EXECUTIVE SUMMARY

NORESCO is pleased to present to Illinois State University this comprehensive Investment Grade Audit (IGA) for an Energy Performance Contracting Program. The primary purpose of conducting this audit per the Energy Audit Agreement (EAA) is to:

- Develop projections of energy and cost savings for potential Energy Conservation Measures (ECMs)
- Provide engineering and economic basis for negotiating an Energy Savings Agreement
- Follow the guidelines of the Public University Energy Conservation Act, 110 62

The primary scope of this audit includes improvements at Milner Library, Science Lab Building, Heating Plant and their associated Chilled Water Systems. Based on the criteria set forth by the University, the final project must self fund in aggregate in 20 years or less and each ECM must either save energy or improve the infrastructure or both while enhancing the learning environment on campus.

Despite an extremely effective operating staff at Illinois State University and multiple energy efficient upgrades throughout the facilities this audit concludes that there are still a number of Energy Conservation Measures available that will reduce energy costs while enhancing the learning environment. The savings from the Energy Conservation Measures illustrated in this audit are significant enough to fund over $8 Million dollars worth of projects using only guaranteed energy savings in under 20 years. In fact, for one specific scenario the ECMs are arranged to generate over $580,000 dollars worth of energy savings in the first year alone!

Reasons for Using ESCO Process

While there are various benefits for completing an ESCO project, the following prove to be most important to ISU and as such were presented during the July 23 Board of Trustees meeting:

- Streamlined Procurement Process / Single Source Responsibility
- Capture Energy Savings to Finance Improvements
- ESCO's Have Specific Expertise in Identifying Cost Effective Improvements
- Financial Accountability is Placed on the ESCO
- Allows ISU to Accomplish Multiple Future Projects at One Time
- Complements Current Facility Staff and Relieves Burden

Overview of the Process

Every effort was taken during this audit process to be sure the final project scope and recommendations are economically and logistically feasible and that improvements are designed specifically to enhance the learning environment for students and staff. NORESCO conducted countless meetings and discussion groups with University administrators and building operators that resulted in a substantial amount of knowledge and insight as to how the University operates and utilizes the facilities. NORESCO also presented updates in an open forum to allow all interested stake holders the opportunity to discuss the potential improvements which provided excellent feedback as to their feasibility from multiple perspectives. In addition, because the most successful projects include an internal "checks and balances" component, the University designed a team of professionals to work with NORESCO in the following capacities to be sure the University's interests are always considered:

- Stanley Consulting – Long term engineering partner of the University, responsible to work collaboratively with NORESCO on Illinois State's behalf to review and assist in the engineering effort for ECMs and to ensure any improvements are appropriate and consider current and future operational impacts.

- Department of Commerce and Economic Opportunity (DCEO) – DCEO retains a very well respected Performance Contracting Consultant, Dave Birr who has been working on the University's behalf to be sure the process and project economics including savings and ECMs are appropriate and realistic in comparison to other performance contracting projects throughout the country.

As a result of this team dynamic and open communication, NORESCO is very confident that the University will find all of the proposed improvements contained herein to be appropriate and realistic from both and engineering perspective and a cost/savings perspective while staying consistent with the expectations set by the update presentations given throughout the process.

Energy Conservation Measures

The "Financial Analysis" section of this document includes a comprehensive list of ECMs broken out per building with a detailed table of costs and savings illustrated in both dollars and energy units.

The following table is an example of how the projects could be arranged to create a scenario that adheres to the economic criteria set forth by the University:
This scenario will cost justify itself in less than 20 years including financing costs by using only the guaranteed energy savings with a 5% interest rate and a 3% escalation factor for energy costs.

ECM	Price	Utility Savings	O&M Savings	Annual M&V	Annual O&M	Combined Annual
Lighting and Water Conservation	$ 925,206	$ 92,858	$ -	$ 2,365	$ -	$ 2,365
VAV & DDC Conversion	$ 1,860,249	$ 123,914	$ -	$ 3,989	$ -	$ 3,989
Isolate & Control Temp/Humidity Rare Books	$ 142,465	$ (1,108)	$ -	$ -	$ -	$ -
Air Handler & Duct Cleaning	$ 115,544	$ -	$ -	$ -	$ -	$ -
Variable Primary Chilled Water Control	$ 2,310,366	$ 71,975	$ -	$ 2,045	$ -	$ 2,045
Submeters	$ 174,758	$ -	$ -	$ -	$ -	$ -
Fume Hood Removal - RM 112/114	$ 95,753	$ 15,418	$ -	$ 496	$ -	$ 496
Replace Absorption Chillers w/ Electric	$ 2,178,435	$ 280,844	$ -	$ 9,021	$ -	$ 9,021
Energy Conservation Through Behavioral Change	$ 50,457	$ -	$ -	$ -	$ 56,250	$ 56,250
Web Based Green Screen Student Initiative	$ 66,509	$ -	$ -	$ -	$ -	$ -
	$ 7,919,742	$ 583,901	$ -	$ 17,916	$ 56,250	$ 74,166

The "Energy Conservation Measures" section of this document describes in detail each individual ECM and its benefits to the project and ultimately to the University. In summary the following are some benefits of this program:

- Dramatically improved ventilation, heating and cooling with decreased noise and maintenance for Milner Library
- Isolation of the Rare Books room will considerably increase the preservationists' ability to preserve valuable rare documents
- Tighter control and greater flexibility in delivering reliable chilled water for air conditioning for the majority of the North campus
- Greater monitoring through sub meters will improve future energy usage decisions
- Significant energy and maintenance savings from new Chillers at the Heating Plant
- Student initiatives will increase the energy awareness and conservation culture while providing learning opportunities in this emerging industry to complement studies

Other projects including an extensive damper replacement at Milner as well as a major upgrade to the central humidity control is included in the comprehensive list in the "Financial Analysis" section but because those projects are relatively extensive and provide no savings they will extend the term of the project past 20 years if they are included in this scenario.

Savings, Measurement & Verification

The cost justification for this project was based on only those energy savings that can be guaranteed by NORESCO. In addition to those savings, these improvements will produce significant savings from reduced capital expenditures, reduced operational costs as well as other energy savings that can not be specifically measured such as those from installing sub meters for example. If the University should choose to stipulate any of those additional savings, other Energy Conservation Measures such as the damper and/or humidity improvements could prove to be economically feasible within the scope of the entire program and included to create a more comprehensive project. A detailed description of how NORESCO calculated savings is included in the “Detailed Savings Calculations” of the Engineering Book associated with this audit. Also, because the very nature of this project is based on cost savings the measurement and verification portion of the process needs to be carefully considered. Collaboratively with the University, NORESCO has developed a program that balances the need to monitor and report on savings while keeping the actual cost of that monitoring reasonable. The process is outlined in the “Measurement and Verification” section of this document.

Student Involvement

NORESCO fully understands that the sole purpose for operating facilities is ultimately to create a learning environment for students. Currently the students who enter Illinois State University have one of the highest average ACT scores compared to every other Illinois Public College. Enrollment is increasing so dramatically that for nearly every four students who apply to the University only 1 seat is available. In addition, new progressive multidisciplinary programs such as the recent Renewable Energy Major are evidence that the University is dedicated to preparing students for the emerging sustainability and energy conservation industry. Because this project is directly related to this emerging industry and the work performed will spread across multiple disciplines of education including construction, energy conservation, manufacturing etc… NORESCO proposes to include a number of initiatives to help bring students into the process and help provide additional practical experience to help complement their studies.

Student Internships

NORESCO plans to develop at least two internship opportunities depending on the final scope of work to be completed. These interns would work directly with NORESCO personnel and be located mainly on campus. Opportunities would include experience in construction management, energy analysis, marketing and account management.

Energy Conservation Through Behavioral Change

A Performance Contracting program is not complete without a formal approach to the behavioral side of energy savings. Our program includes an ECM called Energy Conservation Through Behavior Change which is a custom and proven initiative administered by NORESCO that helps identify the social cognitive behaviors of students and how they understand and use energy on campus. The program includes multiple stakeholders of the residence halls including administrators and students to create sustained behavioral change and dramatic increases in the energy conservation culture and awareness that is documented and easily communicated throughout campus.

Web Based Green Screen

NORESCO has designed a custom program in the list of ECMs that includes the installation of an interactive monitor located at the Bone Student Center that will display real time energy usage for the Library and Science Lab while describing the Performance Contracting initiatives. Also, the monitor will display a graphic depiction of numerous "green" initiatives throughout campus to help educate and create a culture of energy conservation and social responsibility at Illinois State. NORESCO is working to include the design and installation of this initiative as a capstone class within the Renewable Energy Department to help maximize the learning opportunity of this initiative.

Summary

The purpose of this audit is to find cost effective Energy Conservation Measures that enhance the learning environment at Illinois State University. Based on the criteria set forth by the Public University Energy Conservation Act, 110 62 and the direction of Illinois State University, NORESCO feels confident that the results of the audit successfully illustrate a number of cost effective Energy Conservation Measures that easily meet the criteria. As illustrated herein, at least one specific scenario includes a project that saves over $580,000 in energy costs in the first year alone and will easily fund over $8,000,000 worth of facility improvements. Major renovations to the ventilation system at Milner Library as well as the systems that provide chilled water for air conditioning for at least a dozen buildings on campus will be accomplished that would otherwise be deferred by using only those funds that are generated from the guaranteed savings. The project is also expected to save significant capital and operational dollars in addition to the guaranteed energy savings. Finally, the installation of the project will complement the current operating staff rather than burdening them all while providing additional learning opportunities for students. NORESCO very much appreciates the opportunity to work with Illinois State University and looks forward to developing the Energy Services Agreement that will enable us to begin installing these improvements.

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GROUP

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April 26, 2010

Mr. Rick Kentlzer
Director, Facilities Planning Department
Illinois State University
608 S. Main Street
Campus Box 3390
Normal, IL 61790-3390

Subject: Hovey Hall Column Cladding
FGI Project No. 0091574.00

Dear Mr. Kentzler:

The purpose of this letter is to confirm that the steel plates bolted to the precast concrete column covers on seven columns at the east elevation of Hovey Hall are adequate to remain in place and perform the function for which they were designed until the summer of 2011. The function of the plates is to prevent the column covers from falling from the steel columns that they cover.

These steel plates and the bolted connection of the plates to the column covers were designed by FGI and indicated on Sheet S1.0 dated January 27, 2010. They were installed by Stark Excavating, Inc. in February 2010. The column covers on one of the seven columns were subsequently removed by methodical demolition for the purpose of observing the connections of the column covers to the steel columns. Therefore, there are six remaining columns with column covers connected with the steel plates indicated on the referenced Sheet S1.0.

Feel free to contact me if you have any further questions or comments regarding this matter.

Sincerely,

FARNSWORTH GROUP, INC.

Steven E. Bishop, SE, PE, AIA
Structural Engineering Manager

/gr

cc: Dave Burnison

Letter to ISU re service life of cladding connectors

Farnsworth GROUP

ILLINOIS STATE UNIVERSITY
HOVEY HALL COLUMN EVALUATION
(REVISED)

FGI Project No. 0091574.01

Presented to
Illinois State University

April 16, 2010

ENGINEERS | ARCHITECTS | SURVEYORS | SCIENTISTS

April 16, 2010

Dr. Richard Runner
Director, Facilities Planning
Illinois State University
Facilities Planning Building
608 S. Main St.
Normal, IL 61790

Subject: Hovey Hall Column Evaluation (Revised)
FGI Project Number 0091574.01

Dear Dr. Runner:

The purpose of this letter is to report on an investigation of the precast concrete covers on the steel columns at the east side of Hovey Hall Annex (Annex), which serves as an administrative office building for Illinois State University (ISU) in Normal, IL. The Annex is located at 201 South School Street, Normal, IL.

The covers on the west side of the northeast column of the Annex were reported to have fallen into School Street east of Hovey Hall on the morning of December 25, 2009. The column covers on the east side of that column fell against the building envelope approximately 11 feet away. The scope of this report is limited to the following:

- Observations of the remaining precast concrete column covers on the tall columns at the east face of the Annex
- Observations of the condition of the building structure at the northeast corner that was impacted by the collapsing column covers
- Observations of the column cover debris that was removed from the site of the collapse on Christmas Day 2009
- Observations during methodical demolition of the column covers on the column at column G6 (second column north of the southeast corner column)
- A professional opinion of the possible cause of the failure at the northeast corner
- Recommendations for temporary stabilization of the remaining column covers and for long-term improvements

EXECUTIVE SUMMARY

Introduction

The Annex was visited by Farnsworth Group, Inc. (FGI) on December 28, 2009 to observe the post-collapse conditions. Debris from the collapse was taken to two remote storage sites in Normal. Over the last three months, both remote sites were visited by engineers from FGI and Wiss, Janney, Elstner Associates, Inc. (WJE) to take measurements and photographs.

During the week of March 8, 2010, the column covers on the column immediately north of the southeast corner column of the Annex (column G6) were methodically demolished by Stark Excavating, Inc. Representatives from FGI and WJE periodically observed the demolition to verify the connections at the top, mid-height and bottom of the covers.

Interpretation of Original Drawings

A copy of a portion of the original Site Plan for the Hovey Hall Annex is provided in Exhibit D, to which the column grids have been added. The column at the northeast corner that lost its column covers is at grid A6.

The Annex was constructed in 1967 as an addition to the original Hovey Hall. The east elevation contains eight four-story high steel columns, each of which is clad with two pairs of precast concrete column covers. One pair of covers clad the bottom half of the steel column and the second pair clads the upper half.

The column covers rest on a square concrete foundation pedestal at the bottom and each cover is to have two one inch diameter x 18 inch long coil rods threaded into coil loop inserts in the bottom of the column cover and grouted into the pedestal. See Exhibit B for an example of coil loop inserts and coil rods. See Exhibit E for a detail of the column covers.

At mid-height of the column, the top of the lower column covers is to have an embedded weld plate that is to be welded to a clip angle welded to each flange of the steel column (Detail 1 in Exhibit H). The upper column cover connects to the lower column cover with ¾ inch diameter x 8 inch long coil rods in coil loop inserts (Exhibit G).

The top of the column covers connect to the steel column with weld plates and clip angles in the same manner as the top of the lower column covers (Exhibit J). There are precast concrete fascia panels running north/south in line with the east face of the column covers. These fascia panels connect to the structural steel beams at the roof. They also are to connect to the column covers on each side of the column with a ¾ inch diameter x 8 inch long coil rod in coil loop inserts.

At the corner columns, there is a fascia panel on each side of the corner. At non-corner columns, there is a precast concrete "lintel" in the soffit that spans from the upper west column cover to the column cover at the building enclosure approximately 11 feet away. This lintel connects to the column covers at each end with two ¾ inch diameter machine bolts (Exhibits J and K).

Observations

Based on several visits to the Annex building site and the sites where the collapsed column covers are stored, it was determined that there was only one 1 inch diameter coil rod at the bottom of the two column covers at the northeast column. This coil rod was located at the northwest corner of the pedestal and extended approximately 2 inches beyond the bottom of the column cover. There should have been 4 coil rods in the two column covers, each extending at least 6 inches, but more likely greater than 12 inches, below the bottom of the column covers. These coil rods were to have been grouted into sleeves in the concrete pedestal. Hard grout was found in the sleeves at least 2 ½ inches below the top of the pedestal. There was no indication that the single coil rod that was installed had been embedded in hardened grout.

The top of the lower column covers showed an impression where the weld plates had been anchored and had a rust stain where the anchor for the weld plate was still embedded in the concrete. The weld plates were still connected to the clip angles on the column flanges. The welds connecting the anchors to the weld plates are considered to be of poor quality.

The bottom of the upper column covers appear to have been connected to the lower column covers as detailed on the original drawings. All four ¾ inch diameter coil rods were found, still threaded into the coil loop inserts on the bottom of the upper column covers at the northeast column.

The top of the upper column covers were found to be in the same condition as the top of the lower column covers. The weld plate anchors were embedded in the concrete at the storage site, but the weld plates were still attached to the clip angles on the column flanges at the Annex. No coil rods were found at the top of the northeast column covers.

Damage was noted on the column cover west of the northeast column in two locations. One location is near the top of the cover and the other is just below the third floor level. There is also a scar in the paint on the steel column at the northeast corner. These damaged locations help determine the probable collapse sequence on the west side of the column.

The top of several of the east column covers were observed to have rotated outward with respect to the fascia panels as much as ½ inch.

Sealant in the column cover joints was found to have failed in most locations.

Minor damage was noted inside the Annex in the northeast corner. Hairline cracks were noted in the drywall and minor debris was scattered on some fin tube enclosures. The glazing seal on the curtain wall on the north side of the Fourth Floor appeared to be disturbed, but it was not clear if this was related to the collapse.

Temporary Bracing

Nylon straps were installed by Stark Excavating, Inc. at the top and bottom of each pair of remaining column covers shortly after removal of debris from the collapse. Because the straps may need periodic tightening and may not perform adequately over the period of service, it was recommended that they be replaced with steel plates bolted to the column covers. FGI prepared construction documents for the steel plates and they were installed in early February 2010.

Testing of Concrete

Testing Service Corporation obtained a sample of the column cover concrete and determined the unit weight of the concrete was 118.9 pounds per cubic feet (PCF) and the compressive strength of the material was 3,250 pounds per square inch (PSI). This compares to the originally specified unit weight of 145 PCF and compressive strength of 6,000 PSI.

Methodical Demolition of Column Covers on Column G6

Four 1 inch diameter coil rods were found installed at the base of the two column covers, but they were only approximately 5 ½ inches long, with an extension beyond the bottom of the column cover of around 2 inches. The sleeves in the concrete pedestal were found to have hardened grout at approximately 2½ inches below the top of the pedestal, so the coil rods were never embedded in the hardened grout.

The connections at mid-height of the column were as indicated on the drawings, except that the weld plate on the east side did not appear to be connected to its anchor. The anchor on the west side appeared to be welded at the time of the observation, but the weld broke with subsequent chipping activity. The clip angle on the east side of the column was a different size than specified.

The connections at the top of the column were generally as described in the drawings. The variations include that the weld plates were no longer connected to the anchors in the concrete and no coil rods were found for the connection between fascia panels and the east column cover.

Several of the precast concrete "lintels" in the soffit appear to have cracked and deflected below the plaster soffit level.

Discussion

The failure sequence at the northeast column appears to be fairly clear, but what initiated the collapse, and which side went first, is not known for certain. A theory of a possible failure sequence is outlined in the report.

One major concern is that it appears that the coil rods that were specified to connect the fascia panels to the column covers at the top of the column were not installed. The weld plates were probably the "primary" lateral connection of column cover to steel column, but the coil rods served as a "secondary" lateral restraint. Given that the welds connecting the anchors to the weld plates appear to have failed, there may be no lateral restraint for the column covers at the top.

The failure of the weld plate anchor connection may be caused by improper welding technique, corrosion or overload. Since the anchors and the weld plates were specified to be galvanized, and the anchor bar may have high-carbon content, the welds could have been difficult to properly install. Regardless of the reason, the welds appear to be of poor quality.

In addition, failed sealant joints allowed water to penetrate the joints and corrode the metal elements. And, overload may have occurred due to movement in the column covers caused by thermal forces or freeze/thaw cycles.

The discrepancies between the specified unit weight and compressive strength of the column cover concrete are very large, and could be an indication of a problem with the concrete. However, there was only one test performed, and the results may not represent the overall properties of the precast concrete. Consideration should be given to performing additional tests to determine the average unit weight and compressive strength.

Recommendations

1. The remaining column covers on the tall columns supporting the high roof at the east end of the Annex should be removed during the fair weather construction season in 2010.
2. Sealant joints must be monitored and repaired periodically.
3. It is strongly recommended that a more detailed investigation be undertaken in year 2010 to evaluate the remaining precast concrete on all sides of the Annex, with particular attention to

the connections of the precast concrete elements to the building. Further testing of the concrete to determine the average unit weight and compressive strength should be undertaken.

4. The "lintels" that span from the column covers on the west face of the tall columns on the east elevation of the Annex to the column covers at the building enclosure to the west should be investigated to determine if they are stable and safe in their current cracked and deflected condition.
5. If similar details are present in other buildings on the campus, it would be prudent to investigate the condition of those buildings in the near future.