Solicitation Information
December 15. 2017

RFP# 7582482

TITLE: Chapin Health Lab – HVAC Upgrade

Submission Deadline: Friday January 12, 2018 at 11:00 AM Local Time

PRE-BID/ PROPOSAL CONFERENCE: **MANDATORY: No** **If YES, any Vendor who intends to submit a bid proposal in response to this solicitation must have its designated representative attend the mandatory Pre-Bid/ Proposal Conference. The representative must register at the Pre-Bid/ Proposal Conference and disclose the identity of the vendor whom he/she represents. A vendor's failure to attend and register at the mandatory Pre-Bid/ Proposal Conference shall result in disqualification of the vendor's bid proposals as non-responsive to the solicitation.** **DATE: 12/22/2017 at 10:00 AM** **LOCATION: Chapin Building, 50 Orms Street, Providence, Rhode Island**

Questions concerning this solicitation must be received by the Division of Purchases at Thomas.bovis@purchasing.ri.gov no later than **1/3/2018 at 4 PM).** Questions should be submitted in a *Microsoft Word attachment.* Please reference the RFP# on all correspondence. Questions received, if any, will be posted on the Division of Purchases' website as an addendum to this solicitation. It is the responsibility of all interested parties to download this information.

BID SURETY BOND YES **PAYMENT AND PERFORMANCE BOND REQUIRED: YES**

Thomas Bovis
Interdepartmental Project Manager

Applicants must register on-line at the State Purchasing Website at www.purchasing.ri.gov

Note to Applicants:

Proposals received without a completed RIVIP Bidder Certification Cover Form attached may result in disqualification.

THIS PAGE IS NOT A BIDDER CERTIFICATION COVER FORM

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SECTION 1. INTRODUCTION

The Rhode Island Department of Administration/Division of Purchases, on behalf of the Rhode Island Division of Capital Asset Maintenance and Management (DCAMM)), is soliciting proposals from qualified firms to provide HVAC and controls upgrades at the Rhode Island Department of Health (Chapin Health Lab in accordance with the terms of this Request for Proposals ("RFP") and the State's General Conditions of Purchase, which may be obtained at the Division of Purchases' website at www.purchasing.ri.gov.

The initial contract period will begin approximately January 1, 2018 for one year. Contracts may be renewed for up to four additional 12-month periods based on vendor performance and the availability of funds.

This is a Request for Proposals, not a Request for Quotes. Responses will be evaluated on the basis of the relative merits of the proposal, in addition to cost; there will be no public opening and reading of responses received by the Division of Purchases pursuant to this solicitation, other than to name those offerors who have submitted proposals.

Instructions and Notifications to Offerors

1. Potential vendors are advised to review all sections of this RFP carefully and to follow instructions completely, as failure to make a complete submission as described elsewhere herein may result in rejection of the proposal.

2. Alternative approaches and/or methodologies to accomplish the desired or intended results of this RFP are solicited. However, proposals which depart from or materially alter the terms, requirements, or scope of work defined by this RFP may be rejected as being non-responsive.

3. All costs associated with developing or submitting a proposal in response to this RFP or for providing oral or written clarification of its content, shall be borne by the vendor. The State assumes no responsibility for these costs even if the RFP is cancelled or continued.

4. Proposals are considered to be irrevocable for a period of not less than 180 days following the opening date, and may not be withdrawn, except with the express written permission of the State Purchasing Agent.

5. All pricing submitted will be considered to be firm and fixed unless otherwise indicated in the proposal.

6. It is intended that an award pursuant to this RFP will be made to a prime vendor, or prime vendors in the various categories, who will assume responsibility for all aspects of the work. Subcontracts are permitted, provided that their use is clearly indicated in the vendor's proposal and the subcontractor(s) to be used is identified in the proposal.

7. The purchase of goods and/or services under an award made pursuant to this RFP will be contingent on the availability of appropriated funds.

8. Vendors are advised that all materials submitted to the Division of Purchases for consideration in response to this RFP may be considered to be public records as defined in R. I. Gen. Laws § 38-2-1, *et seq*. and may be released for inspection upon request once an award has been made.

   Any information submitted in response to this RFP that a vendor believes are trade secrets or commercial or financial information which is of a privileged or confidential nature should be clearly marked as such. The vendor should provide a brief explanation as to why each portion of information that is marked should be withheld from public disclosure. Vendors are advised that the Division of Purchases may release records marked confidential by a vendor upon a public records request if the State determines the marked information does not fall within the category of trade secrets or commercial or financial information which is of a privileged or confidential nature.

9. Interested parties are instructed to peruse the Division of Purchases website on a regular basis, as additional information relating to this solicitation may be released in the form of an addendum to this RFP.

10. By submission of proposals in response to this RFP vendors agree to comply with R. I. General Laws § 28-5.1-10 which mandates that contractors/subcontractors doing business with the State of Rhode Island exercise the same commitment to equal opportunity as prevails under Federal contracts controlled by Federal Executive Orders 11246, 11625 and 11375.

    Vendors are required to ensure that they, and any subcontractors awarded a subcontract under this RFP, undertake or continue programs to ensure that minority group members, women, and persons with disabilities are afforded equal employment opportunities without discrimination on the basis of race, color, religion, sex, sexual orientation, gender identity or expression, age, national origin, or disability.

    Vendors and subcontractors who do more than $10,000 in government business in one year are prohibited from engaging in employment discrimination on the basis of race, color, religion, sex, sexual orientation, gender identity or expression, age, national origin, or disability, and are required to submit an "Affirmative Action Policy Statement."

    Vendors with 50 or more employees and $50,000 or more in government contracts must prepare a written "Affirmative Action Plan" prior to issuance of a purchase order.

    a. For these purposes, equal opportunity shall apply in the areas of recruitment, employment, job assignment, promotion, upgrading, demotion, transfer, layoff, termination, and rates of pay or other forms of compensation.

    b. Vendors further agree, where applicable, to complete the "Contract Compliance Report" (http://odeo.ri.gov/documents/odeo-eeo-contract-compliance-report.pdf), as well as the "Certificate of Compliance" (http://odeo.ri.gov/documents/odeo-eeo-certificate-of-compliance.pdf), and submit both documents, along with their Affirmative Action Plan or an Affirmative Action Policy Statement, prior to issuance of a purchase order. For public works projects vendors and all subcontractors must submit a "Monthly Utilization Report" (http://odeo.ri.gov/documents/monthly-employment-utilization-report-form.xlsx) to the ODEO/State Equal Opportunity Office, which identifies the workforce actually utilized on the project.

For further information, contact the Rhode Island Equal Employment Opportunity Office, at 222-3090 or via e-mail at Krystal.Waters@doa.ri.gov .

11. In accordance with R. I. Gen. Laws § 7-1.2-1401 no foreign corporation has the right to transact business in Rhode Island until it has procured a certificate of authority so to do from the Secretary of State. This is a requirement only of the successful vendor(s). For further information, contact the Secretary of State at (401-222-3040).

12. In accordance with R. I. Gen. Laws §§ 37-14.1-1 and 37-2.2-1 it is the policy of the State to support the fullest possible participation of firms owned and controlled by minorities (MBEs) and women (WBEs) and to support the fullest possible participation of small disadvantaged businesses owned and controlled by persons with disabilities (Disability Business Enterprises a/k/a "DisBE")(collectively, MBEs, WBEs, and DisBEs are referred to herein as ISBEs) in the performance of State procurements and projects. As part of the evaluation process, vendors will be scored and receive points based upon their proposed ISBE utilization rate in accordance with 150-RICR-90-10-1, "Regulations Governing Participation by Small Business Enterprises in State Purchases of Goods and Services and Public Works Projects". As a condition of contract award vendors shall agree to meet or exceed their proposed ISBE utilization rate and that the rate shall apply to the total contract price, inclusive of all modifications and amendments. Vendors shall submit their ISBE participation rate on the enclosed form entitled "MBE, WBE and/or DisBE Plan Form", which shall be submitted in a separate, sealed envelope as part of the proposal. ISBE participation credit will only be granted for ISBEs that are duly certified as MBEs or WBEs by the State of Rhode Island, Department of Administration, Office of Diversity, Equity and Opportunity or firms certified as DisBEs by the Governor's Commission on Disabilities. The current directory of firms certified as MBEs or WBEs may be accessed at http://odeo.ri.gov/offices/mbeco/mbe-wbe.php. Information regarding DisBEs may be accessed at www.gcd.ri.gov.

For further information, visit the Office of Diversity, Equity & Opportunity's website, at http://odeo.ri.gov/ and *see* R.I. Gen. Laws Ch. 37-14.1, R.I. Gen. Laws Ch. 37-2.2, and 150-RICR-90-10-1. The Office of Diversity, Equity & Opportunity may be contacted at, (401) 574-8670 or via email Dorinda.Keene@doa.ri.gov

13. Bid Surety Bond – Vendors responding to this RFP must furnish, with their bid proposals, either a bid bond from a surety licensed to conduct business in the State of Rhode Island or a certified check payable to the State of Rhode Island in the amount of five (5%) percent of the vendor's cost proposal. An attorney-in-fact who executes a bond on behalf of the surety must provide a certified current copy of the power of attorney. A successful vendor who fails to submit the additional documentation required by the tentative letter of award and/or fails to commence and pursue the work in accordance with the contract awarded pursuant to this solicitation may forfeit, at the discretion of the State Purchasing Agent, the full amount of the bid surety as liquidated damages. The State will retain the bid surety of all vendors until the earliest of: (i) the issuance of the Purchase Order; (ii) the 61st day following the proposal submission deadline; or (iii) the rejection of all proposals.

14. Payment and Performance Bond - The successful vendor must furnish a 100% payment and performance bond from a surety licensed to conduct business in the State of Rhode Island upon the tentative award of the contract pursuant to this solicitation.

SECTION 2. BACKGROUND

Chapin Lab was built in the 1970s and houses the Rhode Island Department of Health Laboratories and associated support staff, autopsy labs, and body storage for the Medical Examiner. It also includes other laboratories such as Histology, General Chemistry, and Biosafety Level 1, 2 and 3. Due to the age of the facility and the deteriorating condition of equipment and operating sequences, immediate repairs and upgrades are required to maintain acceptable building conditions until a comprehensive project can be developed later.

The retro-commissioning study provides a good description of the current situation of the building.

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SECTION 3: SCOPE OF WORK AND REQUIREMENTS

Specific Activities / Tasks

1. The Vendor will be responsible for all costs associated with postage, client invoices and other related forms and/or correspondence.

2. The Vendor must have sufficient liability insurance coverage and/or be bonded.

Summary of the Selected Existing systems and Deficiencies:

1. Rooftop Air Handling Units (AHU-1 and 2):

   The building is primarily heated, ventilated and air conditioned by two large rooftop air handling units. These units require replacement, but in the short term they need selected control component upgrades and an improved operating sequence. They are failing to maintain consistent supply air temperatures and often overheat the entire building.

2. Laboratory Variable Air Volume (VAV) terminal units:

   There are approximately 30 pairs of laboratory VAV air supply and exhaust terminals which are designed to control space temperature and airflow. They are also required to maintain a slight negative pressure in each lab relative to the corridor. These terminals are equipped with pneumatic controls and most units are original from the 1970s. There are also 30 laboratory exhaust fans that draw air from the room through fume hoods located in the labs. Some labs are operating with excessive negative pressures, and based on observation, the laboratory VAV systems are only partially functional.

3. Chillers:

   The two water-cooled chillers located in the basement are the sole cooling source for the facility. They do function, but currently cannot operate independently of each other without severe water flow issues and high discharge chilled water temperature, which reduces the ability to cool the building.

4. Building Automation System (BAS):

   The main building HVAC control terminal is not connected to the State's dedicated communication link (VLAN), so it is only accessible by the building facility operator inside Chapin. So, in the event of a failure or alarm condition during unoccupied hours, no one on the maintenance staff can observe the problem and respond in a timely manner. Given the critical nature of this facility, this communication link needs to be established.

   Attachments:

   - National Grid Retro-Commissioning Report (July 7, 2016)

Proposed Repairs and Upgrades:

1. AHU-1 and 2:

   A. Verify if the steam control valves associated with hot water heat exchanger, C-1, function. Implement a hot water temperature reset schedule. Overheating can result in mild weather, if heating hot water supply temperature is too high.
   B. Establish the mixed-air temperature set-point at proper air temperature. It is currently set too high, and cold deck temperature is too high.
   C. Correct issues with free-cooling sequence. This should be enabled at the correct outside air temperature, and mixed air dampers need to be better controlled to maintain minimum mixed air setpoint. Mixed air flow should be better controlled to reduce the air recirculated from the general laboratory exhaust. The long term strategy (under a future project) will be to completely replace the air handlers and use 100% outside air.
   D. Add additional control points for each air handler, as follows; Output signal to cold deck preheat valve (valve must be closed if chilled water system is enabled); output signal to supply fan discharge dampers; hot and cold deck supply temperatures ; hot and chilled water supply and return temperatures.

2. Laboratory VAV terminals:

   A. Remove existing 31 Supply and Return Air terminals pairs.
   B. Replace supply terminals with new dual-duct terminals with electric actuators and flow stations. These terminals need to control both space temperature and, to maintain pressurization in conjunction with the exhaust terminals.
   C. Provide electronic differential pressure (DP) sensors to measure difference in pressure between lab and corridor.
   D. Install averaging pressure probes in all 30 exhaust ducts to fume hood exhaust fans.
   E. Install new space temperature sensors.

F. Integrate all the above into the Johnson Controls BAS so that all airflows can be observed and controlled to maintain proper pressure differential and temperature.
G. The size of the terminal units shall match existing max and min airflows, but shall be sized as much as possible for future air flow reductions, as described in the Retro-commissioning report.
H. Set final max and min airflow rates. Determine if non-bypass fume hoods should have fixed or minimum sash settings.

3. Chillers:

A. System is a primary-only with a bypass line to maintain minimum flow through chillers. However, the chillers cannot be automatically isolated from each other and the bypass does not deliver equal flow to both. This results in poor chilled water flow and temperature control.
B. Close cross-over valves downstream of condenser water pumps. Dedicate one pump to each chiller.
C. Remove existing chilled water supply butterfly valves at each chiller and replace with new with electric actuators.
D. Install differential pressure sensors on CHWS & R lines at chiller evaporators to measure flow.
E. Test and repair existing CHW bypass valve to maintain chiller minimum flow.
F. Test existing 3-way mixing valve which controls condenser water supply temperature.

4. Building Automation System (BAS):

A. Provide all BAS equipment, programming and graphics for the above scope. Furnish updated control drawings and sequences.
B. Migrate the BAS to the virtual Johnson Controls ADX server at 50 Service Ave., via the State's dedicated HVAC VLAN. Set up access to Metasys through Internet Explorer.
C. Set up selected alarm points and coordinate with Owner the notification list.
D. Provide 8 hours of training.

SECTION 4: PROPOSAL

A. Technical Proposal

Narrative and format: The proposal should address specifically each of the following elements:

1. **Staff Qualifications** – Provide staff resumes/CV and describe qualifications and experience of key staff who will be involved in this project.

2. **Capability, Capacity, and Qualifications of the Offeror** - Please provide a detailed description of the Vendor's experience with HVAC and controls projects. A list of relevant client references must be provided, to include client names, addresses, phone numbers, dates of service and type(s) of service(s) provided. The Vendor, or the Vendor's control subcontractor, shall be factory

certified in Johnson Controls Metasys architecture and have on staff a technician, programmer, graphics programmer and controls engineer.

3. **Products-** Provide a list and description of the major products and manufacturers to be used. This shall include VAV boxes, flow sensors, and valve/damper actuators.

4. **Approach/Methodology** – The Proposed Repairs and Upgrades, above, are to provide reasonably specific guidance on implementing the corrective action .It is expected that the Vendor will not restrict his scope to the literal interpretation of these. Explain how the Vendor will address unforeseen component replacement or significant changes in scope. If unit pricing or hourly labor rates would apply, list these.

B. Cost Proposal

Detailed Budget and Budget Narrative:

Provide a proposal cost proposal to include the following…..

C. ISBE Proposal

See Appendix A for information and the MBE, WBE, and/or Disability Business Enterprise Participation Plan form(s). Bidders are required to complete, sign and submit these forms with their overall proposal in a sealed envelope. Please complete separate forms for each MBE, WBE and/or Disability Business Enterprise subcontractor/supplier to be utilized on the solicitation.

SECTION 5: EVALUATION AND SELECTION

Proposals shall be reviewed by a technical evaluation committee (“TEC”) comprised of staff from State agencies. The TEC first shall consider technical proposals.

Technical proposals must receive a minimum of 60 out of a maximum of 70 points to advance to the cost evaluation phase. Any technical proposals scoring less than 60 points shall not have the accompanying cost or ISBE participation proposals opened and evaluated. The proposal will be dropped from further consideration.

Technical proposals scoring 60 points or higher will have the cost proposals evaluated and assigned up to a maximum of 30 points in cost category bringing the total potential evaluation score to 100 points. After total possible evaluation points are determined ISBE proposals shall be evaluated and assigned up to 6 bonus points for ISBE participation.

The Division of Purchases reserves the right to select the vendor(s) or firm(s) (“vendor”) that it deems to be most qualified to provide the goods and/or services as specified herein; and, conversely, reserves the right to cancel the solicitation in its entirety in its sole discretion.

Proposals shall be reviewed and scored based upon the following criteria:

Criteria	Possible Points
Staff Qualifications	20 Points
Capability, Capacity, and Qualifications of the Offeror	30 Points
Products	10 Points
Approach/ Methodology	10 Points
Total Possible Technical Points	**70 Points**
Cost proposal*	30 Points
Total Possible Evaluation Points	**100 Points**
ISBE Participation**	6 Bonus Points
Total Possible Points	**106 Points**

*Cost Proposal Evaluation:
The vendor with the lowest cost proposal shall receive one hundred percent (100%) of the available points for cost. All other vendors shall be awarded cost points based upon the following formula:

(lowest cost proposal / vendor's cost proposal) x available points

For example: If the vendor with the lowest cost proposal (Vendor A) bids $65,000 and Vendor B bids $100,000 for monthly costs and service fees and the total points available are thirty (30), Vendor B's cost points are calculated as follows:

$65,000 / $100,000 x 30= 19.5

**ISBE Participation Evaluation:

a. Calculation of ISBE Participation Rate

1. ISBE Participation Rate for Non-ISBE Vendors. The ISBE participation rate for non-ISBE vendors shall be expressed as a percentage and shall be calculated by dividing the amount of non-ISBE vendor's total contract price that will be subcontracted to ISBEs by the non-ISBE vendor's total contract price. For example if the non-ISBE's total contract price is $100,000.00 and it subcontracts a total of $12,000.00 to ISBEs, the non-ISBE's ISBE participation rate would be 12%.

2. ISBE Participation Rate for ISBE Vendors. The ISBE participation rate for ISBE vendors shall be expressed as a percentage and shall be calculated by dividing the amount of the ISBE vendor's total contract price that will be subcontracted to ISBEs and the amount that will be self-performed by the ISBE vendor by the ISBE vendor's total contract price. For example if the ISBE vendor's total contract price is $100,000.00 and

it subcontracts a total of $12,000.00 to ISBEs and will perform a total of $8,000.00 of the work itself , the ISBE vendor's ISBE participation rate would be 20%.

b. Points for ISBE Participation Rate:

The vendor with the highest ISBE participation rate shall receive the maximum ISBE participation points. All other vendors shall receive ISBE participation points by applying the following formula:

(Vendor's ISBE participation rate ÷ Highest ISBE participation rate

X Maximum ISBE participation points)

For example, assuming the weight given by the RFP to ISBE participation is 6 points, if Vendor A has the highest ISBE participation rate at 20% and Vendor B's ISBE participation rate is 12%, Vendor A will receive the maximum 6 points and Vendor B will receive (12% ÷ 20%) x 6 which equals 3.6 points.

General Evaluation:

Points shall be assigned based on the vendor's clear demonstration of the ability to provide the requested goods and/or services. Vendors may be required to submit additional written information or be asked to make an oral presentation before the TEC to clarify statements made in the proposal.

SECTION 6. QUESTIONS

Questions concerning this solicitation must be e-mailed to the Division of Purchases at Thomas.bovis@purchasing.ri.gov no later than the date and time indicated on page one of this solicitation. No other contact with State parties is permitted. Please reference **RFP # 7582482** on all correspondence. Questions should be submitted in writing in a Microsoft Word attachment in a narrative format with no tables. Answers to questions received, if any, shall be posted on the Division of Purchases' website as an addendum to this solicitation. It is the responsibility of all interested parties to monitor the Division of Purchases website for any procurement related postings such as addenda. If technical assistance is required, call the Help Desk at (401) 574-8100.

SECTION 7. PROPOSAL CONTENTS

A. Proposals shall include the following:

1. One completed and signed RIVIP Bidder Certification Cover Form (included in the original copy only) downloaded from the Division of Purchases website at www.purchasing.ri.gov. *Do not include any copies in the Technical or Cost proposals.*

2. One completed and signed Rhode Island W-9 (included in the original copy only) downloaded from the Division of Purchases website at http://www.purchasing.ri.gov/rivip/publicdocuments/fw9.pdf**.** *Do not include any copies in the Technical or Cost proposals.*

3. Two (2) completed original and copy versions, signed and sealed Appendix A. MBE, WBE, and/or Disability Business Enterprise Participation Plan. Please complete separate

forms for each MBE/WBE or Disability Business Enterprise subcontractor/supplier to be utilized on the solicitation. *Do not include any copies in the Technical or Cost proposals.*

4. Technical Proposal - describing the qualifications and background of the applicant and experience with and for similar projects, and all information described earlier in this solicitation. The technical proposal is limited to six (6) pages (this excludes any appendices and as appropriate, resumes of key staff that will provide services covered by this request).
   a. One (1) Electronic copy on a CD-R, marked "Technical Proposal - Original".
   b. One (1) printed paper copy, marked "Technical Proposal -Original" and signed.
   c. Four (4) printed paper copies

5. Cost Proposal - A separate, signed and sealed cost proposal reflecting the hourly rate, or other fee structure, proposed to complete all of the requirements of this project.
   a. One (1) Electronic copy on a CD-R, marked "Cost Proposal -Original".
   b. One (1) printed paper copy, marked "Cost Proposal -Original" and signed.
   c. Four (4) printed paper copies

B. Formatting of proposal response contents should consist of the following:

A. Formatting of CD-Rs – Separate CD-Rs are required for the technical proposal and cost proposal. All CD-Rs submitted must be labeled with:
   a. Vendor's name
   b. RFP #
   c. RFP Title
   d. Proposal type (e.g., technical proposal or cost proposal)
   e. If file sizes require more than one CD-R, multiple CD-Rs are acceptable. Each CD-R must include the above labeling and additional labeling of how many CD-Rs should be accounted for (e.g., 3 CD-Rs are submitted for a technical proposal and each CD-R should have additional label of '1 of 3' on first CD-R, '2 of 3' on second CD-R, '3 of 3' on third CD-R).

Vendors are responsible for testing their CD-Rs before submission as the Division of Purchase's inability to open or read a CD-R may be grounds for rejection of a Vendor's proposal. All files should be readable and readily accessible on the CD-Rs submitted with no instructions to download files from any external resource(s). If a file is partial, corrupt or unreadable, the Division of Purchases may consider it "non-responsive". USB Drives or any other electronic media shall not be accepted. Please note that CD-Rs submitted, shall not be returned.

B. Formatting of written documents and printed copies:
   a. For clarity, the technical proposal shall be typed. These documents shall be single-spaced with 1" margins on white 8.5"x 11" paper using a font of 12 point Calibri or 12 point Times New Roman.
   b. All pages on the technical proposal are to be sequentially numbered in the footer, starting with number 1 on the first page of the narrative (this does not include the cover page or table of contents) through to the end, including all forms and attachments. The Vendor's name should appear on every page, including

attachments. Each attachment should be referenced appropriately within the proposal section and the attachment title should reference the proposal section it is applicable to.

c. The cost proposal shall be typed using the formatting provided on the provided template.

d. Printed copies are to be only bound with removable binder clips.

SECTION 8. PROPOSAL SUBMISSION

Interested vendors must submit proposals to provide the goods and/or services covered by this RFP on or before the date and time listed on the cover page of this solicitation. Responses received after this date and time, as registered by the official time clock in the reception area of the Division of Purchases, shall not be accepted.

Proposals should be mailed or hand-delivered in a sealed envelope marked "**RFP# 7582482"** to:

RI Dept. of Administration
Division of Purchases, 2nd floor
One Capitol Hill
Providence, RI 02908-5855

NOTE: Proposals received after the above-referenced due date and time shall not be accepted. Proposals misdirected to other State locations or those not presented to the Division of Purchases by the scheduled due date and time shall be determined to be late and shall not be accepted. Proposals faxed, or emailed, to the Division of Purchases shall not be accepted. The official time clock is in the reception area of the Division of Purchases.

SECTION 9. CONCLUDING STATEMENTS

Notwithstanding the above, the Division of Purchases reserves the right to award on the basis of cost alone, to accept or reject any or all proposals, and to award in the State's best interest.

Proposals found to be technically or substantially non-responsive at any point in the evaluation process will be rejected and not considered further.

If a Vendor is selected for an award, no work is to commence until a purchase order is issued by the Division of Purchases.

The State's General Conditions of Purchase contain the specific contract terms, stipulations and affirmations to be utilized for the contract awarded for this RFP. The State's General Conditions of Purchases can be found at the following URL: https://www.purchasing.ri.gov/RIVIP/publicdocuments/ATTA.pdf.

APPENDIX A. PROPOSER ISBE RESPONSIBILITIES AND MBE, WBE, AND/OR DISABILITY BUSINESS ENTERPRISE PARTICIPATION FORM

A. Proposer's ISBE Responsibilities (from 150-RICR-90-10-1.7.E)

1. Proposal of ISBE Participation Rate. Unless otherwise indicated in the RFP, a Proposer must submit its proposed ISBE Participation Rate in a sealed envelope or via sealed electronic submission at the time it submits its proposed total contract price. The Proposer shall be responsible for completing and submitting all standard forms adopted pursuant to 105-RICR-90-10-1.9 and submitting all substantiating documentation as reasonably requested by either the Using Agency's MBE/WBE Coordinator, Division, ODEO, or Governor's Commission on Disabilities including but not limited to the names and contact information of all proposed subcontractors and the dollar amounts that correspond with each proposed subcontract.

2. Failure to Submit ISBE Participation Rate. Any Proposer that fails to submit a proposed ISBE Participation Rate or any requested substantiating documentation in a timely manner shall receive zero (0) ISBE participation points.

3. Execution of Proposed ISBE Participation Rate. Proposers shall be evaluated and scored based on the amounts and rates submitted in their proposals. If awarded the contract, Proposers shall be required to achieve their proposed ISBE Participation Rates. During the life of the contract, the Proposer shall be responsible for submitting all substantiating documentation as reasonably requested by the Using Agency's MBE/WBE Coordinator, Division, ODEO, or Governor's Commission on Disabilities including but not limited to copies of purchase orders, subcontracts, and cancelled checks.

4. Change Orders. If during the life of the contract, a change order is issued by the Division, the Proposer shall notify the ODEO of the change as soon as reasonably possible. Proposers are required to achieve their proposed ISBE Participation Rates on any change order amounts.
5. Notice of Change to Proposed ISBE Participation Rate. If during the life of the contract, the Proposer becomes aware that it will be unable to achieve its proposed ISBE Participation Rate, it must notify the Division and ODEO as soon as reasonably possible. The Division, in consultation with ODEO and Governor's Commission on Disabilities, and the Proposer may agree to a modified ISBE Participation Rate provided that the change in circumstances was beyond the control of the Proposer or the direct result of an unanticipated reduction in the overall total project cost.

B. MBE, WBE, AND/OR Disability Business Enterprise Participation Plan Form:

Attached is the MBE, WBE, and/or Disability Business Enterprise Participation Plan form. Bidders are required to complete, sign and submit with their overall proposal in a sealed envelope. Please complete separate forms for each MBE, WBE and/or Disability Business Enterprise subcontractor/supplier to be utilized on the solicitation.

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
DEPARTMENT OF ADMINISTRATION
ONE CAPITOL HILL
PROVIDENCE, RHODE ISLAND 02908

MBE, WBE, and/or DISABILITY BUSINESS ENTERPRISE PARTICIPATION PLAN
Bidder's Name:
Bidder's Address:
Point of Contact:
Telephone:
Email:
Solicitation No.:
Project Name:
This form is intended to capture commitments between the prime contractor/vendor and MBE/WBE and/or Disability Business Enterprise subcontractors and suppliers, including a description of the work to be performed and the percentage of the work as submitted to the prime contractor/vendor. Please note that all MBE/WBE subcontractors/suppliers must be certified by the Office of Diversity, Equity and Opportunity MBE Compliance Office and all Disability Business Enterprises must be certified by the Governor's Commission on Disabilities at time of bid, and that MBE/WBE and Disability Business Enterprise subcontractors must self-perform 100% of the work or subcontract to another RI certified MBE in order to receive participation credit. Vendors may count 60% of expenditures for materials and supplies obtained from an MBE certified as a regular dealer/supplier, and 100% of such expenditures obtained from an MBE certified as a manufacturer. This form must be completed in its entirety and submitted at time of bid. **Please complete separate forms for each MBE/WBE or Disability Business Enterprise subcontractor/supplier to be utilized on the solicitation.**

Name of Subcontractor/Supplier:					
Type of RI Certification:	☐ MBE ☐ WBE ☐ Disability Business Enterprise				
Address:					
Point of Contact:					
Telephone:					
Email:					
Detailed Description of Work To Be Performed by Subcontractor or Materials to be Supplied by Supplier:					
Total Contract Value ($):		Subcontract Value ($):		ISBE Participation Rate (%):	
Anticipated Date of Performance:					

I certify under penalty of perjury that the forgoing statements are true and correct.		
Prime Contractor/Vendor Signature	**Title**	**Date**
Subcontractor/Supplier Signature	**Title**	**Date**

M/W/Disability Business Enterprise Utilization Plan - RFPs - Rev. 5/24/2017

Rhode Island State Health Lab
Chapin Building
50 Orms Street
Providence, RI ESR#66866

Commercial New Construction and Retrofit
Technical Assistance
Study Report

Draft Report
July 7th 2016

Prepared by
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Commercial New Construction and Retrofit

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PROJECT CONTACT INFORMATION

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EXECUTIVE SUMMARY

National Grid (NGRID) secured the services of Applied Energy Engineering and Commissioning (AEEC) to conduct a Retro commissioning Study which meets the requirements of ASHRAE's Procedures for Commercial Building Energy Level II Energy Survey and Analysis (Second Edition) for the Chapin Building which houses the Rhode Island State Health Lab located at 50 Orms Avenue in Providence, RI. NGRID then retained AEEC to submit some of the energy conservation measures identified in that report in a Technical Assistance Report under the New Construction and Retrofit custom incentive programs The measures were analyzed using EXCEL based weather bin calculations based on inputs from design documents, trend data and operational information from State personnel. A brief summary of the recommended measures are provided below.

Both the Commercial New Construction and Retrofit Approaches, which are two of the NGRID incentive program options, were used in the analysis. These approaches require a specifically defined methodology to be applied to the analysis and also a detailed reporting format (with many fixed components) to be used for the report. The New Construction looks at the entire project to find ways to optimize the proposed new design including system and equipment selection to maximize the future energy efficiency of the building systems and to reduce the associated first cost. The Retrofit approach looks at the entire project to find ways to optimize the existing system(s) including system and equipment operations to maximize the future energy efficiency of the building systems and to reduce the associated operating costs. Each ECM is first evaluated individually. Energy and cost savings are calculated independently, taking into account interaction with other measures, for each measure and each measure is screened by NGRID for cost-effectiveness. Measures that are determined cost-effective are then presented as a package for final energy and cost savings analysis.

Details of utility providers are provided in the Facility Description section of this report. The building is provided electricity and natural gas from NGRID.

A brief summary of each measure presented in this report is provided below.

<u>Commercial New Construction</u>

- ECM #1 – Airflow Reduction for Offices and Conference Rooms (Electric & Gas) Install new dual duct terminal unit retrofit kits, DDC control and program and balance offices and conference rooms to required air changes (ACH) and set back/shut off when unoccupied. The base case would be controlling existing terminal units to meet existing design conditions via upgraded BAS.
- ECM #2 -Airflow Reduction for Laboratories (Electric& Gas) Install new fume hood, supply air and exhaust air valves and DDC control and program and balance labs to required air changes and set back/reduce to minimum ACH when unoccupied. The base case would be controlling existing hoods, supply and exhaust valves to meet existing design conditions via upgraded BAS.
- ECM #3 – Modify AHU 1&2 Discharge Air Temperature Set points (Electric and Gas) Modify programming for AHU 1&2 cold and hot deck discharge air temperature (DAT) to reset the set point(s) based on outdoor air temperature. Base case is controlling the DAT at constant temperature via upgraded BAS. Chilled and Condenser Water System Modifications (Electric)
- ECM #4 – Program to Reset Condenser Water Temperature Set points (Electric) Program the cooling tower condenser water temperature to reset temperature according to outdoor air temperature. Base case is controlling the condenser water temperature at a constant temperature via upgraded BAS.
- ECM #5– Convert AHU4 to Variable Air volume (Electric and Gas) Install new fan VFD and controls to vary airflow based on maintaining space temperature set point. Base case is controlling AHU4 as constant volume with existing controls via the upgraded BAS.

<u>Commercial Retrofit</u>

- ECM #8 - Install New Cooling Tower & Modify Chilled and Condenser Water Systems (Electric). Install one new cooling tower with VFD fan control to provide condenser water to the existing chilled water system chillers. The proposed tower will be rated at 300 tons and include VFD fan controls. Add two new chilled water pumps (Primary), new VFD controlled secondary pumps and new controls and programming to enable building automation system (BAS) to control all chilled and condenser water pumps. New tower and system modifications will allow pumps to be sequenced off and provide cooler condenser water saving pumping and chiller energy.

- ECM #9 – Replace Existing Domestic Hot Water Heaters with New Instantaneous Heaters (Gas). Replace existing domestic hot water steam coil heaters and storage tanks with new instantaneous steam fed heaters. New heaters reduce heat loss from storage tanks and improve heat transfer efficiency.

<u>Not Eligible for New Construction or Retrofit</u>

These measures did not meet cost benefit criteria for ether the New Construction or Retrofit programs. Applicable prescriptive incentive programs are indicated for those measures which appear to meet the program criteria.

- ECM #6 – Install new AHU 1&2 with Energy Recovery (Electric and Gas) Remove existing AHU-1&2 and replace with new AHUs with energy recovery. Energy recovery to include installing new strobic exhaust fans and connecting to existing individual roof top exhaust ducts on the roof. Individual exhaust and existing general exhaust will be returned to AHU's energy recovery section. New AHUs will be dual duct (cold and hot deck) variable volume with 100% outdoor air, energy recovery, chilled water cooling and hot water heating. Base case is upgrading existing AHU 1 & 2 by converting to 100% outdoor air, upgrading variable speed control and upgrading AHU casing and dampers. This measure does not meet savings criteria for new construction program.

- ECM #7 - Install New Chillers (Electric) Install two high-efficiency water-cooled chillers (in lieu of baseline chillers) to produce chilled water for use in labs, offices and conference rooms. The proposed chillers are 150-ton, variablee speed (magnetic bearings) centrifugal types (McQuay), the base case would be similar type chillers with minimum full load efficiency as stipulated in the Rhode Island Energy Code. This measure does not meet savings criteria for new construction program, however it does appear based on the type and capacities of potential proposed chillers (in the appendix MRDs) it may be eligible for the New Construction Chiller prescriptive program (2016).

- ECM #10– Install New Hot Water Boilers (Gas) Install two new condensing type natural gas fired hot water boilers to provide hot water to the AHU hot water heating coils and radiation heating system. The new boilers will provide hot water with less heat loss at a higher fuel to hot water efficiency than the existing steam boilers and steam to hot water converters. Note this measure assumes existing steam boilers will remain to provide for existing high pressure steam loads. This measure does not meet savings criteria for the Retrofit program, however it does appear based on the type and capacities of potential proposed boilers (in the appendix MRDs) it may be eligible for the New Construction Boiler prescriptive program (2016).

Energy Savings and Carbon Emissions/Environmental Impact

Our investigation of the cost savings opportunities was based on a review of available design documents, discussions with Building operating personnel, independent analysis of trend logs, measurements taken by our balancing contractor (Thomas Young Associates) and programs analyzed with our control contractor (EMC Services).

To analyze existing energy consumption patterns for the building and the efficiency of the various energy conservation measures considered for the site, an EXCEL based bin analysis was done based on Providence, RI TMY 20 year data and load assumptions based on walkthrough observations and building automation point logs.

The baseline building electric and natural gas use is based on recent billing data (September 2014 thru August 2015 for electric and June 2014 thru May 2015) at about 3,010,700 kWh/yr and 157,700 therms/yr. Compared to the baseline/existing electric and natural gas annual energy use, the proposed upgrades (with all ECMs implemented) is expected to save approximately 672,870 kWh/yr of electricity (22% of calculated baseline) and 43,410 therms/yr (28% of baseline) corresponding to an overall reduction of about 1,127 thousand pounds in carbon dioxide emissions per year.

A more detailed description of each measure can be found in the Energy Conservation Measures section starting on page 21. For information on the building please refer to the Facility Description section on page 8. For information on the method of analysis and the baseline building model, refer to the section titled Analysis Methodology. Table 1 on the following page summarizes the energy and cost savings and payback information for the measures.

Rhode Island State Health Lab - Chapin Building - Providence, RI

Table 1: Summary of Energy Conservation Measures

		Electric Energy Savings and NEBS						Total Cost Savings	Estimated Installed Costs	Simple Paback
		Electric Savings		Gas Savings		Other				
ECM#	Measure Description	kWH	$	Therms	$	MMBTU	$	$	$	Years
	NEW CONSTRUCTION PROGRAM									
ECM#1	AirFlow Reduction for Offices and Conference Rooms	168,037	$ 24,037	13,950	$ 14,647	0	$ -	$ 38,685	$ 350,000	9.0
ECM#2	Airflow Reduction for Laboratories	232,659	$ 33,281	16,854	$ 17,697	0	$ -	$ 50,978	$ 450,000	8.8
ECM#3	Modify AHU DAT Set Points	4,353	$ 623	154	$ 162	0	$ -	$ 784	$ 3,880	4.9
ECM#4	Modify Condenser Water Temperature Set Points	8,595	$ 1,230	-	$ -	0	$ -	$ 1,230	$ 3,880	3.2
ECM#5	Convert AHU-4 to Variable Air Volume	14,354	$ 2,053	7,145	$ 7,503	0	$ -	$ 9,556	$ 15,000	1.6
	RETROFIT PROGRAM									
ECM#8	Modify Chilled & Condenser Water Systems Including New Cooling tower	244,875	$ 35,029	-	$ -	0	$ -	$ 35,029	$ 253,400	7.2
ECM#9	Install New Steam Instananeous Domestic Hot Water Heaters	-	$ -	5,302	$ 5,568	0	$ -	$ 5,568	$ 35,000	6.3
All Measures Combined	Total Savings and Costs	672,873	96,253	43,406	45,576	-	$ -	$ 141,829	$ 1,111,160	7.8
	Percentage Reductions	22%		28%		0%				
	Incentives	Electric: TBD		Gas: TBD		Other:		Total Incentives: TBD		
	Net Cost & Payback								TBD	TBD
Prescriptive	N/A	Incentve: $ -						Combined Incentives: TBD		
Savings and cost estimates (ASHRE Level II equivalent) further design engineering required for Level III savings and cost estimates (level III recommended for capi										
Notes	Electr Rate NGRID	$ 0.1430	per kWh (electric) from 2014-2015 Meter Data - includes deliver and supply charges'							
	Ngas rate thru 2011	$ 1.05	per therm (natural gas) from 2014-2016 Meter Data -includes delivery and supply charges							
	CO2 emissions reduction	1,127	klbs							

NOT ELIGIBLE FOR NEW CONSTRUCTION OR RETROFIT

		Electric Energy Savings and NEBS						Total Cost Savings	Installed Costs	Simple Paback
		Electric Savings		Gas Savings		Other				
ECM#	Measure Description	kWH	$	Therms	$	MMBTU	$	$	$	Years
ECM#6	Replace AHUs 1&2 with New 100% OA with Energy Recovery	29,021	$ 4,151	14,510	$ 15,235	0	$ -	$ 19,386	$ 1,000,000	51.6
ECM#7	Upgrade Proposed Chillers to High Efficiency	9,531	$ 1,363	-	$ -	0	$ -	$ 1,363	$ 45,000	33.0
ECM#10	Instal New Condensing Hot Water Boilers	-	$ -	11,297	$ 11,862	0	$ -	$ 11,862	$ 300,000	25.3

FACILITY DESCRIPTION

Chapin Building (50 Orms Ave.)

General

The Chapin Health Laboratory Building (c. 1973) is a 69,240 square foot, four-story building with a partial basement. The Chapin Health Laboratory Building houses the Rhode Island Department of Health Laboratories and associated support staff along with autopsy laboratories and body storage for the Rhode Island Medical Examiner and its administration staff. Laboratory types that are located in this facility are classified as Histology, General Chemistry, Biosafety Level 1, Biosafety Level 2 and Biosafety Level 3. Medical gases including oxygen, nitrogen and helium are stored and used in numerous laboratories throughout the building.

The building envelope components are briefly described below.

Wall Construction:
Typical wall construction – Brick veneer with metal studs backup: 4” brick veneer, air space, 3” continuous rigid insulation (R-5/inch), and 5/8” ext. grade gypsum board. Overall U-value of 0.055.

Roof Construction:
The roofs are reinforced single-ply roof membrane with 6” extruded polystyrene rigid insulation (R-40 total) over continuous vapor retarder over 5/8” dense deck sheathing on ½” galvanized metal deck. Overall U-value of 0.024.

Windows:
All windows are double glazed with thermally broken aluminum framing. Some windows have fixed framing and some are single hung. Windows with curtain wall assemblies use a framing system of type EFCO S-5600 or Kawneer 1600 series system 1.

The table below provides a brief description of the spaces located on each floor:

Floor	Square Feet	Space Use Description
1st	15,360	• Lobbies, Elevators, Corridors & Stairs • Morgue, Autopsy and offices
2nd	15,360	• Vestibules, Elevators, Corridors & Stairs

		• Labs, Lecture and offices
3rd	15,360	• Vestibules, Elevators, Corridors & Stairs • Rest rooms, Electric Rooms, • Labs, Glass Wash and offices
4th	15,360	• Vestibules, Elevators, Corridors & Stairs • Rest rooms, Electric Rooms, • Labs, BSL-3 Lab and offices
Roof		• Rooftop units 1 & 2 • Cooling tower • BSL-3 Makeup and Exhaust • Exhaust fans

Occupancy & Controls

The hours of occupancy, indoor temperature settings and means of control are indicated in the following table.

	Occupancy			Indoor Temp Setting	
Space Usage	Mon - Fri	Sat	Sun	Summer/Winter	Automation System
				74F Space Temp Cool 72F Space Temp Heat	BAS – JCI Metasys with pneumatic room thermostats
Offices	8AM-5PM	Unoccupied	Unoccupied		
Meeting/Conference Rooms/Auditorium	8AM-5PM	Unoccupied	Unoccupied		
Labs and Supporting Areas	8:00 AM-5:00 PM	Unoccupied	Unoccupied	73F Space Temp Cool 71 F Space Temp Heat	

Typical building occupancy is approximately 8:30 am to 4:30 pm Monday through Friday, however the HVAC systems operate 24x7 continuously to maintain minimum air change rates in the labs. Some labs are used after hours as well as the first floor morgue and autopsy. The space temperature setpoints in all rooms are adjusted by local pneumatic thermostats that have a range of 55 to 85 F. These stats control dual duct (mix hot/cold duct air) VAV boxes and do not have an unoccupied setting.
National Grid is the electric and natural gas utility provider for the building.

Mechanical Systems

Hot Water

System Description
Heat is provided to the building via two 250 HP Cleaver Brooks steam boilers. Boilers are dual fuel rated for 10,461.0 CFH (natural gas) and 70.0 GPH (#2 fuel oil). Boilers operate at 60 PSIG. Steam to hot water converters are used for heating hot water and domestic hot water production. Hot water is distributed via three hot water pumps (including one stand-by pump) located in the basement Mechanical Room.

Hot water pump #P-1 (with dedicated stand-by pump #P-3) provides 528 gpm via HX-1 to AHU-1 & 2 heating coils.

Each air handling unit receives 264 gpm via 4-inch hot water supply and return pipes. Flow is modulated via a three-way control valve.

P-2 and P-4 design is 50 GPM at 75 feet of head and serves general heating perimeter via HX-2.

Existing Conditions
The boilers appear to be original to the building (1977) and in fair condition. Pictures are provided in the appendix of Boiler 2 opened up for cleaning. It is not clear if the boiler tube sheet has had any leaks or required repairs. We did not perform boiler efficiency testing however noted that one boiler was operating and cycling frequently.

The EMS is set to enable the perimeter hot water pump 2 when OA temp drops below 60 F, however the pump had to be turned on manually at the motor starter. The steam control valve is was controlled by a local pneumatic controller and was maintaining 125 F.

The HX-1 steam control valve is manually enabled by the EMS operator. When running the hot water supply temp is reset from 70 to 120 F based on the average building temp (uses two sensors, autopsy and medical exam office) setpoint is 72F. Pump 1 had to be turned on at the local starter by the operator.

The steam to hot water heat exchangers HX-1 & 2 appear to have been replaced within the past 20 years. P-1 and P-2 are operational which provides no backup for the heating systems. P-3 & P-4 are not operable and are electrically disconnected. Some of the hot water piping from HX-1 is uninsulated and rusting on the outside due to water dripping from above.

Very few loads in the building require high pressure steam. The rooftop units and perimeter heating systems use hot water which could be generated by a high efficiency hot water boiler. Domestic hot water could also be generated using a gas fired condensing boiler.

Some Steam traps in the boiler room were leaking by as evidenced by steam rising from the condensate return tank drain lines

Recommendations
Remove one of the 250 HP steam boilers and leave the other in place to provide capability of providing heat to all systems using gas or oil. Rebuild or replace P-1 through P-4 as necessary to provide a lead and lag pump for each system.

Reset the HX-1 hot water supply temp based on outside air temp and reset the hot deck supply air temp based on outside air temp to lowest possible setting. Reset HX-2 based on outside air temp.
Install two new gas fired hot water condensing boilers to heat hot water for perimeter heating and in the AHU-1 & 2 hot deck. Each boiler should be similar to Cleaver Brooks Model CFC and rated for 2500 MBH minimum. Final required rating to be determined by a design Engineer.
Provide a circulating pump with each boiler and pipe in a side-stream arrangement on the hot water return pipe to each existing steam heat exchanger. This will allow the existing boiler to provide steam to the heat exchanger if there is a failure of the new boiler or of gas supply.

Install one new gas fired steam boiler to provide 60 psig steam to glass washers, autoclaves and other steam users. The boiler should be similar to Cleaver Brooks Model CFH and rated for 50 HP. Final required rating to be determined by a design Engineer. Design of condensate return tank and associated pumps would also have to be prepared by a design engineer.

Install one new gas fired condensing boiler for domestic hot water. Boiler should be similar to Camus Dynamax model DMNC-0802 with 800 MBH input. Final required rating to be determined by a design Engineer. Provide a circulating pump with the boiler to recirculate water in the existing storage tank. This will allow the existing boiler to provide steam to the heat exchanger if there is a failure of the new boiler or of gas supply. Alternate approach to heating domestic hot water would be using an instantaneous steam heat exchanger (would allow removal of hot water storage tank to reduce standby losses).

Chilled Water System

System Description

Chilled water is provided to the building by one 150-ton and one 213-ton, water cooled, centrifugal chillers manufactured by Trane, which are located in the basement Mechanical Room. There are two chilled water distribution pumps (including one stand-by pump). Condenser water is provided by cooling towers which are located on the roof of the building. Condenser water pumps (including one stand-by pump) are located in the basement Mechanical Room.

Chilled water pump #P-4 (with a dedicated stand-by pump #P-5) provides 868 gpm to AHU-1 & 2. Each air handling unit receives 432 gpm from 6-inch chilled water supply and return pipes. Three-way control valves modulate the flow to air handling units.

Existing Conditions

There is no condenser or chilled water pump status or start/stop on EMS. Both chilled and condenser pumps run continuously. Original design requires only one chilled and condenser pump to run for both chillers.

There is a separate CHW return leg from AHU-1 & 2. Each has a 2-way control valve in the return line in the basement. There is an automatic 2-way bypass valve in the basement that allows supply water to be recirculated to the chillers. The bypass valve is controlled using an inverse relationship with the AHU-1 & 2 CHW control valves.

During our site visit the AHU-1 & 2 CHW control valves and the bypass valve were fully open. We tried opening and closing the bypass valve but it did not move. The pilot positioner requires adjustment. Low chiller delta T (48-42=6) indicates that bypass is open preventing AHU coils from getting design flow. We noted that chiller 1 had a low delta T of about 3 F when running while chiller 2 delta T was about 6 F. The CHW system bypass ties into the chillers return directly above chiller 1. This shows that bypass valve is open short-circuiting much of the chilled water supply to chiller 1 return.

There are two CHW flow meters in the CHW supply line in the basement. Flow on August 25th was reading 845 GPM to AHU-1 & 2 and 21 GPM total to AHU-1 & 2 and bypass. The Flow meters are installed as shown on the EMS graphic however one reads total flow (incorrectly labeled as bypass) and the second meter reads just what is delivered to the AHUs. In order to determine actual bypass flow the program should take the difference between the two meters. One of the meters was just replaced and is located too close to elbows which will affect the meter accuracy.

The CHW lines close to the ceiling above the boiler burners are uninsulated and rusting. Also, chilled water lines at flow meters are uninsulated and rusting.

Cooling tower is mounted on the roof and is BAC model 15325DW. The Tower fan starters are mounted approximately 1 foot (too close) above the roof which has caused the bottom of the enclosures to rust through. Tower media on one side appears to be completely broken. Recommend that a representative from BAC determine if just the fill is broken or if the distribution box above the fill has a hole in it. The readings taken below provide further evidence that the tower is not able to meet design leaving temperature of 85 F even when partially loaded.

On 8/25/15 OA temp was 90 F and both chillers were running and the CHW supply and return was 42/48 F for each chiller. Chiller 1 was at 70% and chiller 2 at 90% load. The EMS CHW return temp was 66 F. Chillers entering and leaving condenser water temp was 90/97 F with the tower fans both running. On 8/27 the OA temp was 80 F with chiller 1 running up to 40% and cycling on/off on its internal temperature controls and chiller 2 running between 50 and 70%.

Air Handling Units, Exhaust Fans & Terminal Units

System Description

There are two rooftop air handling units that serve science laboratories, autopsy laboratories, support staff office areas and corridors. These rooftop units (denoted as AHU-1 and AHU-2) were originally designed to provide conditioned, 100% outdoor air to the building. Units are dual duct, variable air volume type equipped with the following sections:

- 34x60 Oval Cold Deck Supply Connection
- 36x24 Oval Hot Deck Supply Connection
- Chilled Water Coil 432 gpm (44-55°F)
- Hot Water Coil 264 gpm (200-180°F)
- Steam Humidifier (800 lbs/hr)
- High Efficiency Filter Section
- Supply Air Sound Attenuator
- Two (2) VAV In-line Vane Axial Supply Fans (75 HP / 30,000 cfm / 3.5 in. ESP each)
- One (1) VAV In-line Vane Axial Return/Exhaust Fan (32,000 cfm maximum)
- Exhaust Air Pre-Filter Section
- Discharge Air Sound Attenuator
- Two (2) Outdoor Air Intake Louvers
- One (1) Exhaust Air Louver

Ventilation air is ducted to each air handling unit from two (2) 4-feet wide X 10-feet high intake louvers which are located 13-feet above grade on the east exterior elevation of the building.

The hot deck supply air ducts and cold deck supply air ducts from AHU-1 & 2 are manifolded together to serve the building. Each floor of the building is equipped with modulating control dampers on hot deck and cold deck supply air mains. Hot and cold deck branch take-offs are connected to dual temperature, VAV terminal boxes to provide heating and air conditioning to each room. General exhaust is ducted from each room back to air handling units controlled by duct mounted airflow dampers. Laboratories are equipped with constant volume fume hoods exhausted by roof mounted laboratory hood exhaust fans.

There are a total of 30 constant volume exhaust fans (LHE) serving fume hoods and 25 constant volume fans (RF & CE) providing miscellaneous exhaust.

LHE Fans	CFM	Hood Rm		RF & CE Exhaust fans	CFM
1	1625	203		RF-1	2400
2	750	302		CE-1	290
3	1490	302		CE-2	450
4	1625	203		CE-3	305
5	1625	204		CE-4	2000
6	1490	304		RF-2	726
7	1625	204		CE-5	134
8	750	304		RF-3	1894
9	750	304		RF-4	234
10	1146	304		RF-5	468
11	1625	305		RF-6	234
12	1146	122		RF-7	1894
13	1900	311		RF-8	540
14	1500	220		RF-9	240
15	1625	311		RF-10	540
16	2200	311		RF-11	90
17	1260	312		RF-12	295
18	1625	222		RF-13	234
19	1000	313	perchloric	RF-14	234
20	916	405		RF-15	468
21	1625	414		RF-16	9480
22	1625	414		RF-17	759
23	1100	414		RF-18	760
24	1260	415		RF-19	2904
25	916	415		RF-20	2000
26	1260	115		Total	29573
27	1260	122			
28	200	313			
29	200	311			
30	200	220			
Total	37319				

Existing VAV rooftop units were designed to control supply air volume equally via static pressure transmitters located near the end of the hot deck and cold deck ducts. Exhaust air volume is controlled by a static air pressure transmitter in the return duct. The hot deck discharge air temperature was designed to vary inversely in accordance with outdoor air temperature control panel that modulates the steam valves at the steam-hot water converter. The cold deck discharge air temperature is controlled by modulating two-way chilled water valves.

Terminal boxes were designed to have three control sequences. Sequence A modulates the hot deck-cold deck damper to control the room thermostat adjustable setpoint. The room static pressure controller shall maintain negative (or positive if required) room pressure relative to the corridor static pressure by modulating the room exhaust damper and air handling unit volume damper. Sequence B modulates the hot deck-cold deck damper and unit volume damper to control room thermostat adjustable setpoints. Sequence C modulates the hot deck-cold deck dampers only.

AHU-1 and 2 were installed in about 1977 and are beyond their expected useful life. We noted the following issues with the equipment:

- AHU-1 floor under cold deck coil is leaking air and water.
- Sections of insulation under the unit fans are falling off.
- Return air dampers are in poor condition and allow air to be recirculated
- In AHU-1 one supply fan VFD has been replaced however it was not operating because water was found leaking in through the unit roof causing it to short out and trip.
- Fans are original vane axial with blade control arms disconnected. It is not clear whether bearings or motors have ever been replaced.
- Door latches on some doors do not work and some doors are being held closed with wood braces.
- These units do not have heat recovery.
- Insulation is missing on chilled and hot water piping that feeds these units.
- Many of the electronic controllers in the air handling units are not calibrated and/or are not functioning properly.

AHU-1 & 2 both have return dampers and relief dampers (no outside air dampers). Economizer is enabled based on OA dry bulb temp below 55 F. When Economizer is on the mixed air dampers control to mixed air temp of 55 F. When Economizer is off the mixed air dampers remain at minimum position.

In September 2015 a balancer measured airflows for each unit hot deck, cold deck and outside air with economizer on and off. One of the two supply fans in AHU-1 was off which is the reason for the difference (imbalance) in airflows between AHU-1 & 2. Supply air fan VFDs operate to 1.5 inch static pressure setpoint and return fans at 0.5 inches. When readings were taken the supply fans were operating at 100% and return fans at 85% speed.

The results are shown below in CFM

'100% OUTSIDE AIR-ECONOMIZER	
AHU-1 CD	21,639
AHU-1 HD	0
RTU-1 Total	**21,639**
AHU-1 OSA	**23,400**
AHU-1 RA	**30,072**
AHU-2 CD	27,830
AHU-2 HD	20,402
RTU-2 Total	**48,232**
AHU-2 OSA	**49,200**
AHU-2 RA	**27,766**

MINIMUM OUTSIDE AIR-NO ECONOMIZER (RTU-1=50%; RTU-2=40%)	
AHU-1 CD	21,327
AHU-1 HD	0
RTU-1 Total	**21,327**
AHU-1 OSA	**9,750**
AHU-1 RA	**29,746**
AHU-2 CD	28,533
AHU-2 HD	25,029
RTU-2 Total	**53,563**
AHU-2 OSA	**29,250**
AHU-2 RA	**27,566**
AHU-3 OSA	**946**

According to recent trend data all the AHUs and EAHs operate 24 hours per day seven days per week, year round. AHU-1 & 2 are variable air volume units using VSD controls on the supply and exhaust fans to maintain static pressure set points.

Laboratories and office areas include original pneumatic room thermostats which control dual duct terminal boxes to satisfy the room temperature setpoint. Each dual duct (pressure dependent) box has two actuators; one to mix hot and cold duct air and one to vary the volume of air. A room type pneumatic static pressure controller was provided to maintain negative (or positive, as required) room pressure relative to the Corridor by modulating general exhaust from each lab.

Tests and Airflow readings of some existing labs were performed with a balancer in September 2015 which showed room pressure controls do not respond to changes in supply airflow. The table below shows the measured difference between supply and exhaust airflow to each room (should be between -200 and -300 CFM) in both heating and cooling mode.

	Measured CFM Differential	
Room	Heating	Cooling
Rooms 115, 119, 122 & 123	-1600	-116
Lab 304	-86	315
lab 305	-1589	-1368
lab 311	-3121	-2233
lab 312	-700	-427
lab 313	-1988	-303
glass wash 317	-2636	-2104

All hoods tested in these labs were constant volume. Most hoods have bypass grille on the face above the sash which bypasses air when the sash was between 0 and 6 inches open. Each hood has a face velocity indicator that is set to alarm below 100 FPM. Some of these indicators were not providing accurate readings which means that they require cleaning and calibration or replacement.

General exhaust was too high or makeup air was too low in most labs preventing doors from closing especially when supply boxes are in heating mode. Some labs have had hoods replaced or new hoods and fixed point exhausts added without increasing supply airflow. This all contributes to the room pressures being very negative.

Room 306 Evidence Receiving

Evidence receiving room 306 has a cooling unit with no electronic controls. Trane Model KAVA050406 Serial S77B02985. Rooftop condensing unit Model CTA090200AA (new in 2007). This room originally had a computer server but now has a few desks.

Room 421 Animal Room

Animal testing room 421 is served by AHU-3 (Trane Model RAS 848) which has a steam coil and DX cooling from roof mounted condenser and has Siemens local control only. Exhaust air is by RF-20. Room pressure was -0.085 inches. There are no fume hoods, 2 bio-safety hoods, 2 freezers and 1 large refrigerator. The unit is located above the drop ceiling in the 4th floor lobby and appears to be in very poor condition. The outside air was measure by the balancer at 946 CFM (original design is 2000 CFM).

The rooftop condensing unit does not work well. The AHU appears in very poor condition and access is difficult above the ceiling.

Room 403A BSL-3 Lab

BSL-3 lab is located in room 403A and was built in about 2002. There are 2 Greenheck exhaust fans designed for 2328 CFM. The Program shuts down both makeup and exhaust fans if makeup unit fails to run for any reason (low temp, smoke, OA damper end switch). At least one of these exhaust fans should remain running if the supply AHU trips on any type of safety to maintain labs under negative pressure.

There is an electronically actuated two-position steam control valve located in the 4th floor mechanical corridor that feeds the unit heating coil. The control valve is shown on the graphic without a control signal. The program opens the valve below 55 F OA temp and closes when OA temp rises to 60 F.

The control drawing sequence of operation calls for the unit to have a discharge temp setpoint of 53 F at all times. The unit is programmed to reset the discharge temp setpoint based on exhaust air temp as follows:

Exhaust air temp	Disch temp setpoint
68	72
72	55

The sequence calls for the two electric reheat coils to modulate to maintain room temp setpoint however the Electric reheat circuit breakers in distribution panel are turned off.

There are two stages of DX cooling, only the first stage has hot gas bypass that is internally controlled. The program is setup for min on/off time of 30 seconds, max cycles per hour 6 and a sequencer that enables stage 1 at 33% and stage 2 at 66%.

Control drawings show AO-2 connected to the humidifier controller input. JCI is not connected to the humidifier control input point which means that there is no external control of the humidifier.

Control Drawing shows	**Actual installed configuration**
No connection to steam preheat valve	Steam preheat valve connected to DO-3.
No OA damper point	DO-8 connected to OA damper which when opened trips end switch to start unit.
No Smoke detector point	Smoke detector is connected to DI-8.

Current controls setup will not maintain space relative humidity setpoint in the summer or winter.

Emergency Generator serving BSL-3 Lab and HVAC system. Catalog 0066CN6D00864
Model C6.6 Model generator D150-8 rated for 150 kW. Unit was installed in 2002 and appears in good condition. No tests were run.

Room 115 Autopsy
Autopsy room 115 is exhausted by CE-4 which is located in the mechanical corridor on the first floor. The fan is designed to exhaust 2000 CFM to outside. The Balancer measured 1643 CFM exhaust from space. CE-4 fan discharge static pressure was high causing significant exhaust air to enter the mechanical corridor. We determined that there is a screen and louver in the basement wall creating the large pressure drop. .

Morgue
There is one new air cooled unit that serves the cooler. We could not read all nameplate data. Recommend interface with EMS.

The two older air cooled units serve the freeze for which we could not locate nameplate. There are No controls on morgue freezer located in the basement mechanical area. Recommend replacement of these units with new high efficiency units that are interfaced with the EMS.

AHU-4 Basement Mechanical Room
This unit is original 100% outside air unit with constant speed fan and steam coil serving the basement mechanical rooms.

Energy Management Systems

Existing Conditions
There is a Johnson Controls, Inc. Metasys building automation system with workstation in basement and 2nd floor office.

The energy management system consists of limited points for AHU-1 & 2 controlling pneumatic end devices which are very difficult to maintain and calibrate.

These units do not have individual temperature sensors for each unit, instead control is dependent upon a common sensor in the hot and cold ducts. This provides no indication of actual temp from each unit which makes it difficult to diagnose the source of temperature control issues.

The two supply fans for each unit do not have individual status points which means that when one AHU-1 supply fan failed, the operator was not notified or aware of the situation. This also created a large difference in supply, return and outside airflows between the units which contributed to the imbalance of building pressure.

Pneumatic Compressed air System

Pneumatic controls are served by a single Sullair air compressor with 7.5 hp motor
Serial 201001120014
Part # 02250055-487

The unit runs continuously automatically loading/unloading to maintain a pressure of __ PSIG which is fed through air dryers and reduced to __ PSIG for distribution to the system.

Building Emergency Generator

Emergency generator serving building is Manufactured by Swam Electric, Hanover, PA. Serial 8102 date 2/77. Hour meter indicates 920 hours total. The Fuel tank is beside generator.

Need to ID areas and equipment served. Need to ID size of generator.

We noted that the top of fuel tank is dented and are not sure if this effect the fill or vent for the tank.

Domestic Hot Water System

The domestic hot water (DHW) heater includes steam heating coils and storage tanks used in the building. The building's DHW loads include showers, sinks, lavatory sinks and janitorial uses.

Process Equipment

Direct Electric Users:

The only equipment that we were able to identify that were significant electric energy users:

- Refrigerators and freezers in some laboratories
- Typical lab equipment used to heat and mix Chemicals

Direct Steam Users: Operating personnel indicate that there are multiple process related equipment which are significant steam users including:

- Auto Claves
- Glass Washers
- AHU-3 (during winter)
- BSL-3 Makeup AHU (during winter)

We requested a list of Autoclaves and glass washers from Ranger company (800-237-5432) with steam capacities to help determine how much load requires high press steam (have not received this info yet). Glass wash room has the following equipment:

- 1 washer Ref 1400 LXP SN 0E073837
- 1 washer Ref 1300 LX SN 5C034378

- 1 oven Wilt industries Ser. 8132 Mod 160
- 2 Better Built turbo dryers Mod 8000 Ser 9218. Dryers appear to be abandoned in place.

One Autoclave is installed in each room: 317, 403, 403A, 422 & 423

Miscellaneous Office Equipment

The office areas are typical office area users which indicates that a typical office equipment power use density (W/sf) would be expected. In addition to the office areas there are smaller conference rooms dispersed on each floor.

Lighting Systems

The lighting system in the building has not been retrofitted to LED (except for exit signs). Most of the labs and offices are a mixture of T8 and T12 fluorescent fixtures. Lobbies and corridors used recessed compact fluorescent fixtures. Lights are controlled with manual switches.

Exterior lighting fixtures: parking lot poles, bollards and wall wash fixtures consist mainly of high pressure sodium lamps and metal halide lamps. Lamps are used principally for egress and security purposes and stay on all night (controlled by timers).
Lighting Contractor needs to confirm installed equipment and provide a report.

Water/Sewer

Water and sewer services are provided by Providence Water. Major end users include:

- Glass Washers
- Cooling Tower make up and Steam system makeup.

ANALYSIS METHODOLOGY

Our investigation of the cost savings opportunities was based on a review of available design documents, discussions with Building operating personnel and a balancing contractor (Thomas Young Assoc.) and control contractor (EMC Services, inc).

To analyze existing energy consumption patterns for the Chapin building and the efficiency of the various energy conservation measures considered for the site, the baseline (existing) building energy and proposed building energy for each measure was calculated using custom EXCEL spreadsheets based on TMY-20 weather bin data (Providence, RI).

The opinion of probable installed cost estimates were based on the proposed design and either our experience with similar measures and/or budget costs by contractors familiar with the building (F Rounds, EMC controls, etc.).

Natural Gas and Electric rates were based on billing data provided by the client (RI DOA). The incremental blended electric rate is $0.1430 / kWh, the assumed combined energy and delivery natural gas rate is $1.05/ therm, the blended water/sewer rate is $12.00 / CCF.

ENERGY CONSERVATION MEASURES

This section contains a description of each of the recommended ECMs. EXCEL workbook baseline and proposed chilled water plant energy use and inputs for the NGRID Screen reports for the measures are included in Appendix D.

New Construction Program

- ECM #1 – Airflow Reduction for Offices and Conference Rooms (Electric & Gas)
- ECM #2 -Airflow Reduction for Offices and Conference Rooms (Electric& Gas)
- ECM #3 –Modify AHU 1&2 Discharge Air Temperature Set points (Electric and Gas)
- ECM #4 – Program to Reset Condenser Water Temperature Set points (Electric)
- ECM #5 – Convert AHU4 to Variable Air volume (Electric and Gas)

Commercial Retrofit

- ECM #8 - Install New Cooling Tower Chilled and Condenser Water System Modifications (Electric) (Electric).
- ECM #9 – Replace Existing Domestic Hot Water Heaters with New Instantaneous Heaters (Gas)

Not Eligible for New Construction or Retrofit

- ECM #6 – Install new AHU 1&2 with Energy Recovery (Electric and Gas).
- ECM #7 - Install New Chillers (Electric).
- ECM #10– Install New Hot Water Boilers (Gas)

NEW CONSTRUCTION PROGRAM

ECM-1: Airflow Reduction for Offices & Conference Rooms

Summary of Savings and Economic Results									
ECM #1	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
	168,037	9.0	35.4	$ 24,037	13,950	$ 14,647	0	$ -	$ 38,685

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ 350,000	$ 350,000	$ -	$ -	$ 350,000	9.0	9.0	9.0	9.0

Measure Description

This measure consists of installing dual duct terminal retrofit kits, balancing spaces to required air changes, controlling terminal units to set back/shut off when spaces unoccupied. The proposed modifications will save energy by:

The VAV boxes are operating between 10 and 18 ACH which results in conditioning more outdoor air than necessary resulting in more heating, cooling and fan energy use than required. The VAV boxes not shutting off during unoccupied periods results in relatively constant airflow, conditioning more outdoor air than necessary resulting in more heating, cooling and fan energy use than required (during unoccupied periods).

Baseline Conditions:

Original design minimum air change rates in offices and conference rooms are between 10 and 18 air changes per hour (ACH). Current ventilation code ASHRAE 62.1-2010 allows minimum of 4 to 6 ACH for these types of rooms. Office and conference room dual duct boxes are pneumatically operated variable volume and do not have unoccupied temperature or airflow set points that allow temperatures or airflows to be setback. Occupied temperature and airflow settings remain in effect 24/7.

Proposed Modifications:

Install new dual duct retrofit terminals into the hot and cold duct at the entrance to each supply box. Remove the pneumatic actuators and thermostats that serve each VAV box. Install new exhaust air box for each office/conference room.

Adjust the minimum number of air changes in all offices, conference rooms and break rooms to minimum of 4 ACH and maximum of 6 ACH. The exhaust for each room shall track the supply air CFM.

Control each hot/cold deck box as variable volume to minimize mixing of air. Each room shall have a heating and cooling setpoint of 70 and 74 F that is adjustable by plus or minus 2 F. Schedule offices and conference room VAV boxes to close during unoccupied periods. Install an occupancy sensor in each room and program boxes to close during occupied periods if no motion is sensed for 15 minutes. Boxes would open to maintain standby temperature set points (htg sp -2, clg sp +2) during occupied periods when no motion is sensed. Each space would return to normal airflow settings if motion is sensed during the occupied period.

Summary of total airflow reduction for each floor when selected boxes are closed.

Terminal units original design Mark	Max CFM	Min CFM	Room #	Room Use	New Supply Min CFM	New Supply Max CFM	Existing gen exh box #	orig design return to AC-1/2	new design min return AC-1/2 Exh	New design max return AC-1/2 Exh
5	225	100	427	office	43	65			43	65
13	225	225	408	break room	63	95			63	95
14	225	225	409	office	63	95	14	225	63	95
21	600	200	430	office	97	146			97	146
22	225	100	426	office	43	65			43	65
24	225	100	424	office	43	65			43	65
29	225	225	413	office	64	96	29	225	64	96
107	600	200	401	break room?	136	204			236	304
4th floor	2550	1375	Total 4th floor		553	830		450	653	930
84	225	100	323	office	43	65	84	200	43	84
85	225	100	320	office	43	65			43	-
86	225	100	318	office	43	65	86	200	43	86
91	600	200	316	office	93	140	91	300	93	140
95	225	100	324	office	43	65	95	200	43	65
96	225	100	321	office	43	65			43	65
97	225	100	319	office	43	65	97	200	43	65
102	600	200	315	office	93	140	102	300	93	140
3rd floor	2550	1000	total 3rd floor		445	668		1,400	445	643
59	2400	1000	206	Lecture	276	414	59	1,500	276	414
60	225	100	232	office	43	65	60	200	43	65
61	225	100	230	office	43	65	61	200	43	65
62	600	200	207	lab director	237	356	62	500	237	356
63	600	200	209	secretary	90	135	63	300	90	135
64	225	100	227	office	46	69	64	200	46	69
65	1600	1200	211	clerical	553	829	65	1,300	553	829
66	1600	912	226	office	270	405	66	900	270	405
67	600	304	213	office	103	154	67	150	103	154
70	1500	1500	219	eating & vending	424	635	70	1,500	424	635
72	225	100	228	office	46	69			46	69
75	225	100	231	office	43	65			43	65
76	225	100	233	office	43	65			43	65
78	600	300	235	office	94	141	78	200	94	141
2nd floor	10850	6216	Total 2nd floor		2,311	3,467		6,950	2,311	3,467
39	225	100	121	conference	48	72			48	72
40	225	100	120	office	136	204			136	204
45	500	500	132	office	144	216	45	400	144	216
46	800	800	137,133	office	207	311	46	500	207	311
47	500	500	134	office	151	227	47	450	151	227
48	300	300	135	office	96	144	48	300	96	144
49	300	300	136		96	144	49	300	96	144
50	300	300	138		96	144				
52	570	570	143	office	170	255	52	600	170	255
53	600	600	144	office, copy	194	291	53	600	194	291
54	600	600	145	office	189	284	54	600	189	284
55	1000	1000	147	office	159	239	55	900	159	239
56	500	500	101	office	136	204			136	204
1st floor	6420	6170	Total 1st floor		1,822	2,733		4,650	1,726	2,589
Total All	22,370	14,761	Total All Floors		5,132	7,698		13,450	5,136	7,629

Energy Savings Methodology:

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates.

Baseline: The rooms are considered occupied during the occupied schedule. For the baseline the minimum flow for the dual duct boxes is per design (see table above). Rooftop unit 1&2 fan, cooling and heating energy was calculated based on: return and supply fan VFD, mixed air temperature, outdoor air temperature, cold and hot deck temperatures, et al.

Proposed: The ACH for all the groups was reduce to 6 ACH during occupied and 4 ACH during unoccupied hours. Building non-lab occupancy is modelled from 7:00 am to 6:00 pm Monday-Friday, year round

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

AHU En Exist = Base AHU Energy and demand usage

EEM1 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook)

All of these spreadsheets are provided in Appendix.

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water and cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- Dual duct box occupied/unoccupied status and supply and exhaust airflow for appropriate office and conference rooms (see table above).

Cost Estimate

Dual Duct Box retrofit kits, new exhaust boxes, new thermostats, new controllers, map and program boxes and thermostats, balancer to set minimum airflows to new ACH

Incremental cost = $350,000

		Material		Labor/Install		Engineering		
Item	Qty	Unit	Cost	Unit	Cost	Unit	Cost	Total
Retrokits boxes	42	$ 560	$ 23,520	$ 64	$ 2,688	$ 620	$ 26,040	$ 52,248
New Exh Boxes	15	$ 645	$ 9,675	$ 64	$ 960	$ 710	$ 10,650	$ 21,285
Box DDC	84	$ 1,500	$ 126,000	$ 720	$ 60,480	$ 200	$ 16,800	$ 203,280
Adj Min ACH	64			$ 180	$ 11,520	$ 140	$ 8,960	$ 20,480
Occ Sensors	42	$ 250	$ 10,500	$ 720	$ 30,240	$ 140	$ 5,880	$ 46,620
Programming	80			$ 180	$ 14,400			$ 14,400
								$ 358,313

Source of Estimate

The cost for this measure was based on similar experience with past projects and on recent engineering report by Wilkinson Associates July 25, 2013.

ECM-2: Airflow Reduction for Laboratories

Summary of Savings and Economic Results									
	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
ECM #2	232,659	15.0	74.3	$ 33,281	16,854	$ 17,697	0	$ -	$ 50,978

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ 450,000	$ 450,000	$ -	$ -	$ 450,000	8.8	8.8	8.8	8.8

Measure Description:

This measure consists of converting fume hoods to variable volume, install fume hood zone presence sensors, upgrade supply and exhaust air valves to DDC, balancing spaces to required air changes, controlling terminal units to set back/shut off when spaces unoccupied. The proposed modifications will save energy by:

The supply and exhaust VAV boxes and fume hoods are operating at higher airflow rates than necessary creating the need to condition more outdoor air than necessary which results in more heating, cooling and fan energy use than required.

Baseline Conditions:

Laboratory air change rates were designed to operate between 13 and 32 ACH. Using current ASHRAE ventilation codes the average number of air changes required for lab spaces in this building is between 8 and 13 ACH.

Proposed Modifications:

Reduce minimum and maximum supply and exhaust airflow set points to laboratory spaces. Convert most fume hoods to variable volume with digital control including new variable volume exhaust valve that is controlled based on sash position to maintain minimum face velocity of 100 FPM. Install zone presence sensors for each VAV hood to reduce face velocity to 60 FPM when no person is within 5 feet of the sash for 30 seconds. This measure requires the installation of new electronic controls on supply and exhaust boxes and new fume hood controls.

Control each hot/cold deck box as variable volume to minimize mixing of air. Each room shall have a heating and cooling setpoint of 70 and 74 F that is adjustable by plus or minus 2 F.

A summary of unoccupied airflow reduction by floor is shown below.

high velocity Terminal units original design

Mark	Max CFM	Min CFM	Room #	Room Use	New Min ACH Req.	New Min CFM	New Max ACH Req.	New Max CFM	new design min return AC-1/2 Exh	New desig max return AC-1/2 Exh	Calculated Hood CFM required at 18 inches	Calculated Hood CFM required Minimum	Notes
1	200	200	404	TB Isolation	6	79	8	106	179	206			
2	1225	200	405	TB Isolation	6	222	8	688	0	0	838	372	VAV Hood. A-33 ?? listed on roof fan chart. Hood size estimated - no access
4	3200	1700	403	microbiology special patho	6	666	8	888	816	1038			
7	3200	1700	403	microbiology special pathogens									
10	2400	1500	406	sanitary microbiology	6	1152	8	1536	1302	1686			
11	2400	1500	406										
16	2400	1000	418	serology lab	6	522	8	696	672	846			
17	2400	1000	418							?			
18	225	225	417	serology lab	6	90	8	120	190	220			
19	225	225	416	serology lab	6	90	8	120	190	220			
23	4000	1140	415	volatile organics	6	544	8	1413	0	0	725	322	VAV hood
											838	372	VAV hood
											1563	694	
9	3200	600	422	virology	6	446	8	595	596	745			
25	3200	600	422										not used per roof fan chart
26	4000	1300	414	Molecular diagnostics	6	1008	8	2006	200	0	844	375	VAV hood
27	4000	1300	414								844	375	VAV hood
						0					469	208	VAV hood
											2156	958	
AHU-3	2000	2000	421	animal room	15	1116	20	1488	1316	1688			
4th floor tc	38275	16190				5936		9655	5462	6649	4556	2025	
								Total exhaust for floor			7487	11205	

Mark	Max CFM	Min CFM	Room #	Room Use	New Min ACH Req.	New Min CFM	New Max ACH Req.	New Max CFM	new design min return AC-1/2 Exh	New desig max return AC-1/2 Exh	Calculated Hood CFM required at 18 inches	Calculated Hood CFM required Minimum	Notes
82	4000	1140	302	forensics lab	6	1620	8	2160	358	898	1025	1025	Constant Volume hoods
											438	438	Constant Volume hoods
				Check to see if 302 & 304 are joined as one room??							1463	1463	
83	4000	1500	304	toxicology lab	6	1602	8	2136	0	400	1025	456	constant volume hood
87	4000	1500	304								438	194	constant volume hood
											438	194	constant volume hood
											1900	844	
			304A	shows one fume hood??							838	372	hood size estimated - no access. Determine room size and air dist.
88	4000	1000	317	glass wash	10	1395	20	2790	1695	3090			RF-16 orig design is 9480 CFM. Recommend track supply
89	4000	1000	317										
			305								550	244	VAV hood
			305								838	372	VAV hood
90	4000	1520	305	forensic biology	6	778	8	1938			700	311	VAV hood
											2088	928	
94	4000	1500	313	biochemical and Metabolic	6	1440	8	1920	701	0	438	194	VAV hood
											838	372	VAV hood
98	4000	1500	313							?	838	372	VAV hood
											2113	939	
100	4000	1500	311	water chemistry	6	1675	8	3956	0	0	625	278	VAV hood
101	4000	1500	311								1050	467	VAV hood
											781	347	VAV hood. unidentified fan on roof fan chart serves rm 311?
											763	339	VAV hood
											888	394	VAV hood
											4106	1825	
			312								838	372	VAV hood
			312								838	372	VAV hood
105	1600	300	312	extraction	6	967	8	2363	0	0	838	372	VAV hood
											2513	1117	
3rd floor tc	41600	13960				9,476		17,262	2754	4388	15019	7488	
								Total exhaust for floor			10241	19406	

high velocity Terminal units original design Mark	Max CFM	Min CFM	Room #	Room Use	New Min ACH Req.	New Min CFM	New Max ACH Req.	New Max CFM	new design min return AC-1/2 Exh	New design max return AC-1/2 Exh	Calculated Hood CFM required at 18 inches	Calculated Hood CFM required Minimum	Notes
57	4000	1140	203	chemistry	6	567	8	1525	0	0	838	372	VAV hood
											838	372	VAV hood
											1675	744	
58	4000	1140	204	Lead	6	906	8	2225	0	0	838	372	VAV hood
											769	342	VAV hood
											769	342	VAV hood
											2375	1056	
74	3200	1500	220	air pollution lab	6	1494	8	1992	938	1436	756	756	Constant Volume Hood
71	3200	1500	220										
											756	756	
77	1600	760	221	breath analysis	6	374	8	498	524	648			
79	4000	1520	222	occupational and radiologi	6	746	8	995	96	345	850	850	Constant Volume Hood
2nd floor t	20000	7560				4086		7235	1557	2429	5656	3406	
								Total exhaust for floor			4964	8085	

31	2500	2500	106	autopsy	12	693	15	866	843	1016			RF-1 constant exhaust design 2400 CFM
33	800	800	110, 11,12		12	814	15	1017	964	1167			CE-2 constant exhaust design 450 CFM
34	600	200	113, 14	autopsy	12	414	15	518	564	668			
35	350	350	154, 55	veiwing, forensic	12	790	15	988	940	1138			RF-10 constant exhaust design 540 CFM
36	2000	2000	115	autopsy	12	1548	15	1935			2000	2000	CE-4 constant exhaust
37	3200	1300	122	histology	4	272	6	409	422	559			
38	800	800	119	autopsy	12	1017	15	1271	1167	1421			
41	400	400	128	DNA lab	6	186	8	606	0	0	756	336	VAV hood
42	530	530	129	DNA lab	6	248	8	606	0	0	756	336	VAV hood
43	700	700	130		6	568	8	757	718	907			
44	1000	1000	118,16,17	photo, storage	10	480	15	720	630	870			RF-12 Not used currently
1st floor to	12880	10580				7030		9693	6248	7746	3513	2672	
											Min total	Max total	
								Total exhaust for floor			8920	11258	

Energy Savings Methodology:

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates.

Baseline: The Labs are considered occupied during the occupied schedule (24x7, year round). For the baseline the minimum flow for the dual duct boxes is per the design (see table above). Rooftop unit 1&2 fan, cooling and heating energy was calculated based on: return and supply fan VFD, mixed air temperature, outdoor air temperature, cold and hot deck temperatures, et al. Baseline is interactive with ECMs 1 meaning AHU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this baseline.

Proposed: The ACH for the labs in the table above were reduced based on the minimum ACH required by the fume hoods or the amount required to maintain the required room minimum ACH.

The following tabs from excel workbook “NGRID TA Draft Chapin Lab Energy Use.xlsm” contain the calculations used to determine the energy savings:

EEM1 En = Base AHU Energy and demand usage (savings interactive with ECM-1)

EEM2 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water and cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- Dual box supply and exhaust CFM, fume hood exhaust CFM, and lab temperature.
- RTU-1 and 2 supply and exhaust fan % speed.

Cost Estimate

Convert fume hoods to variable volume with new exhaust valves, new fume hood zone presenc sensors, new supply and exhaust box cotrols (DDC), new thermostats, new controllers, map and program boxes and thermostats, balancer to set minimum airflows to new ACH and new unoccupied min flow.

Incremental cost = $450,000

Cost Estimate								
		Material		Labor/Install		Engineering		
Item	Qty	Unit	Cost	Unit	Cost	Unit	Cost	Total
New Exh Valves and DDC	26	$ 15,526	$ 403,684.21		INCL			$ 403,684
Adj Min ACH	64			$ 180	$ 11,520	$ 140	$ 8,960	$ 20,480
Zone Pres Senso	26	$ 500	$ 13,000	$ 360	$ 9,360	$ 140	$ 3,640	$ 26,000
								$ 450,164
							USE	$ 450,000

Source of Estimate

The cost for this measure was based on similar experience with past projects and on recent fume hood conversion project at nearby University started December, 2013.

ECM-3: Modify AHU Discharge Air Temperature Set Point Programming

Summary of Savings and Economic Results									
	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
ECM #3	4,353	-	(0.4)	$ 623	154	$ 162	0	$ -	$ 784

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ 3,880	$ 3,880	$ -	$ -	$ 3,880	4.9	4.9	4.9	4.9

Measure Description:

This measure consists of upgrading AHU 1&2 programming to reset the hot and cold deck discharge air temperature set points based on outdoor air temperature. The proposed modifications will save energy by:

The constant cold deck discharge air temperature setpoint results in increased cooling. The hot deck hot water flow is uncontrolled which causes elevated hot deck temperatures which causes rooms to increase airflow from cold deck to maintain space temperature setpoint.

Baseline Conditions

RTU-1 & 2 cold deck discharge air temperature set point is constant at 57 F and hot deck does not have a control valve and is dependent upon the hot water supply temperature and flow rate.

Proposed Modifications

For RTU-1 & 2 we recommend that the cold deck discharge air temperature set point be reset according to outdoor air temperature:

OA-T	DA-T
55	60
75	55

Reset the hot deck supply air temperature based upon outside air temp as follows:

OA-T	DA-T

55	80
25	110

All setpoints should be adjustable.

Savings Calculation Methodology

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates

Baseline: Rooftop Units 1&2 cold deck and hot deck temperatures were taken from trends (sept-Oct 2015) using the common hot deck and cold deck sensors. Baseline is interactive with ECMs 1,2 & 8 meaning RTU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this baseline.

Proposed: The proposed cold deck and hot deck temperatures were based on the reset tables shown in the proposed modifications section of this measure.

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

EEM3 En = Base AHU Energy and demand usage (interactive with ECM-1,2 & 8)

EEM4 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water and cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- OAT
- RTU Cold Deck DAT
- RTU Hot Deck DAT

Cost Estimate

Estimates about 8 hours of programming and 8 hours to test and verify the programming updates.

Incremental cost = $3,880

Source of Estimate

The cost for this measure was based on similar experience with past projects (control technician hourly rate = $180/hr).

ECM-4: Program Condenser Water Temperature Reset

Summary of Savings and Economic Results									
ECM #4	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
	8,595	-	4.3	$ 1,230	-	$ -	0	$ -	$ 1,230

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ 3,880	$ 3,880	$ -	$ -	$ 3,880	3.2	3.2	3.2	3.2

Measure Description:

This measure consists of upgrading the cooling tower programming to reset the leaving water temperature set point based on outdoor air temperature. The proposed modifications will save energy by:

Chiller efficiency increases as the entering condenser water temperature decreases. Therefore not minimizing the tower leaving condenser water temperature results in increased cooling energy usage.

Baseline Conditions

Cooling tower is controlled to a constant temperature set point for the condenser water system serving electric chillers.

Proposed Modifications

Reset condenser water supply temp based upon the outside air wet bulb temperature. Typically (to be determined by engineer/contractor during implementation):

ECWT = OA (wb) + 7 F

Reset condenser water temperature from 65 to 85 F.

Savings Calculation Methodology

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates

Baseline: Condenser water supply and return temperatures were taken from trends (sept-Oct 2015) using the existing temperature sensors. Baseline is interactive with ECMs 1, 2, 3 & 8 meaning RTU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this baseline.

Proposed: The proposed condenser water supply temperature set point was based on the reset tables shown in the proposed modifications section of this measure.

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

EEM4 En = Base AHU Energy and demand usage (interactive with ECM-1,2,3 & 8)

EEM5 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- OA % RH, OAT dry bulb and wet bulb temps, LCWT and ECWT set point
- Cooling tower fan speeds

Cost Estimate

Estimates about 8 hours of programming and 8 hours to test and verify the programming updates.

Incremental cost = $3,880

Source of Estimate

The cost for this measure was based on similar experience with past projects (control technician hourly rate = $180/hr).

ECM-5: AHU-4 Supply Fan VFD

Summary of Savings and Economic Results								
ECM #5	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
	14,354	-	-	$ 2,053	7,145	$ 7,503	0	$ -	$ 9,556

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ 15,000	$ 15,000	$ -	$ -	$ 15,000	1.6	1.6	1.6	1.6

Measure Description:

This measure consists of upgrading new/modified AHU-4 with supply fan VFD and controls to convert from constant air volume to variable air volume control. The proposed modifications will save energy by:

Energy is wasted conditioning more outside air than is necessary.

Baseline Conditions

AHU-4 operates at a constant speed to provide 100% outside air ventilation to the basement mechanical room. Steam coil modulates to maintain space temp set point.

Proposed Modifications

Provide and install a VFD on the supply fan. Replace fan motor if not rated for operation with a VFD. Install digital controls for VFD and steam heating coil.

1. Provide new DAT sensor wire/map to EMS controller.
2. Provide new space temperature sensor wire/map to EMS controller.
3. Balancer to measure full load cfm discharge, if not at design retrofit/replace existing fan sheave.
4. Provide control points for new VFD and AHU-4.
    a. AHU-4 fan (start/stop, status)
    b. AHU-4 % speed (status and speed command)
    c. Alarm points for status, hand operation

d. Program new fan VFD to modulate to maintain space temperature set point, reset space temperature set point based on OAT

Savings Calculation Methodology

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates

Baseline: AHU-4 fan and heating energy calculations were based on operating the unit 24x7 year round, and with a DAT set point = 80 F during heating mode. Baseline is interactive with ECMs 1, 2, 3, & 8 meaning AHU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this baseline.

Proposed: The proposed fan and heating energy calculations were based on same operating hours and DAT set point but included varying the new fan VFD from 50% to 100% based on space temperature.

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

EEM4 En = Base AHU Energy and demand usage (interactive with ECM-1,2,3 & 8)

EEM7 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water to the boilers.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- OAT dry bulb, space temperature, space temperature set point
- Fan speed

Cost Estimate

Installing new 7.5 Hp VFD on supply fan, new controls and space thermotat including connecting new VFD to BAS

Incremental cost = $15,000

Cost Estimate								
		Material		Labor/Install		Engineering		
Item	Qty	Unit	Cost	Unit	Cost	Unit	Cost	Total
New VFD	7.5	$ 600	$ 4,500			INCL		$ 4,500
Programm	24			$ 180	$ 4,320		$ -	$ 4,320
New DAT s	2	$ 1,500	$ 3,000			INCL		$ 3,000
Contiency	1	$ 3,000	$ 3,000			INCL		$ 3,000
Total								$ 14,820
							Use	$ 15,000

Source of Estimate

The cost for this measure was based on similar experience with past projects.

ECM-8: New Cooling Tower and Chilled & Condenser Water System Modifications and Repairs

Summary of Savings and Economic Results									
ECM #8	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
	244,875	-	62.1	$ 35,029	-	$ -	0	$ -	$ 35,029

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ -	$ 253,400	$ -	$ -	$ 253,400	7.2	7.2	7.2	7.2

Measure Description:

This measure consists of installing a new cooling tower, retrofitting the chilled water distribution system and new chilled and condenser water pump controls. The proposed modifications will save energy by:

The chillers are operating at condenser water temperatures that are above design due to broken cooling tower media which is wasting water and electrical energy.

Operating two chilled and two condenser water pumps when only one of each is required is wasting energy.

Existing Conditions:

There are two chilled water pumps P-4 & 5 each with 20 hp motor rated 868 GPM at 75 ft of head (per original drawings, no nameplate on pump). Actual installed motor on P-5 is 25 HP.

There are two condenser water pumps P- 6 & 7 each with 20 HP motor rated 1000 GPM at 60 ft of head (per original drawings, no nameplate on pump). Each chiller has a condenser water automatic flow control valve (Flow Design model WS-600) sized: Chiller 1 – 450 GPM and Chiller 2 = 645 GPM. These were installed due to the two chillers being different sizes.

There is no condenser or chilled water pump status or start/stop on EMS. Both chilled and condenser pumps run continuously. Original design requires only one chilled and condenser pump to run for both chillers.

There is a separate CHW return leg from RTU-1 & 2. Each has a 2-way control valve in the return line in the basement. There is an automatic 2-way bypass valve in the basement that allows supply water to be recirculated to the chillers. The bypass valve is controlled using an inverse relationship with the AHU-1 & 2 CHW control valves. The AHU-1 & 2 CHW control valves and the bypass valve appears to be fully open. We tried opening and closing the bypass valve but it did not move. The pilot positioner requires adjustment. Low chiller delta T (48-42=6) indicates that bypass is open preventing AHU coils from getting design flow. We noted that chiller 1 had a low delta T of about 3 F when running while chiller 2 delta T was about 6 F. The CHW system bypass ties into the chillers return directly above chiller 1. This shows that bypass valve is open short-circuiting much of the chilled water supply to chiller 1 return.

There are two CHW flow meters in the CHW supply line in the basement. Flow on August 25th was reading 845 GPM to AHU-1 & 2 and 21 GPM total to AHU-1 & 2 and bypass. The Flow meters are installed as shown on the EMS graphic however one reads total flow (incorrectly labeled as bypass) and the second meter reads just what is delivered to the AHUs. In order to determine actual bypass flow the program should take the difference between the two meters. One of the meters was just replaced and is located too close to elbows which will affect the meter accuracy.

The CHW lines close to the ceiling above the boiler burners are uninsulated and rusting.

On 8/25 OA temp was 90 F and both chillers were running and the CHW supply and return was 42/48 F for each chiller. The chiller 1 was at 70% and chiller 2 90% load. The EMS CHW return temp was 66 F. Chillers entering and leaving condenser water temp was 90/97 F with the tower fans both running. On 8/27 the OA temp was 80 F with chiller 1 running up to 40% and cycling on/off on its internal temperature controls and chiller 2 running between 50 and 70%. The tower is not able to produce design of 85 F condenser water even with chillers partially loaded.

Cooling tower is mounted on the roof and is BAC model 15325DW. The Tower fan starters are mounted approximately 1 foot (too close) above the roof which has caused the bottom of the enclosures to rust through. Tower media on one side appears to be completely broken, which while still operational is causing reduced chiller capacity and chiller efficiency.

Chilled water system bypass valve being wide open is preventing chillers from fully loading.

Chilled water flow meters installation and chiller staging program configuration is preventing chillers from staging down when load is reduced.

Proposed Modifications:

The existing piping and pumping configuration is extremely difficult to control due to the fact that there are two chillers and two RTUs. Any small change in control valve position will cause large changes in chilled water flow and risk tripping the chillers. We believe that this is the reason that all pumps and bypass valves are being operated fully open. To greatly reduce the potential for future trips and save energy we have the following recommendations:

1. Reconfigure chilled water piping to a primary/secondary system. Add a constant speed primary pump for each chiller. Add a new VFD for each secondary chilled water pump (utilize existing chilled water pumps). Verify that existing motors are rated for VFDs. If not, replace with VFD rated motors. Eliminate the chilled water bypass valve.
2. If RTU-1 & 2 are replaced, eliminate the chilled water control valves in the basement for RTU-1 & 2 and provide new control valves with electronic actuators in each RTU.
3. Replace any sections of chilled water piping that are rusted and re-insulate.
4. Provide control points for each pump.
    a. Primary chilled water pumps (start/stop, status)
    b. Secondary chilled water pumps (start/stop, status and speed command)
    c. Condenser water pumps (start/stop and status)
    d. Cooling tower fans (start/stop, status, speed command).
5. Replace the existing towers with new open type induced draft cooling towers. Each fan should be equipped with a VFD that is controlled by the Building Control System. Each VFD should have disconnect and automatic bypass and be mounted in an accessible location that is protected from snow/rain

Energy Savings Methodology:

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates.

Existing: The chilled water and condenser water pumps are operated in hand and all four pumps were considered on whenever the chiller plant is enabled. The chiller and tower energy calculations based on chilled water temperature, condenser water temperature, chiller status trends (Sept-Oct 2015). Baseline is interactive with ECMs 1 & 2 meaning RTU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this existing condition.

Proposed: The proposed chiller, tower and pump energy calculations were based on chiller performance part load calculations and pump and fan power calculations.

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

AHU2 En = Base AHU Energy and demand usage (Interactive with ECM-1&2)

EEM3 En= Proposed Case AHU Energy and demand

EEM3BC CHW En = ECM-3 base case chilled water plant energy and demand usage (interactive with ECMs 1&2)

EEM3 CHW En = ECM-3 Proposed Case chilled water plant energy and demand usage.

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Chiller performance data (Chlr data tab same workbook)
- Trends and observation data (Trends & Obsv tab same workbook)

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- Supply and return condenser water temperatures.
- Supply and return chilled water temperatures.
- Chiller status (both chillers).

Cost Estimate

New cooling tower (use $40/gpm (1,000 gpm) for new tower, pipiing modifications, new secondary chilled water pumps with VFDs, new chilled water control valves (include in new RTU 1&2 cost), new controller and programming.

Installed cost = $290,000

Cost Estimate								
		Material		Labor/Install		Engineering		
Item	Qty	Unit	Cost	Unit	Cost	Unit	Cost	Total
New Tower	1000	$ 40	$ 40,000			INCL		$ 40,000
New piping, val	1	$140,000	$140,000			INCL		$140,000
(2) New 20 CH\	2	$ 32,000	$ 64,000			INCL		$ 64,000
New DDC and	1	$ 25,000	$ 25,000			INCL		$ 25,000
Programming	100			$ 180	$ 18,000		$ -	$ 18,000
Total								$287,000
							Use	$290,000

Source of Estimate

The cost for this measure was based on similar experience with past project

.

ECM-9: Install New Domestic Instantaneous Hot Water Heaters

Summary of Savings and Economic Results									
	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
ECM #9	-	-	-	$ -	5,302	$ 5,568	0	$ -	$ 5,568

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ -	$ 35,000	$ -	$ -	$ 35,000	6.3	6.3	6.3	6.3

Measure Description:

This measure consists of installing new instantaneous domestic hot water heaters. The proposed modifications will save energy by:

The new heaters will reduce storage (less heat loss) and increase heat transfer resulting in reduced natural gas energy use by the steam boiler(s).

Existing Conditions

The domestic water storage tank (located in the basement) uses high pressure steam to heat water and has significant standby losses.

Proposed Modifications

Install two instantaneous hot water heaters that use high pressure steam. The storage tank would not be needed with this approach and could be removed.

Alternate approach is to install a new gas fired condensing boiler with circulating pump to heat the water in the tank. If this approach is taken along with FI-6 further reduction in the size of the steam boilers may be possible.

Energy Savings Methodology:

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates.

Baseline: The baseline domestic hot water heating energy use was estimated as 40% of the non-heating end use.

Proposed: The proposed heating energy was calculated by increasing heat transfer efficiency from 60% to 83%. .

The following tabs from excel workbook “NGRID TA Draft Chapin Lab Energy Use.xlsm” contain the calculations used to determine the energy savings:

ECM-9 Calcs = Base and proposed domestic hot water energy use

Back up data including

- Weather Bin Data (Providence, RI.)

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water to the boiler.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- Domestic hot water supply temperature.
- Steam control valve position for instantaneous DHW(s).

Cost Estimate

New steam fed instantaneous domestic hot water heaters, associated controls and pipiing and fittings.

Installed cost = $35,000

Source of Estimate

The cost for this measure was based on similar experience with past projects

.

NOT ELIGIBLE FOR NEW CONSTRUCTION OR RETROFIT

ECM-6: Install New Rooftop Units with Heat Recovery

Summary of Savings and Economic Results									
	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
		winter	summer						
ECM #6	29,021	-	32.1	$ 4,151	14,510	$ 15,235	0	$ -	$ 19,386

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$1,000,000	$1,000,000	$ -	$ -	$1,000,000	51.6	51.6	51.6	51.6

Measure Description:

This measure consists of upgrading modified AHUs 1&2 to 100% outdoor air units with energy recovery as well as connecting individual rooftop exhaust fans to new central strobic exhaust fans (with VFDs) and connecting all fume hood and general exhaust to energy recovery section in new AHUs (1&2). The proposed modifications will save energy by:

- Recovering heat and cooling from exhaust based on outdoor air temperature provide heating and cooling energy savings
- There may be exhaust fan savings due to new strobic fans with VFD controls – savings NOT included in report because savings will be impacted by the type of fans specified by the design engineer.

Baseline Conditions

RTU-1 and 2 were installed in about 1977 and are beyond their expected useful life. We noted the following issues with the equipment:

- AHU-1 floor under cold deck coil is leaking air and water.
- Sections of insulation under the unit fans is falling off.
- Return air dampers are in poor condition and allow air to be recirculated
- One VFD has been replaced. Water was found leaking in through the unit roof causing it to trip.
- Fans are original vane axial with blade control arms disconnected. It is not clear whether bearings or motors have ever been replaced.
- Door latches on some doors do not work and doors are being held closed with wood braces.
- These units do not have heat recovery.

- Insulation is missing on chilled and hot water piping that feeds these units.
- Many of the electronic controllers in the air handling units are not calibrated and/or are not functioning properly.

AHU-1 & 2 both have return dampers and relief dampers (no outside air dampers). Economizer is enabled based on OA dry bulb temp below 55 F. When Economizer is on the mixed air dampers control to mixed air temp of 55 F. When Economizer is off the mixed air dampers remain at minimum position.
In September 2015 a balancer measured airflows for each unit hot deck, cold deck and outside air with economizer on and off. One of the two supply fans in AHU-1 was off which is the reason for the difference in airflows between AHU-1 & 2. Supply air fan VFDs operate to 1.5 inch static pressure setpoint and return fans at 0.5 inches. When readings were taken the supply fans were operating at 100% and return fans at 85% speed.

AHU-1 & 2 operate continuously and serve the building variable volume dual duct system with between 50% and 100% outside air depending upon economizer mode and the mixed air temperature. <u>This does not meet current codes which require 100% outside air and exhaust.</u>

There are numerous roof mounted exhaust fans that serve laboratory fume hoods, bathrooms, etc. These exhaust fans currently operate at a constant volume and would be reduced as described in EEM-2 Laboratory Airflow Reduction measure. The current configuration of exhaust fans do not provide adequate exhaust stack height to remove potentially dangerous contaminants from the breathing zone of personnel working on the roof.

Exhaust fans from original design:

LHE Fans	CFM	Hood Rm		RF & CE Exhaust fans	CFM
1	1625	203		RF-1	2400
2	750	302		CE-1	290
3	1490	302		CE-2	450
4	1625	203		CE-3	305
5	1625	204		CE-4	2000
6	1490	304		RF-2	726
7	1625	204		CE-5	134
8	750	304		RF-3	1894
9	750	304		RF-4	234
10	1146	304		RF-5	468
11	1625	305		RF-6	234
12	1146	122		RF-7	1894
13	1900	311		RF-8	540
14	1500	220		RF-9	240
15	1625	311		RF-10	540
16	2200	311		RF-11	90
17	1260	312		RF-12	295
18	1625	222		RF-13	234
19	1000	313	perchloric	RF-14	234
20	916	405		RF-15	468
21	1625	414		RF-16	9480
22	1625	414		RF-17	759
23	1100	414		RF-18	760
24	1260	415		RF-19	2904
25	916	415		RF-20	2000
26	1260	115		Total	29573
27	1260	122			
28	200	313			
29	200	311			
30	200	220			
Total	37319				

Many of these fans are not operating and are due to be repaired including:

RF-4	RF-7	LHE-27
RF-5	RF-12	LHE-28
RF-6	RF-15	
RF-8	RF-17	
RF-9	RF-18	

The base line energy use assumes existing AHU 1&2 are modified/upgraded to 100% outdoor air units and supply fan VFDs upgraded to provide original design specifiecations.

Suggested Modifications:

Since approximately 75% of the supply air serves laboratories the new unit is required by code to be 100% outside and exhaust.

If EEM-2 is implemented the reduction in exhaust flow would create greater risk to personnel working on the roof to be exposed to harmful exhaust. In order to create a safer condition on the roof we recommend that all roof mounted exhaust fans be removed and a ductwork header be installed to connect all roof exhaust openings to a minimum of three (3) strobic exhaust fans. These fans would have variable frequency drives that would be controlled to maintain a constant exhaust duct system static pressure required to allow all fume hoods to maintain their design airflow setpoint. The new strobic exhaust system would also have bypass dampers or fans with variable nozzles which would be controlled to maintain an exhaust plume height that would make it safer for persons working on the roof.

In order to save heating and cooling energy we recommend the installation of heat recovery coils in AHU-1 & 2 and the exhaust system. One possible configuration would be glycol heat recovery coils in the outside air intake of AHU-1 & 2 and at the inlet of the new bank of strobic exhaust fans. Piping and a pump would be installed to circulate a glycol mixture between the supply and exhaust coils whenever the outside air is above 75 F or below 50 F in order to reduce the amount of cooling and heating energy required to condition outside air.

This measure requires the implementation of EEM-1 & 2 which would provide new controls and retrofit terminals for each supply and exhaust box serving the building..

The approach used for the proposed case savings is to remove AHU-1 & 2 and rooftop exhaust fans and replace them with two new 100% outside air units each rated at about 50,000 CFM. Each new RTU would have outside air dampers, filters, energy recovery coil, two supply fans with VFDs, hot deck heating coil and cold deck cooling coil. Includes installing one bank of three strobic exhaust fans or two separate banks of strobic exhaust fans with VFDs. Each bank of exhaust fans would have an energy recovery coil with filters. The supply and exhaust energy recovery coils would be connected together with piping and a circulating pump (with VFD) sized for glycol mixture.

Further design engineering is required to obtain an investment grade proposed cost.

Savings Calculation Methodology

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates

Baseline: AHU- 1&2 fan, cooling and heating energy calculations were based on operating the unit 24x7 year round, and with 100% outdoor air and fan VFDs upgraded to provide airflows per original design. Baseline is interactive with ECMs 1, 2, 3, 4 & 8 meaning AHU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this baseline.

Proposed: The proposed fan, cooling and heating energy calculations were based on same operating hours and also 100% outdoor air, however also included energy recovery from general and hood exhaust flows.

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

ECM6BC En = Base AHU Energy and demand usage (interactive with ECM-1,2,3,4 & 8)

ECM6 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water to the boilers and from cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- OAT dry bulb, space temperature, space temperature set point
- AHU 1&2 Fan speed
- Energy Recovery section inlet air temperature (AHUs 1&2)
- Cold and hot deck discharge air temperature (AHUs 1&2)
- Total discharge air flow (cfm) AHUs 1&2

Cost Estimate

Incremental cost between modifying/upgrading existing AHUs 1&2 dampers,controls and VFDs and cost for new AHUs with heat recovery and new strobic exhaust fans serving general and hood exhausts, consolidating hood and other individual rooftop exhaust fans and connection to new strobic fans.

Incremental cost = $1,000,0000

Source of Estimate

The cost for this measure was based on similar experience with past projects.

ECM - 7: Install New Chillers

Summary of Savings and Economic Results									
	Electricty				Natural Gas		Other		Total Cost Savings
	kWH	kW		$	Therms	$	Mbtu	$	
ECM #7		winter	summer						
	9,531	-	10.1	$ 1,363	-	$ -	0	$ -	$ 1,363

Implementation Costs and Economic Results									
Base Case Cost	Proposed Case Cost	Measure Cost	Electric Incentive	Natural Gas Incentive	Net Incremental Cost	Simple Payback (Elect & gas) Years		Simple Payback including NEBS (Years)	
						Before Incentives	After Incentives	Before Incentives	After Incentives
$ -	$ 45,000	$ 45,000	$ -	$ -	$ 45,000	33.0	33.0	33.0	33.0

Measure Description

This measure consists of upgrading proposed new chillers to high efficiency water cooled variable speed magnetic bearing models. The proposed modifications will save energy by:

Increasing the chiller performance efficiency over all loads as compared to same capacity chiller meeting state energy code will provide chiller energy savings.

Baseline Conditions

There are two chillers with constant speed rotary helical screw compressors that were manufactured by Trane company in 1998.

Chiller 1 is rated for 150 tons model RHTB150___00LWP000UNN2LF2LFV00__ Serial U98J03151

Chiller 2 is rated for 215 tons model RTHB215FMF00LWP000NNN2LF2LFV00U0 Serial U98K03152

The baseline chiller efficiency is based on meeting minimum required by the IEEC 2012 Table C403.2.3(7) Minimum Efficiency Requirements Water Chilling Packages:

>= 150 tons < 300tons full load .680 kW/ton IPLV = .580 kW/ton.at AHRI 550/590.

Suggested Modifications

Install two new chillers with variable speed compressors and magnetic bearings. Each chiller should be the same size and rated to meet the new building load (assuming that ECMs 1,2,6 & 8 are implemented). Assume new chillers meet performance of

York YMC2-S1120AA: Full load = .576 kW/ton NPLV = .337 (AHRI 550/590) ECHWT/LCHWT = 44F/54F and ECWT/LCWT = 85F/95F.

Savings Calculation Methodology

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates

Baseline: The baseline chiller energy was calculated based on load profile (tons) as calculated for AHUs 1&2 in ECM-6 (allocated to weather bins). Chiller energy based on baseline chiller kW/ton at percent load (based on load profile and chiller capacity). Baseline is interactive with ECMs 1, 2, 3, 4 & 8 meaning RTU-1 and 2 airflow modifications and cooling and heating savings from these measures are accounted for in this baseline.

Proposed: The proposed chiller energy was calculated using the same load profile however using the proposed chiller performance data (kW/ton) based on the proposed chiller model (York YMC2-S1120AA).

The following tabs from excel workbook “NGRID TA Draft Chapin Lab Energy Use.xlsm” contain the calculations used to determine the energy savings:

ECM7BC En = Base AHU Energy and demand usage (interactive with ECM-1,2,3,4 & 8)

EC76 En= Proposed Case AHU Energy and demand

NGRID Screen inputs = NGRID summer and winter average on peak demand used in the benefit/cost analysis.

Back up data including

- Weather Bin Data (Providence, RI.)
- Trends and observation data (Trends & Obsv tab same workbook
- Chlr Data tab – baseline and propsed chiller performance data.

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from cooling savings which in turn reduces evaporation and drift losses from the cooling tower.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- OAT dry bulb, space temperature, space temperature set point
- Chiller 1&2 Status
- Chiller 1&2 entering and leaving chilled water temperatures
- Chiller 1&2 entering and leaving condenser water temperatures

Cost Estimate

Incrmental cost between baseline and proposed case chillers (two, each rated at 150 tons).

Incremental cost = $45,000

Source of Estimate

The cost for this measure was based on similar experience with past projects. (based on recent study Tufts LAH 320 ton york centrifugal vs 320 York centrifugal with VFD (Magnetic bearings).

ECM-10: Install New Hot Water Heating Boilers

<table>
<tr><th colspan="10">Summary of Savings and Economic Results</th></tr>
<tr><td rowspan="4" colspan="2">ECM #10</td><td colspan="4">Electricty</td><td colspan="2">Natural Gas</td><td colspan="2">Other</td><td rowspan="2">Total Cost Savings</td></tr>
<tr><td>kWH</td><td colspan="2">kW</td><td>$</td><td>Therms</td><td>$</td><td>Mbtu</td><td>$</td></tr>
<tr><td rowspan="2">-</td><td>winter</td><td>summer</td><td rowspan="2">$ -</td><td rowspan="2">11,297</td><td rowspan="2">$ 11,862</td><td rowspan="2">0</td><td rowspan="2">$ -</td><td rowspan="2">$ 11,862</td></tr>
<tr><td>-</td><td>-</td></tr>
<tr><th colspan="10">Implementation Costs and Economic Results</th></tr>
<tr><td rowspan="2">Base Case Cost</td><td rowspan="2">Proposed Case Cost</td><td rowspan="2">Measure Cost</td><td rowspan="2">Electric Incentive</td><td rowspan="2">Natural Gas Incentive</td><td rowspan="2">Net Incremental Cost</td><td colspan="2">Simple Payback (Elect & gas) Years</td><td colspan="2">Simple Payback including NEBS (Years)</td></tr>
<tr><td>Before Incentives</td><td>After Incentives</td><td>Before Incentives</td><td>After Incentives</td></tr>
<tr><td>$ -</td><td>$ -</td><td>$ 300,000</td><td>$ -</td><td>$ -</td><td>$ 300,000</td><td>25.3</td><td>25.3</td><td>25.3</td><td>25.3</td></tr>
</table>

Measure Description:

This measure consists of installing two new condensing hot water boilers. The proposed modifications will save energy by:

The new boilers will produce hot water for space heating more efficiently than the existing steam boilers and hot water converters thus reducing natural gas energy.

Existing Conditions

There are two steam to hot water heat exchangers that provide heat to hot water coils in RTU-1 & 2 and perimeter radiation. The boilers provide 60 psig steam to the heat exchangers which is very inefficient when compared with hot water condensing boilers.

Proposed Modifications

Install two condensing boilers with pumps and connect directly to the air handling units and perimeter heating. If RTU-1 & 2 are replaced with new rooftop units the hot water coils could be sized for lower water temperature which would allow boilers to operate in the condensing region (below 140 F) at much higher efficiency than existing.

One potential issue that should be considered under this approach is if there was a failure of gas pressure to the building. Current boilers are dual fuel which allows use of gas or oil. Possible approach would be to leave one and remove one of the existing steam dual fuel boilers.

Energy Savings Methodology:

Energy savings were calculated using custom EXCEL based spreadsheets. The calculations are weather bin based using TMY data from Providence, RI.

The baseline and proposed energy usage was calculated using information obtained from design drawings and existing use schedules for the facility provided by the owner, trend data from existing controllers and balance readings taken by Thomas Young Associates.

Baseline: The baseline AHU heating energy use was based on heating loads calculated for the new AHUs with heat recovery (ECM-6).

Proposed: The proposed heating energy was calculated by increasing the fuel to hot water efficiency for the AHU heating loads from 75% to 94%.

The following tabs from excel workbook "NGRID TA Draft Chapin Lab Energy Use.xlsm" contain the calculations used to determine the energy savings:

ECM-6 En = Base case hot water heating energy for AHUs 1&2 (interactive with ECMs 1,2,3,4&6)

ECM-10 En = Proposed case hot water heating energy for AHUs 1&2

Back up data including

- Weather Bin Data (Providence, RI.)

Non-Energy Saving Benefits

NEBs associated with this measure consist mainly of city water savings resulting from reduced steam usage which in turn reduces make up water to the boiler.

Measurement and Verification

Measurement and verification to ensure retention of energy savings should include setting up trends (15-minute interval data) which should be retained for at least 6-months and include:

- Heating hot water supply and return temperatures.
- Annual (at least) combustion efficiency test for both new boilers

Cost Estimate

New natural gas fired condensing hot water boilers, associated controls and pipiing and fittings.

Installed cost = $300,000

Source of Estimate

The cost for this measure was based on similar experience with past projects.

APPENDICES

A. Copy of TA Proposal

B. Minimum Requirements Documents

C. EQUIPMENT DATA AND CHILLER PERFORMANCE

   a. Equipment Data

D. EXCEL SPREADSHEETS NGRID INPUTS

   a. BC CHW En Use = Base Case chiller Energy and demand usage
   b. ECM1 CHW En Use = Proposed Case chiller Energy and demand
   c. ECM2 CHW En Use = Proposed Case chiller Energy and demand
   d. ECM3 CHW En Use = Proposed Case chiller Energy and demand
   e. ECM4 CHW En Use = Proposed Case chiller Energy and demand
   f. AHU BL En Use Calculated chilled water load (tons) profile (to weather bins) – same for base and proposed cases
   g. NGRID Screen Inputs

E. Miscellaneous Supporting Data

   1. Mechanical Design
   2. Vendor price quotes

A. Copy of TA Proposal

September 29, 2015 2-07-15b

Mr. Jerry Drummond, CEM, CEP

Lead Energy Efficiency Representative State and Municipal Agencies

National Grid

280 Melrose St.

Providence RI 02907

Subject: Investigation Phase Retro-Commissioning Services Proposal Chapin Building 50 Orms Street Providence RI

Dear Jerry,

Applied Energy Engineering & Commissioning (AEEC) is pleased to submit this revised proposal for existing building commissioning services for the Chapin Building located at 50 Orms Street in Providence, RI.

This proposal supercedes our proposal dated August 6th and is based upon our walkthrough of the building on July 27, 2015 and a brief review of the original mechanical drawings. We feel that we have the knowledge and experience to work with the State and National Grid (NGrid) through this critical process which will yield

energy savings, a more comfortable environment and a plan for maintaining the building in the future.

All commissioning activities will be performed by a Professional Mechanical Engineer with more than 20 years of experience.

Scope:

For the project we propose to use an approach based on ASHRAE Energy Survey and Engineering Analysis Level II which involves a detailed building survey, including energy consumption and peak demand analysis. A breakdown of energy end uses within the building is developed. A Level 2 energy analysis will identify and provide the savings and cost analyses of all practical energy efficiency measures (EEMs) that meet the Owners constraints and economic criteria, along with proposed changes to operation and maintenance (O&M) procedures. It will also provide a listing of potential capital-intensive improvements that require more thorough data collection and engineering analysis as well as an assessment of potential costs and savings.

The proposed scope was defined to provide investigation phase Retro commissioning services that will be utilized as the basis for identifying energy efficiency measures for the Level 2 audit. The RCx process also provides an operational assessment of the building.

The tasks will include:

- Gather and review all available building documentation and operating requirements
- Determine Energy Use Index relative to comparable buildings by using Utility billing data

- Prepare ASHRAE Level II Energy End Use Analysis based on detailed operating data and energy calculations
- Perform independent evaluation of mechanical systems
- Perform detailed diagnostic monitoring with controls and balancing contractors
- Perform functional tests where diagnostic monitoring is not adequate
- Identify, perform and document simple repairs
- Provide site visit reports to The State and NGrid.
- Define a list of potential Energy Efficiency Measures
- Prepare baseline energy and individual measure proposed energy calculations and use to determine savings for each measure.
- Develop list of capital improvement measures with preliminary energy and other operational savings, order of magnitude installed cost and conceptual level design/specification(s).
- Prepare an existing conditions assessment of the emergency generator
- Include results of a Lighting audit performed by an Ngrid Lighting expeditor
- Prepare a draft report with recommended operational improvements and measures.
- Work with the State and National Grid to identify appropriate incentive programs and submit appropriate applications and/or proposals.

Activities

Below we have provided a general list of activities that will be performed by AEEC, the controls and balancing subcontractors. Estimated hours to perform each task is provided in the Fee section near the end of the proposal. Specific systems that will be analyzed are listed in the section titled Systems Included in Investigation.

a. Utility Billing and Usage Data – AEEC will use electric and natural gas billing data to prepare an energy use index analysis. The energy use for this climate and building type/size will be compared with similar buildings.

b. Provide enhanced Energy End Use Analysis- AEEC will perform energy end use analysis using detailed energy calculations and operating data/trends.

c. Perform diagnostic monitoring – AEEC will work with EMC controls to help understand and document exactly how the sequence of operation is programmed for each type of system that is evaluated. We will also work with a Certified Testing, Adjusting and Balancing Contractor to measure air and water flows to help us to understand whether or not EMS readings are accurate or require calibration. We have budgeted to spend up to (5) five days working with these Contractors. This information will be used to help make an assessment of the systems.

d. Perform functional tests – when it is not possible to utilize trend data we will prepare functional tests to determine how the systems are operating.

e. Identify and document simple repairs – for example, when testing dual duct VAV boxes the balancer will measure flows and instead of just documenting how much the flow is off, the controls contractor will make calibration adjustments and complete the work. These types of adjustments will be documented and included in the savings calculations.

f. Site Reports – a site visit report will be prepared for each day spent on-site. The report will document activities performed, findings and recommendations along with next steps. This helps make the Owner aware of progress and issues identified on a regular basis.

g. Identify a list of opportunities – A table will be provided with a list of low cost/no cost energy conservation measures and a separate list of longer payback measures that require capital investment/improvement. The estimated energy savings for each measure proposed will be determined using custom EXCEL based spreadsheet using 20-year weather bin data to calculate baseline and proposed energy use for each of the measures. We will utilize cost estimates prepared by Contractors wherever possible. If there are measures that can be implemented in more than one way, we will identify and evaluate feasibility and cost for each method.

h. Survey emergency generator and Electrical System – we will perform an existing conditions assessment of the emergency generator and comment on expected useful life and any potential demand side management opportunities.

i. Survey Lighting – we will utilize the services of a lighting expeditor who is an approved vendor by National Grid.

j. Prepare a draft report – this report will identify recommended operational improvements and energy conservation measures as low cost or requiring capital investment. The report will include all the information collected above and will be organized as follows: List of low cost/no cost measures, List of measures requiring capital investment, Description of the systems installed with findings of how each was operating and a description of each energy conservation measure identified (including estimated cost and annual energy savings). We will attend a meeting with the State and NGrid to discuss the report and then issue a final version incorporating all comments and recommendations.

Approach:

We plan to review building operation in the summer/fall which will provide a limited picture of the existing issues. This will force us to make assumptions about winter operations.

In order to perform the activities will require close cooperation between The State, NGrid, Contractors and AEEC. Arthur Adler, P. E. will act as the project manager for AEEC. He will perform most of the on-site retro-commissioning activities including meetings and working with the Contractors. Ron MacLellan, P. E. will also be on-site part of the time and will provide support services including development of energy saving calculations and review of all reports.

We have included subcontracting the services of controls and balancing contractors as identified below:

- Subcontract a controls contractor (up to 2 days)
- Subcontract a certified testing adjusting and balancing contractor (up to 4 days)

We will recommend contractors with whom we have previously or will be glad to work with any contractors preferred by The State.

For the building control system we will work with the controls subcontractor (senior person most familiar with the programming) to provide us with an interpretation of how the controls are programmed as compared with the intended sequence of operation. This person will also provide input on how best to manipulate the program to enable a complete test of all systems. They will also provide cost estimates to implement recommended measures.

The balancing subcontractor will confirm if the control system airflow readings on selected air handling units and air valves are accurate. He/she will also determine if selected water systems are balanced in accordance with original design documents. The balancer will be brought on-site after we have spent at least 2 days with the controls contractor.

NGrid will provide the services of an approved lighting expeditor who will provide a report with detailed recommendations. We will incorporate this information into our report.

Systems Included in the Investigation Phase: The following systems will be included:

1. Air Handling and Exhaust Systems
    a. RTU-1 & 2 serving the first though 4th floors
        i. Review and verify the operation of dampers, supply and return fan VFDs, heating and cooling coils and humidifiers
        ii. Review and verify the operation of the supply and return airflow for two dual duct boxes on each floor at minimum and maximum airflow settings. Also, measure and document the room pressure and return airflow for the same spaces.

    b. Lab hood exhaust fans
        i. Review and verify the operation and verify the airflow of 4 lab fume hoods and associated exhaust fans. Note any airflow or room pressure changes at different sash positions.

    c. AHU-3
        i. Review operation of heating and cooling coils and supply/exhaust airflows.

    d. AHU-4 serving the Basement Mechanical room.
        i. Review operation of the unit including dampers and heating coils

2. Chilled water system
    i. Review the operation of chillers, chilled and condenser water pumps and cooling tower.

3. Steam and hot water systems
    i. Review the operation of steam boilers, low and medium pressure systems, steam to hot water heat exchangers, steam traps, condensate receivers, autoclaves, hot water pumps and control valves.

4. Refrigeration systems serving cold rooms

5. Automatic Temperature Controls
    a. Pneumatic controls
        i. Assess compressed air system in the building.

    b. Johnson Controls system
        i. Review control system programs and analyze trend data with JCI technician to document how the mechanical systems listed above are actually functioning.

6. Lighting and lighting controls
    a. A Ngrid approved lighting expediter will review existing lighting and controls systems and provide recommendations for energy saving upgrades. We will incorporate finding into the RCx study.

7. Emergency Generator
    a. Assess existing condition of emergency generator, expected useful life and comment on any potential demand side management application.

Services NOT Included:

Engineering Design services - For any measures identified that require development of design drawings and specifications, a separate engineering design firm will have to be contracted by The State.

Preparation of Scopes of Work – we can prepare scopes of work for measures that do not require further engineering.

Implementation Verification – AEEC can provide these services under a separate contract after the State determines which measures they would like to implement.

Schedule:

We anticipate being able to begin work upon receiving a notice to proceed.

We anticipate being able to provide a draft report within 10 weeks of receiving a notice to proceed.

B. Minimum requirements Documents

C. Equipment Data – in separate electronic EXCEL workbook: "NGRID TA Draft Chapin Lab Energy Use r2.xlsm"

D. EXCEL SPREADSHEETS/ NGRID REPORTS in separate electronic EXCEL workbook: "NGRID TA Draft Chapin Lab Energy Use r2.xlsm"

E. Miscellaneous Project Data

a. HVAC Drawings

Solicitation #:
Solicitation Title: **Chapin Health Lab – HVAC Upgrades**

BID FORM

To: The State of Rhode Island Department of Administration
Division of Purchases, 2nd Floor
One Capitol Hill, Providence, RI 02908-5855

Bidder: ____
Legal name of entity

____
Address (street/city/state/zip)

____
Contact name Contact email

____
Contact telephone Contact fax

1. BASE BID PRICE

1. The Bidder submits this bid proposal to perform all the work (including labor and materials) described in the solicitation for this Base Bid Price (*including the costs for all Allowances, National Grid Incentives, and Addenda).* **Vendors responding to this RFQ are directed to debit project rebates from National Grid from their proposed price.**

$____
(base bid price *in figures* printed electronically, typed, or handwritten legibly in ink)

____
(base bid price *in words* printed electronically, typed, or handwritten legibly in ink)

- **Allowances**

The Base Bid Price ***includes*** the costs for the following Allowances:

No. 1: ______________________ $____________

No. 2: ________________________ $___________________

- **Addenda**

  The Bidder has examined the entire solicitation (including the following Addenda), and the Base Bid Price ***includes*** the costs of any modifications required by the Addenda.

  All Addenda must be acknowledged.

  Addendum No. 1 dated: ____________________________

  Addendum No. 2 dated: _____________________________

  Addendum No. 3 dated: _____________________________

  Addendum No. 4 dated: _____________________________

  Addendum No. 5 dated: _____________________________

  Addendum No. 6 dated: _____________________________

2. CONTRACT TIME

The Bidder offers to perform the work in accordance with the timeline specified below:

- Start of construction: ________________________
- Substantial completion: ________________________
- Final completion: ________________________

3. LIQUIDATED DAMAGES

The successful bidder awarded a contract pursuant to this solicitation shall be liable for and pay the State, as liquidated damages and not as a penalty, the following amount for each calendar day of delay beyond the date for substantial completion, as determined in the sole discretion of the State: $_________.

– – – – – – –

This bid proposal is irrevocable for 60 days from the bid proposal submission deadline.

If the Bidder is determined to be the successful bidder pursuant to this solicitation, the Bidder will promptly: (i) comply with each of the requirements of the Tentative Letter of Award; and (ii) commence and diligently pursue the work upon issuance and receipt of the purchase order from the State and authorization from the user agency.

The person signing below certifies that he or she has been duly authorized to execute and submit this bid proposal on behalf of the Bidder.

BIDDER

Date:________________

____
Name of Bidder

____
Signature in ink

____
Printed name and title of person signing on behalf of Bidder

#________________________________
Bidder's Contractor Registration Number