room - Copper drain line is not isolated from dissimilar metal mount on Boiler #3. The copper line has been isolated from dissimilar metals. **This issue is closed.**

Trending

Parameters were set and trends started by the controls contractor to for evaluation of the systems as well as long-term use by the facilities management group. Trend data in graphical form was not printed but is available from the BAS system.

Air Handling Units -

Temperatures

Trending parameters: Temperature vs. Time

Trending Variables: Mixed Air Temperature and Return Air Temperature

Frequency: 24 hours / 15 minutes intervals

Frequency: 24 hours / 15 minutes intervals

Static Pressure Control

Trending parameters: Static Pressure vs. Time

Trending Variables: Static Pressure Level 2, Static Pressure Level 4, and Fan Speed

Frequency: 24 hours / 15 minutes intervals

Supply Air Temperature Control

Trending parameters: Temperature vs. Time

Trending Variables: Supply Air Temperature, Chilled Water Valve position, and Maximum Outside Air Damper position

Frequency: 24 hours / 15 minutes intervals

Reheat Temperature Control

Trending parameters: Temperature vs. Time

Trending Variables: Preheat Temperature Actual, Preheat Output, and Outside Air Temperature

Frequency: 24 hours / 15 minutes intervals

Energy Recovery Units -

Temperatures

Trending parameters: Temperature vs. Time

Trending Variables: Mixed Air Temperature and Return Air Temperature

Frequency: 24 hours / 15 minutes intervals

Frequency: 24 hours / 15 minutes intervals

Static Pressure Control

Trending parameters: Static Pressure vs. Time

Trending Variables: Static Pressure Level 2, Static Pressure Level 4,
and Fan Speed

Frequency: 24 hours / 15 minutes intervals

Supply Air Temperature Control

Trending parameters: Temperature vs. Time

Trending Variables: Supply Air Temperature, Chilled Water Valve
position, and Maximum Outside Air Damper position

Frequency: 24 hours / 15 minutes intervals

Fan Coil Units

Trending parameters: Temperature vs. Time

Trending Variables: Zone Temperature, Heating Command, and Cooling
Command

Frequency: 24 hours / 15 minutes intervals

Supply Air Terminals

Trending parameters: Temperature vs. Time

Trending Variables: Zone Temperature, Heating Command, and Cooling
Command

Frequency: 24 hours / 15 minutes intervals

Chilled Water System

Differential Pressure Control

Trending parameters: Pressure vs. Time

Trending Variables: Differential Pressure and Chilled Water Valve
position

Frequency: 24 hours / 15 minutes intervals

Temperature Control

Trending parameters: Temperature vs. Time

Trending Variables: Chilled Water Supply Temperature and Chilled
Water Return Temperature

Frequency: 24 hours / 15 minutes intervals Differential

Hot Water System

Temperature Control

Trending parameters: Temperature vs. Time

Trending Variables: hotd Water Supply Temperature and Hot Water
Return Temperature

Frequency: 24 hours / 15 minutes intervals Differential

Recommendations

The following performance enhancing recommendations should be considered to minimize troubleshooting as well as improve energy performance. The recommendations listed here are minor considerations which often define the overall success of a project as well as how it is perceived both by the users and physical plant.

1. Add logic to the building automation system which will identify poor performing reheat valves at the terminal boxes. This can be done by comparing the auxiliary temperature at the outlet of the terminal device with the control valve in the closed position to the supply air temperature of the AHU which serves it.
2. Add logic to the building automation system to reset the chilled water temperature set-point based on short-term cooling load requirements.