INTERNATIONAL ASSOCIATION OF
# Heat & Frost Insulators & Allied Workers
Local 24
Baltimore-Washington, DC

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Laurel, MD 20707
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February 4, 2022

Maryland House of Delegates
Ways and Means Committee
Chair: Vanessa Atterbeary
Vice Chair: Alonzo Washington

**TESTIMONY IN SUPPORT OF HB 405**
**Income Tax – Mechanical Insulation Installation Tax Credit**

Heat and Frost Insulators & Allied Workers Local 24
Brian S Cavey, Business Manager
brian.cavey@insulators24.org

Chairman Atterbeary, Vice Chair Washington and members of the committee, I respectfully submit this testimony in support of HB405

Energy usage has become one of the defining issues of the United States. Industrial and commercial buildings consume 40 % of the energy used on this continent. Properly installed mechanical insulation can increase system efficiency by as much as 80% or more. Mechanical insulation technology reduces the carbon footprint, fuel consumption, greenhouse gas emissions, and is sustainable. Mechanical insulation is defined as materials applied to mechanical services for the purpose of retarding the flow of heat energy. The heat flow retardation can be from hot systems to cooler air surrounding the system or from cold systems gaining heat from the hotter air surrounding the system. No other technology can produce the results toward these goals better and faster than mechanical insulation.

When calculating heat loss data, mechanical insulation pays for itself within four to twelve months on average. Yes, months not years. Mechanical insulation is ready now to perform; it does not require long-term research and new technology. Mechanical Insulation is the original green technology. No other technology can boast the results offered by mechanical insulation.

Despite the belief that it is not an "exciting" subject, it is essential to begin thinking differently about mechanical insulation and the value it can provide. During construction of a new facility, it could be dangerous to consider mechanical insulation under "economic thickness" calculations, given that energy prices have risen substantially over the last 10 to 20 years. Original cost assumptions may change as energy has become more expensive. Furthermore, value engineering mechanical insulation almost always means compromising the insulation thickness, changing the materials or system (a cheaper substitute), or eliminating the insulation. The problem with this is that with insulation reduced, the equipment works harder, thus increasing operating costs and decreasing the equipment's operating life. Nevertheless, this practice of value engineering to reduce initial construction has been real for years, and now building are less efficient because of it. We can change that! We can make building more efficient and drastically lower the carbon emissions by repairing, replacing or upgrading missing and damaged insulation.

Mechanical insulation is one of the best-kept secrets in energy efficiency, and we need to turn it into one of the first things people think about when they want to save money. It not only saves energy but reduces greenhouse gas emissions and extends the life of equipment. The numbers speak for themselves. We just need to get the word out!

We urge a favorable vote on this legislation. Thank you for your time and consideration.

Sincerely and Respectfully,

Brian S Cavey, Business Manager
Insulators and Allied Workers Local 24

*See attached documentation of two insulation energy audits that verify the energy savings and emission reduction mechanical insulation provides

*Watch: https://www.youtube.com/watch?v=P11YCbInvNU

# EXHIBIT A

MITAGS-PMI

MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES / PACIFIC MARITIME INSTITUTE

# MITAGS Insulation Energy Audit

Prepared for: The Maritime Institute of Technology and Graduate Studies

By: Brian S Cavey

November 11, 2016

Building Operations Manager
MITAGS
692 Maritime Boulevard
Linthicum Heights, MD 21090

Dear Operations Manager,

Please find enclosed the MITAGS Insulation Energy Appraisal for Room R-033 within the building at 692 Maritime Blvd in Linthicum Heights, MD. The appraisal evaluates and recommends energy saving opportunities through mechanical insulation. The appraisal provides estimated projects cost, savings and expected payback periods. The details in this report are based on an evaluation of energy consumption and an evaluation of the existing building systems and their operation at the time we conducted the appraisal.

We have developed an approach to identifying and recommending energy conservation measures of the mechanical insulation systems which provides short payback periods; this approach best positions the building against future increases in energy usage, more consistent budgeting of energy usage in the affected areas and cost reductions in both energy usage and equipment maintenance and repair. By implementing the recommended conservation measures you will experience significant energy reductions, cost savings and improved system performance, with an exceptional ROI. In addition, the measures recommended will help to improve building comfort levels, reduce potential employee heat stress issues and provide better working conditions for employees working in the affected areas.

This appraisal was performed and reviewed by Certified Insulation Energy Appraisers. The National Insulation Association's Growing the Insulation Industry Committee created the Insulation Energy Appraisal Program (IEAP). The IEAP is a major industry initiative designed to give facility/energy managers a better understanding of the true dollar and performance value of an insulated system. The program is a tool that quantifies the amount of energy and actual dollars a facility is losing with its current in-place insulation system, and-as mentioned previously-demonstrates the real-world benefits of a more efficient system.

We trust this Energy Appraisal meets with your approval and acceptance.

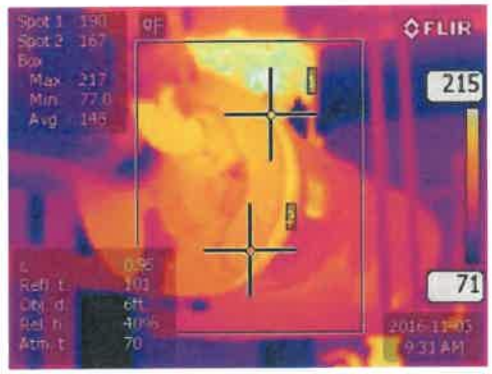
# Energy Savings Calculations

## MITAGS – Mechanical Room, R-033

## Low Pressure Steam System

The following calculations for the low pressure steam system are based on following criteria

- System Operating Temperature is approximately 235°
- System fuel – Natural Gas
- Fuel costs - $3.641/Mcf
- System operates full time – 8320 hours per year




| | | | |
|---|---|---|---|
| Heat Exchasnger | | Emittance of Surface | 0.90 |
| Operating Temperature, *F | ±235° | Expected Useful Life of Insulation System | 20 yrs. |
| Ambient Temperature, *F | 104 | Operating hours per year | 8320 |
| Insulation selected | Fiberglass | Efficiency of fuel Conversion% | 80 |
| | | Selected fuel | Natural Gas |
| | | Cost of Fuel,$/Mcf | 3.641 |

Heat Exchanger, no insulation on head; damaged insulation on body.

Recommendation: Insulate head of heat exchanger and replace insulation on body with 1 ½" Fiberglass Pipe Insulation; heat exchanger requires a total of 28 sq ft of insulation. Application of insulation results in reduced surface temperature to 95.5°, reducing Heat Loss by 510 Btu per hour and reducing the annual cost by $18.80 per year per sq ft with an ROI of approximately 23.5 months. Applying insulation to this valve will also reduce the CO2 emissions by .28 MT/year per sq ft..

**Results**

| **Thickness** (inches) | **Surface Temp** (°F) | **Heat Loss** (Btu/h) | **Cost of Fuel** ($/yr) | **Installed Cost** ($) | **Payback** (months) | **Annual Return** | **$CO_2$ Emissions** (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 234.8 | 544 | $20.06 | $0.00 | NA | NA | 0.3 |
| 1 | 103 | 64 | $2.35 | $35.55 | 24.1 | 50% | 0.04 |
| 1.5 | 95.5 | 44 | $1.64 | $36.03 | 23.5 | 51% | 0.02 |
| 2 | 91.3 | 34 | $1.26 | $36.51 | 23.3 | 51% | 0.02 |

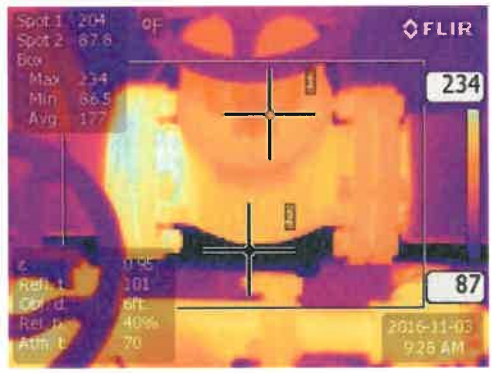
# Energy Savings Calculations

## MITAGS – Mechanical Room, R-033

## Low Pressure Steam System

The following calculations for the low pressure steam system are based on following criteria

- System Operating Temperature is approximately 235°
- System fuel – Natural Gas
- Fuel costs - $3.641/Mcf
- System operates full time – 8320 hours per year




| Low Pressure Steam Valve | |
|---|---|
| Operating Temperature, *F | ±235° |
| Ambient Temperature, *F | 104 |
| Insulation selected | Fiberglass |

| | |
|---|---|
| Emittance of Surface | 0.90 |
| Expected Useful Life of Insulation System | 20 yrs. |
| Operating hours per year | 8320 |
| Efficiency of fuel Conversion% | 80 |
| Selected fuel | Natural Gas |
| Cost of Fuel,$/Mcf | 3.641 |

Low Pressure Steam valve, 3", no insulation.

Recommendation: Insulate Valve with 1 ½" Fiberglass Pipe Insulation results in reduced surface temperature to 114°, reducing Heat Loss by 1,590 Btu per hour and reducing the annual cost by $58.63 per year with an ROI of approximately 17 months. Applying insulation to this valve will also reduce the CO2 emissions by .889 MT/year.

**Results**

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | $CO_2$ Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 235 | 1745 | $64.34 | $0.00 | NA | NA | 0.97 |
| 0.5 | 129 | 334 | $12.30 | $70.20 | 16 | 74% | 0.18 |
| 1 | 119 | 214 | $7.90 | $77.73 | 17 | 73% | 0.12 |
| 1.5 | 114 | 155 | $5.71 | $85.26 | 17 | 69% | 0.09 |

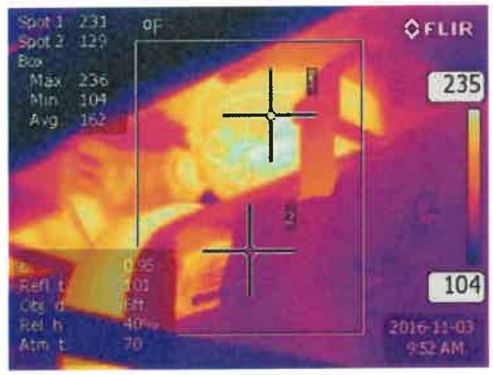
# Energy Savings Calculations

## MITAGS – Mechanical Room, R-033

## Low Pressure Steam System

The following calculations for the low pressure steam system are based on following criteria

- System Operating Temperature is approximately 235°
- System fuel – Natural Gas
- Fuel costs - $3.641/Mcf
- System operates full time – 8320 hours per year




| | |
|---|---|
| Low Pressure Steam Flange | |
| Operating Temperature, *F | ±235° |
| Ambient Temperature, *F | 104 |
| Insulation selected | Fiberglass |

| | |
|---|---|
| Emittance of Surface | 0.90 |
| Expected Useful Life of Insulation System | 20 yrs. |
| Operating hours per year | 8320 |
| Efficiency of fuel Conversion% | 80 |
| Selected fuel | Natural Gas |
| Cost of Fuel,$/Mcf | 3.641 |

Low Pressure Steam Flange, 3", no insulation.

Recommendation: Insulate Valve with 1 ½" Fiberglass Pipe Insulation results in reduced surface temperature to 115°, reducing Heat Loss by 531 Btu per hour and reducing the annual cost by $19.55 per year with an ROI of approximately 17 months. Applying insulation to this valve will also reduce the CO2 emissions by ..29 MT/year.

**Results**

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | $CO_2$ Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 235 | 582 | $21.45 | $0.00 | NA | NA | 0.32 |
| 0.5 | 131 | 110 | $4.06 | $23.40 | 16 | 74% | 0.06 |
| 1 | 120 | 71 | $2.61 | $25.91 | 17 | 73% | 0.04 |
| 1.5 | 115 | 51 | $1.90 | $28.42 | 17 | 69% | 0.03 |

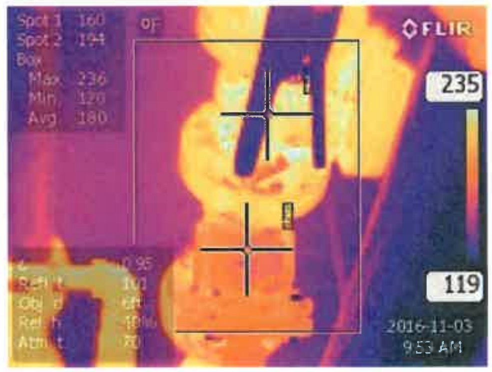
# Energy Savings Calculations

## MITAGS – Mechanical Room, R-033

## Low Pressure Steam System

The following calculations for the low pressure steam system are based on following criteria

- System Operating Temperature is approximately 235°
- System fuel – Natural Gas
- Fuel costs - $3.641/Mcf
- System operates full time – 8320 hours per year




| Low Pressure Steam Valve and Strainer | |
|---|---|
| Operating Temperature, *F | ±235° |
| Ambient Temperature, *F | 104 |
| Insulation selected | Fiberglass |

| | |
|---|---|
| Emittance of Surface | 0.90 |
| Expected Useful Life of Insulation System | 20 yrs. |
| Operating hours per year | 8320 |
| Efficiency of fuel Conversion% | 80 |
| Selected fuel | Natural Gas |
| Cost of Fuel,$/Mcf | 3.641 |

Low Pressure Steam valve and strainer, 3", no insulation.

Recommendation: Insulate Valve with 1 ½" Fiberglass Pipe Insulation results in reduced surface temperature to 115°, reducing Heat Loss by 3,182 Btu per hour and reducing the annual cost by $117.31 per year with an ROI of approximately 17 months. Applying insulation to this valve will also reduce the CO2 emissions by .1.76 MT/year.

**Results**

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | $CO_2$ Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 235 | 3490 | $128.68 | $0.00 | NA | NA | 1.93 |
| 0.5 | 131 | 660 | $24.33 | $140.40 | 16 | 74% | 0.37 |
| 1 | 120 | 426 | $15.69 | $155.46 | 17 | 73% | 0.24 |
| 1.5 | 115 | 308 | $11.37 | $170.52 | 17 | 69% | 0.17 |

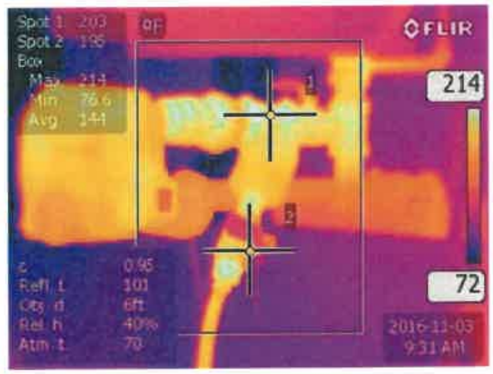
# Energy Savings Calculations

## MITAGS – Mechanical Room, R-033

## Low Pressure Steam System

The following calculations for the low pressure steam system are based on following criteria

- System Operating Temperature is approximately 235°
- System fuel – Natural Gas
- Fuel costs - $3.641/Mcf
- System operates full time – 8320 hours per year




| | | | |
|---|---|---|---|
| Low Pressure Steam Trap piping | | Emittance of Surface | 0.90 |
| Operating Temperature, *F | ±235° | Expected Useful Life of Insulation System | 20 yrs. |
| Ambient Temperature, *F | 104 | Operating hours per year | 8320 |
| Insulation selected | Fiberglass | Efficiency of fuel Conversion% | 80 |
| | | Selected fuel | Natural Gas |
| | | Cost of Fuel,$/Mcf | 3.641 |

Low Pressure Steam Trap, 2", no insulation.

Recommendation: Insulate Valve with 1 ½" Fiberglass Pipe Insulation results in reduced surface temperature to 112°, reducing Heat Loss by 911 Btu per hour and reducing the annual cost by $33.59 per year with an ROI of approximately 17 months. Applying insulation to this valve will also reduce the CO2 emissions by .50 MT/year.

**Results**

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | $CO_2$ Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 235 | 1002 | $36.95 | $0.00 | NA | NA | 0.55 |
| 0.5 | 127 | 201 | $7.40 | $62.56 | 25 | 47% | 0.11 |
| 1 | 115 | 119 | $4.38 | $72.56 | 27 | 45% | 0.07 |
| 1.5 | 112 | 91 | $3.36 | $82.56 | 29 | 41% | 0.05 |

Estimated Calculations supplied by National Institute of Building Sciences Mechanical Insulation Energy Calculator *

Thank you for taking the time to allow us to introduce you to a sample appraisal to provide you with a glimpse of the potential savings that could be achieved by evaluating and properly insulating the mechanical systems in your facility. While the enclosed report is but a sample of the savings that would be achieved in one mechanical room, we have quantified energy loss, calculated potential energy savings as well as reductions in greenhouse gas emissions by utilizing Infrared / Digital Photography and State of the Art Energy Appraisal Software.

**Clarifications**

The preceding information does not include any allowance incentives, for emission reductions, nor does it include the following additional advantages to you of upgrading your mechanical insulation systems as recommended:

a. Potential tax benefits and credits from energy conservation investments
b. Enhanced personnel protection, noise control and fire safety
c. Condensation prevention and freeze protection
d. Reduced corrosion potential
e. Reduced equipment wear and tear
f. Reduced ongoing insulation maintenance expense
g. Improved process flows
h. More attractive and comfortable working environment

Mechanical Insulation is applied as a safeguard to protect personnel from burns. Insulation is used to reduce ambient temperatures to prevent personnel from working under stressful high temperature conditions. "*ASTM Standard Practice C 1057*" contains a Standard Practice for Determination of Skin Contact Temperature from heated surfaces. The Standard Industry Practice is to use 140°F as the maximum temperature of a heated surface that may be contacted by working personnel.

Design of Insulation Systems is a process that must utilize numerous criteria to determine the best materials, applications and temperature changes. We have evaluated the mechanical systems and the design requirements in order to provide solutions to best integrate the often conflicting demands of initial investment, durability, value and life cycle costs. We have tried to minimize the variation of temperature in processes and to minimize energy use.

**Damaged / Inadequate Insulation**

While we evaluated but a small area of the facility, the energy loss due to damaged / inadequate insulation in the facility appears to be significant. Due to the age of the systems, the frequent cycling of HVAC systems, the areas humidity levels and the physical abuse some of these systems have endured, a high percentage of the System Insulation is compromised to the point that it should be replaced. There are places in the facility where the insulation has been removed and has not been replaced. We <u>did not</u> include the energy savings from damaged insulation in any of our calculations.

If you were to choose to conduct a complete facility appraisal we would utilize information provided by your engineering staff including heating and cooling set points, process temperatures, total annual hours of operation, scheduled down times, type of energy used, cost of energy, facility design, HVAC system function and design, business functions and energy conservation strategies to provide a complete evaluation of the mechanical system insulation in your facility. Our report would include this information in conjunction with our expertise and training in analyzing and verifying with thermographs, installed material uses, wind velocities, area weather data, design and relative humidity values as well as facility, mechanical, and equipment geometries to evaluate the existing conditions at the Maritime Institute of Technology and Graduate Studies.

After completing our interview with the facility/ energy manager and other engineering staff, we will review the facility layout system integration and will then conduct a comprehensive walk-through of the facility. We use thermographs to differentiate differences in temperature ($\Delta t$) and to pinpoint underlying problems in energy usage. From this data, in conjunction with a visual survey, we will produce a comprehensive report to provide you with a wealth of detailed information about the locations, causes and extent of problems, potential solutions and calculation of available savings. After obtaining site specific data we will perform calculations, evaluate current and potential energy conservation measures, and then compile a comprehensive, detailed report with recommendations to reduce energy costs, to improve energy efficiency and reduce the carbon footprint. Our final reports will provide you vital information to determine energy loss patterns and potential fuel cost savings in both dollars and Btu's to reveal hidden problems, helping you determine the next course of action.

A thorough inspection of Mechanical Room R-033 revealed a large amount of missing and damaged insulation. The examples on the previous pages show the cost and fuel savings by adding insulation to uninsulated piping and equipment while also greatly reducing the $CO2$ emissions produced when using excessive amounts of energy because of the lack of insulation.

While inspecting the room, we found uninsulated: 7 valves/strainers, 4 flanges, some other miscellaneous fittings and equipment and a significant amount of bare piping. The examples on the previous pages include 2 valves, 1 strainer, 1 flange, 1 piece of equipment and a small amount of uninsulated piping. The savings from insulating just the items in the examples are significant with heat loss savings of 20,494 Btu/h and cost saving of $755.48 per year. These examples account for approximately a quarter of the uninsulated items in Room R-033 leaving you with anticipated savings of over $3,321 per year should you choose to apply the missing insulation.

We welcome the opportunity to meet with you to review and explain any questions you have concerning the attached report.

Sincerely yours,

Brian S Cavey, CIEA

# EXHIBIT B

ST. VINCENT PALLOTTI
HIGH SCHOOL

**Pallotti High School Insulation Energy Audit**

Prepared for: St. Vincent Pallotti High School

By: Brian S Cavey

April 24, 2020

Building Operations Manager
St Vincent Pallotti High School
113 St Marys Pl
Laurel, MD 20707

Dear Operations Manager,

Please find enclosed the Insulation Energy Appraisal for Boiler Room within the building at 113 St Marys Pl, Laurel, MD 20707. The appraisal evaluates and recommends energy saving opportunities through mechanical insulation. The appraisal provides estimated projects cost, savings and expected payback periods. The details in this report are based on an evaluation of energy consumption and an evaluation of the existing building systems and their operation at the time we conducted the appraisal.

We have developed an approach to identifying and recommending energy conservation measures of the mechanical insulation systems which provides short payback periods; this approach best positions the building against future increases in energy usage, more consistent budgeting of energy usage in the affected areas and cost reductions in both energy usage and equipment maintenance and repair. By implementing the recommended conservation measures you will experience significant energy reductions, cost savings and improved system performance, with an exceptional ROI. In addition, the measures recommended will help to improve building comfort levels, reduce potential employee heat stress issues and provide better working conditions for employees working in the affected areas.

This appraisal was performed and reviewed by a Certified Insulation Energy Appraiser. The National Insulation Association's Growing the Insulation Industry Committee created the Insulation Energy Appraisal Program (IEAP). The IEAP is a major industry initiative designed to give facility/energy managers a better understanding of the true dollar and performance value of an insulated system. The program is a tool that quantifies the amount of energy and actual dollars a facility is losing with its current in-place insulation system, and-as mentioned previously-demonstrates the real-world benefits of a more efficient system.

We trust this Energy Appraisal meets with your approval and acceptance.

Thank you for taking the time to allow us to present you with this appraisal to provide you with a glimpse of the potential savings that could be achieved by evaluating and properly insulating the mechanical systems in your facility.  While the enclosed report is but a sample of the savings that would be achieved in one mechanical room, we have quantified energy loss, calculated potential energy savings as well as reductions in greenhouse gas emissions by utilizing State of the Art Energy Appraisal Software.

**Clarifications**

The information does not include any allowance incentives for emission reductions, nor does it include the following additional advantages to you of upgrading your mechanical insulation systems as recommended:

a. Potential tax benefits and credits from energy conservation investments
b. Enhanced personnel protection, noise control and fire safety
c. Condensation prevention and freeze protection
d. Reduced corrosion potential
e. Reduced equipment wear and tear
f. Reduced ongoing insulation maintenance expense
g. Improved process flows
h. More attractive and comfortable working environment

Mechanical Insulation is applied as a safeguard to protect personnel from burns. Insulation is used to reduce ambient temperatures to prevent personnel from working under stressful high temperature conditions. *"ASTM Standard Practice C 1057"* contains a Standard Practice for Determination of Skin Contact Temperature from heated surfaces. The Standard Industry Practice is to use 140°F as the maximum temperature of a heated surface that may be contacted by working personnel.

Design of Insulation Systems is a process that must utilize numerous criteria to determine the best materials, applications and temperature changes. We have evaluated the mechanical systems and the design requirements in order to provide solutions to best integrate the often conflicting demands of initial investment, durability, value and life cycle costs. We have tried to minimize the variation of temperature in processes and to minimize energy use.

**Damaged / Inadequate Insulation**

While we evaluated the boiler system within the facility, the energy loss due to damaged / inadequate insulation to other systems appears to be noteworthy. Due to the age of the systems, the frequent cycling of HVAC systems, the areas humidity levels and the physical abuse some of these systems have endured, a high percentage of the System Insulation is compromised to the point that it should be replaced. There are places in the facility where the insulation has been removed and has not been replaced. We did not include the energy savings from damaged insulation in any of our calculations.

If you were to choose to conduct a complete facility appraisal we would utilize information provided by your engineering staff including heating and cooling set points, process temperatures, total annual hours of operation, scheduled down times, type of energy used, cost of energy, facility design, HVAC system function and design, business functions and energy conservation strategies to provide a complete evaluation of the mechanical system insulation in your facility. Our report would include this information in conjunction with our expertise and training in analyzing and verifying with thermographs, installed material uses, wind velocities, area weather data, design and relative humidity values as well as facility, mechanical, and equipment geometries to evaluate the existing conditions at the Maritime Institute of Technology and Graduate Studies.

After completing our interview with the facility operations manager, we will review the facility layout system integration and will then conduct a comprehensive walk-through of the facility. We use thermographs to differentiate differences in temperature and to pinpoint underlying problems in energy usage. From this data, in conjunction with a visual survey, we will produce a comprehensive report to provide you with a wealth of detailed information about the locations, causes and extent of problems, potential solutions and calculation of available savings. After obtaining site specific data we will perform calculations, evaluate current and potential energy conservation measures, and then compile a comprehensive, detailed report with recommendations to reduce energy costs, to improve energy efficiency and reduce the carbon footprint. Our final reports will provide you vital information to determine energy loss patterns and potential fuel cost savings in both dollars and Btu's to reveal hidden problems, helping you determine the next course of action.

A thorough inspection of the Boiler Room after the removal of the original asbestos insulation shows the cost and fuel savings by adding insulation to uninsulated piping and equipment while also greatly reducing the CO2 emissions produced when using excessive amounts of energy because of the lack of insulation.

While inspecting the room, we found uninsulated: 24 feet of 10" steam piping, 75 feet of 8" steam piping, 12 feet of 6" steam piping, 18 feet of 4" steam piping, 78 feet of 3 " steam piping, 9 feet of 2" steam piping, 75 feet of 1 ½" boiler feed piping and 63 feet of 1 ¼" boiler feed piping. The attached charts show the energy usage and CO2 emissions of uninsulated piping and insulated piping. It is recommended to use 2" thickness of fiberglass insulation on the steam piping and 1 ½" thickness of fiberglass insulation on the boiler feed piping. The savings from insulating the items are significant with heat loss savings of 502,137 Btu/h and cost saving of $11,076.06 per year. Insulators and Allied Workers Local 24 Joint Apprenticeship Program will be donating the insulation and labor to insulate all of the piping in this report during the 2020 apprenticeship school saving Pallotti High School approximately $11,500 in costs. Using this cost, a return on investment of the insulation would be slightly less than one year.

We welcome the opportunity to meet with you to review and explain any questions you have concerning the attached report.

Sincerely yours,

Brian S Cavey, CIEA

10" steam piping (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 349 | 3298 | $73.06 | $0.00 | NA | NA | 1.14 |
| 1 | 104 | 256 | $5.67 | $38.27 | 7 | 176% | 0.09 |
| 1.5 | 93 | 169 | $3.73 | $44.61 | 8 | 155% | 0.06 |
| 2 | 89 | 135 | $2.98 | $52.75 | 9 | 133% | 0.05 |

8" steam piping (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 349 | 2784 | $61.67 | $0.00 | NA | NA | 0.96 |
| 1 | 101 | 200 | $4.43 | $33.78 | 7 | 169% | 0.07 |
| 1.5 | 92 | 144 | $3.20 | $38.79 | 8 | 151% | 0.05 |
| 2 | 88 | 115 | $2.55 | $44.17 | 9 | 134% | 0.04 |

6" steam piping (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 349 | 2283 | $50.58 | $0.00 | NA | NA | 0.79 |
| 1 | 100 | 168 | $3.73 | $28.61 | 7 | 164% | 0.06 |
| 1.5 | 92 | 120 | $2.66 | $33.13 | 8 | 145% | 0.04 |
| 2 | 87 | 93 | $2.06 | $38.22 | 9 | 127% | 0.03 |

4" steam piping (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 349 | 1723 | $38.16 | $0.00 | NA | NA | 0.6 |
| 1 | 95 | 113 | $2.51 | $22.76 | 8 | 157% | 0.04 |
| 1.5 | 88 | 84 | $1.87 | $26.55 | 9 | 137% | 0.03 |
| 2 | 85 | 69 | $1.53 | $31.55 | 10 | 116% | 0.02 |

3" steam piping (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 349 | 1443 | $31.96 | $0.00 | NA | NA | 0.5 |
| 1 | 93 | 95 | $2.11 | $21.42 | 9 | 139% | 0.03 |
| 1.5 | 87 | 70 | $1.55 | $25.04 | 10 | 121% | 0.02 |
| 2 | 84 | 58 | $1.28 | $28.87 | 11 | 106% | 0.02 |

2” steam piping (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 349 | 1107 | $24.53 | $0.00 | NA | NA | 0.38 |
| 1 | 90 | 70 | $1.55 | $19.47 | 10 | 118% | 0.02 |
| 1.5 | 85 | 53 | $1.17 | $22.49 | 12 | 104% | 0.02 |

1 ½” boiler feed (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 200 | 404 | $8.96 | $0.00 | NA | NA | 0.14 |
| 1 | 81 | 23 | $0.52 | $16.75 | 24 | 50% | 0.01 |
| 1.5 | 79 | 18 | $0.40 | $19.55 | 27 | 44% | 0.01 |

1 ¼” boiler feed (per foot)

| Thickness (inches) | Surface Temp (°F) | Heat Loss (Btu/h) | Cost of Fuel ($/yr) | Installed Cost ($) | Payback (months) | Annual Return | CO2 Emissions (MT/yr) |
|---|---|---|---|---|---|---|---|
| 0 | 200 | 372 | $8.23 | $0.00 | NA | NA | 0.13 |
| 1 | 81 | 23 | $0.51 | $16.13 | 25 | 48% | 0.01 |
| 1.5 | 78 | 16 | $0.35 | $19.43 | 30 | 41% | 0.01 |