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Insulation

The Forgotten Technology

ASHRAE

Dayton Chapter
Dec 14, 2009

Presented by:

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Insulation, The Forgotten Technology

Discussion Topics – Learning Objectives:

- ***The need and value to "Think about Insulation Differently" – To obtain a better understanding and appreciation as to "Why Insulate"***
- ***Review evidence of the Power of Insulation – Energy Assessments***
- ***How to quantify the value of this technology, simply known as insulation and***
- ***Demonstration of the "Mechanical Insulation Design Guide" the most comprehensive mechanical insulation resource developed in decades***

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Insulation, The Forgotten Technology

NATIONAL INSULATION ASSOCIATION

- **55 year old trade association**
- **Representing all segments of the industry - contractors, distributors, fabricators and manufacturers**
- **United States industry voice and resource for mechanical insulation information in the, industrial, commercial, and mechanical industries**

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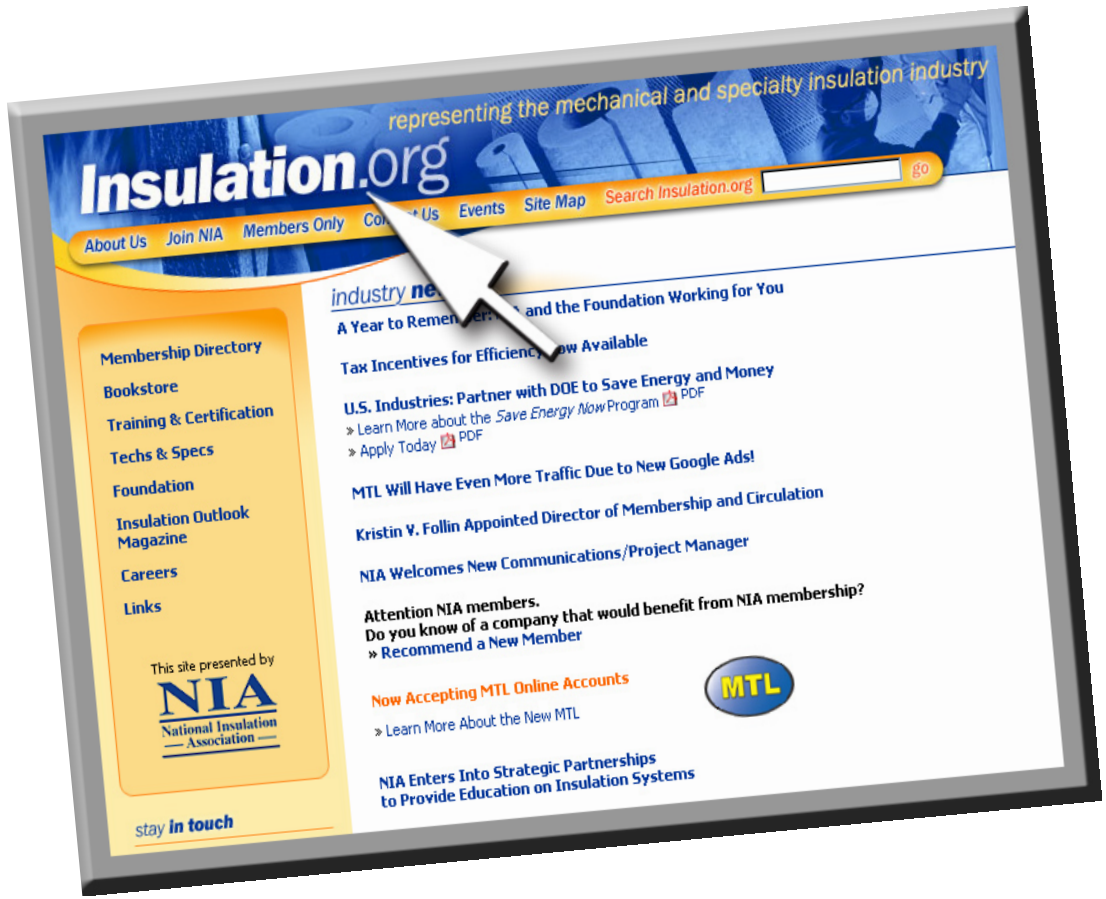


The Voice of the Mechanical Insulation Industry

"INSULATION OUTLOOK"

Free Annual Subscription

Defining Mechanical Insulation

MECHANICAL INSULATION encompasses thermal, acoustical, and personnel and life safety requirements in <u>Commercial and Industrial</u> applications:

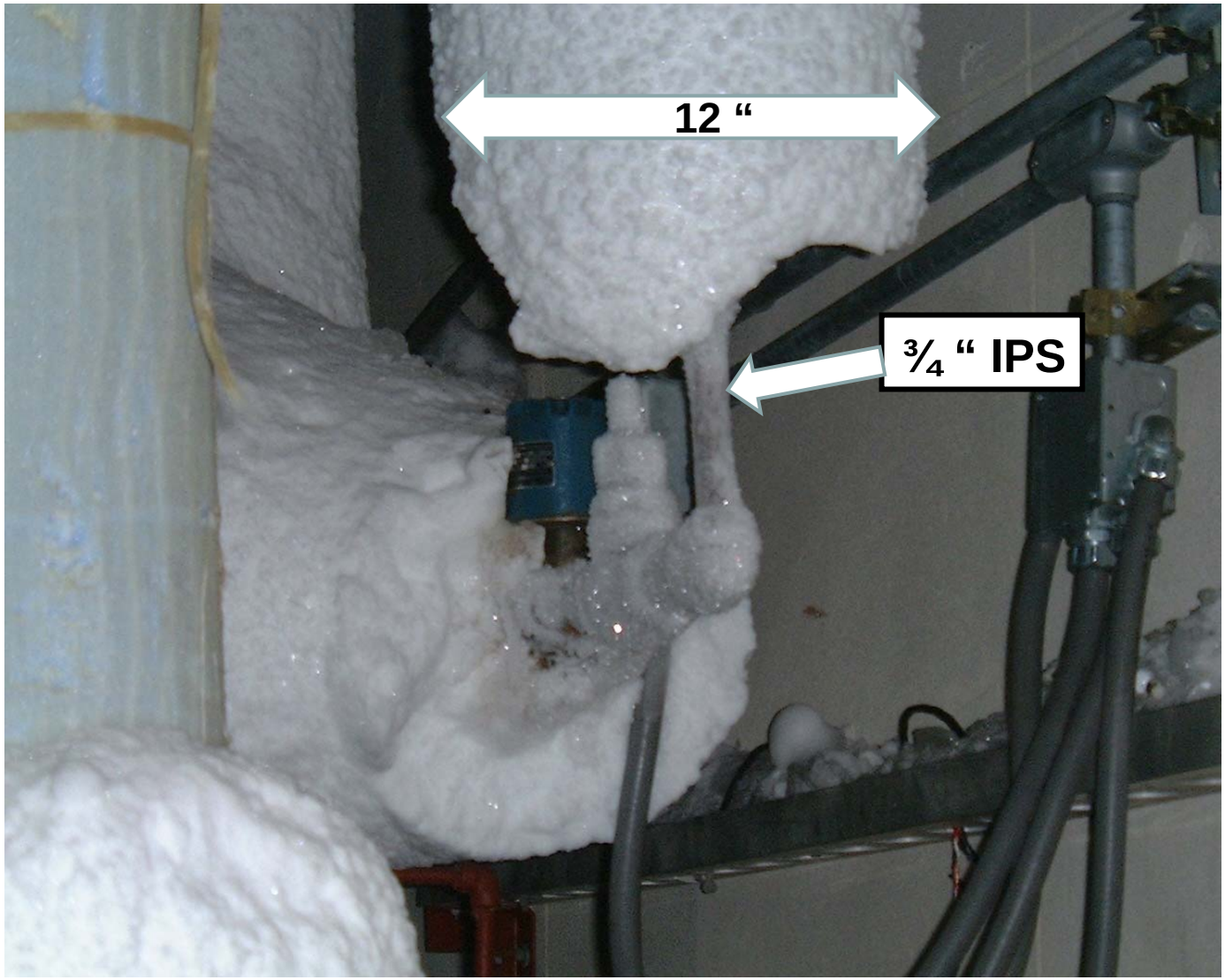
>Mechanical piping and equipment, hot and cold applications

>Heating, Venting & Air Conditioning (HVAC) applications

>Refrigeration and other low - temperature piping and equipment applications

This is not a “state of the art” insulation system!

This is not a “state of the art” insulation system or maintenance procedure!



Insulation, The Forgotten Technology

Mechanical insulation is the "Rodney Dangerfield" of energy conservation.

"No respect" for the potential benefits of mechanical insulation or the potential Return on Investment (ROI)

Mechanical insulation is the "Forgotten Technology"

WHY IS INSULATION, THE FORGOTTEN TECHNOLOGY?

Simple - it is not sexy !

- **Reduced knowledge base has led to underutilization and insulation systems being applied but rarely “engineered”**
- **No gauges**
- **No monitoring**
- **No computer chip**
- **Insulation is normally part of larger mechanical contract**

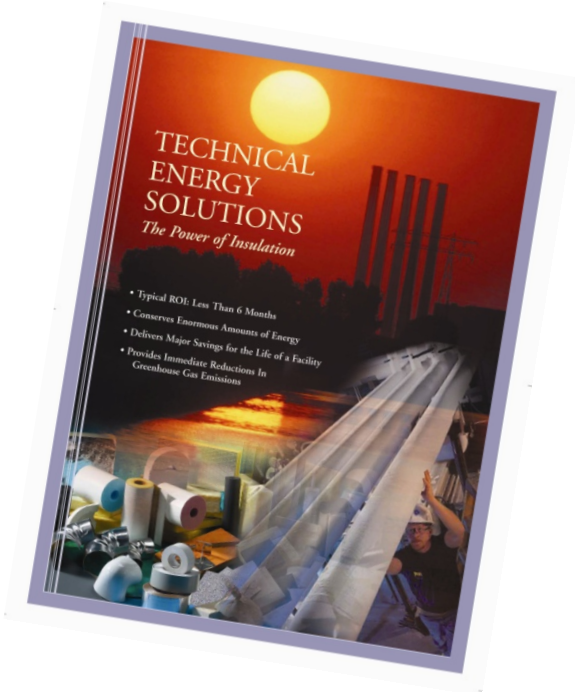
The benefits are instantaneous,

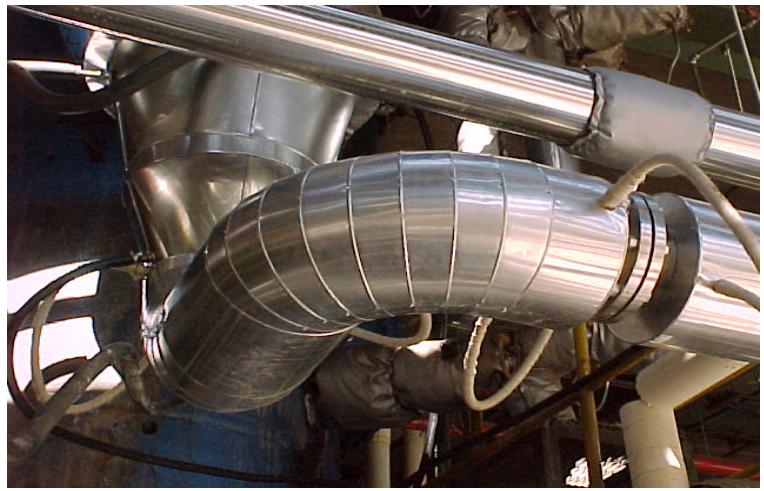
but invisible and taken for granted

Insulation, The Forgotten Technology

WHY INSULATE?

1. Energy Conservation
   - Energy
   - Economics
   - Environment
2. Condensation Control
3. Personnel Protection
4. Fire Protection
5. Process control
6. Freeze Protection
7. Noise Control





Insulation Reduces Energy Costs

Insulation significantly reduces the energy required to run a facility and its processes.

Insulation Reduces Energy Costs

Insulation significantly reduces the energy required to run a facility and its processes.

Hot Example
60F Ambient vs 350F Operating
290F Temperature Difference

Cold Example
80F Ambient vs -10F Operating
90F Temperature Difference

Many times energy conservation is only considered of importance in "hot" applications – that is not correct

The temperature differences may vary which directly affects the degree of savings

But, the savings and ROI on "below ambient" applications are real !

Plus, other design considerations, such as condensation, may be equally important

ANSI/ASHRAE/IESNA Standard 90.1-2007
(Supersedes ANSI/ASHRAE/IESNA Standard 90.1-2004)
Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IESNA Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada).

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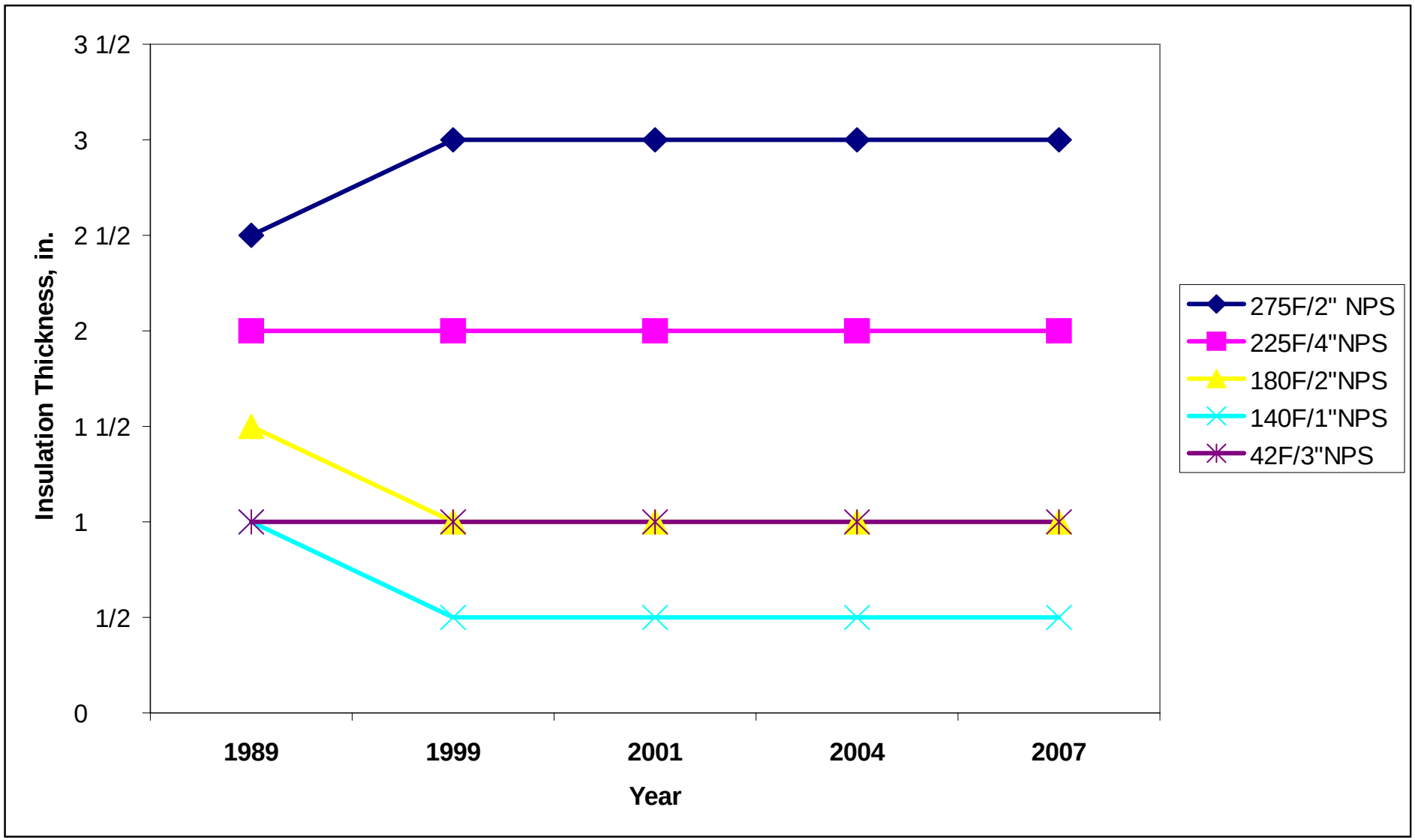
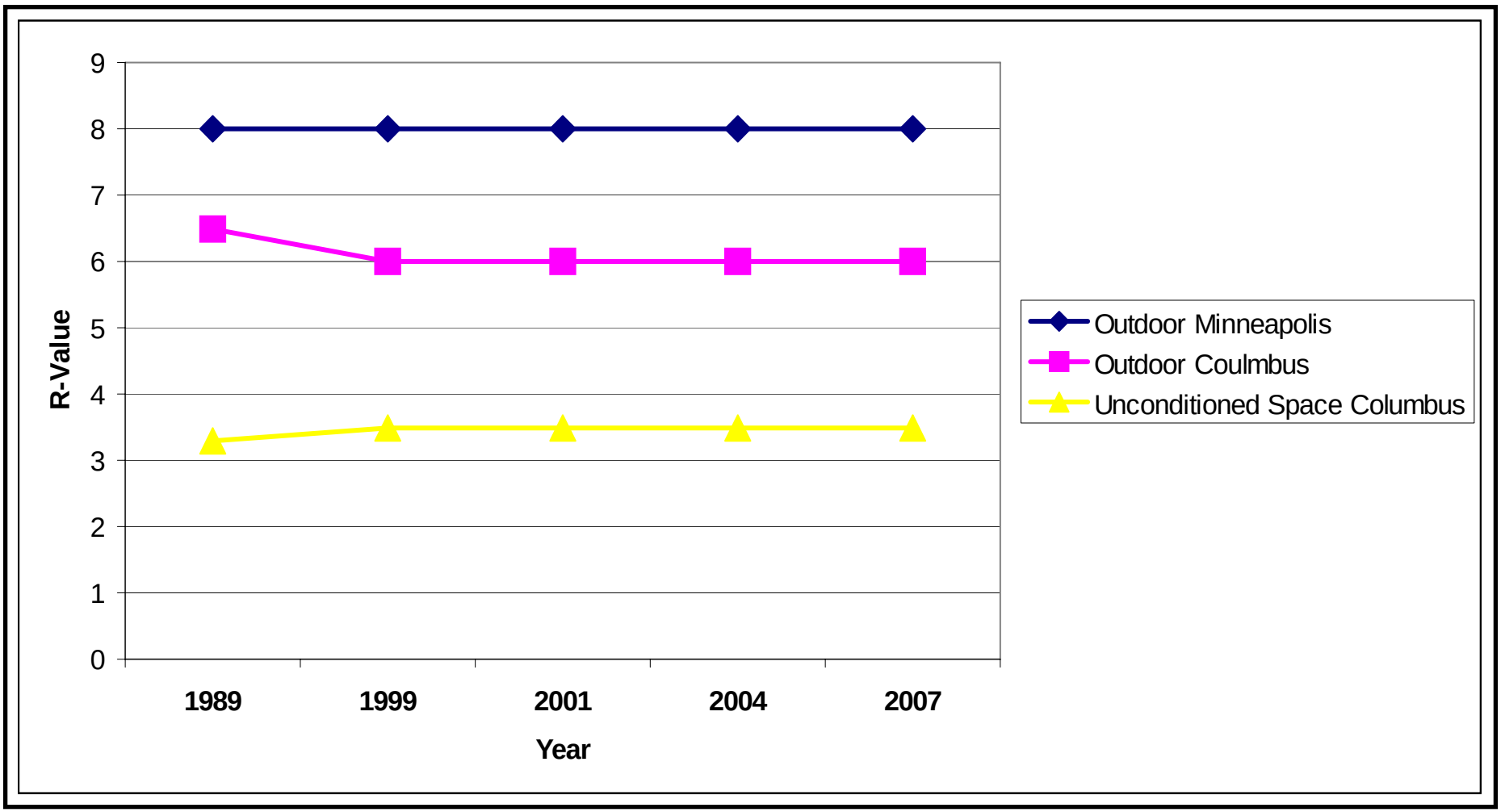
ASHRAE 90.1 Pipe Insulation Requirements -20 Yr History



ASHRAE 90.1 Duct Insulation Requirements -20 Yr History



How much energy is being saved or lost with mechanical insulation?

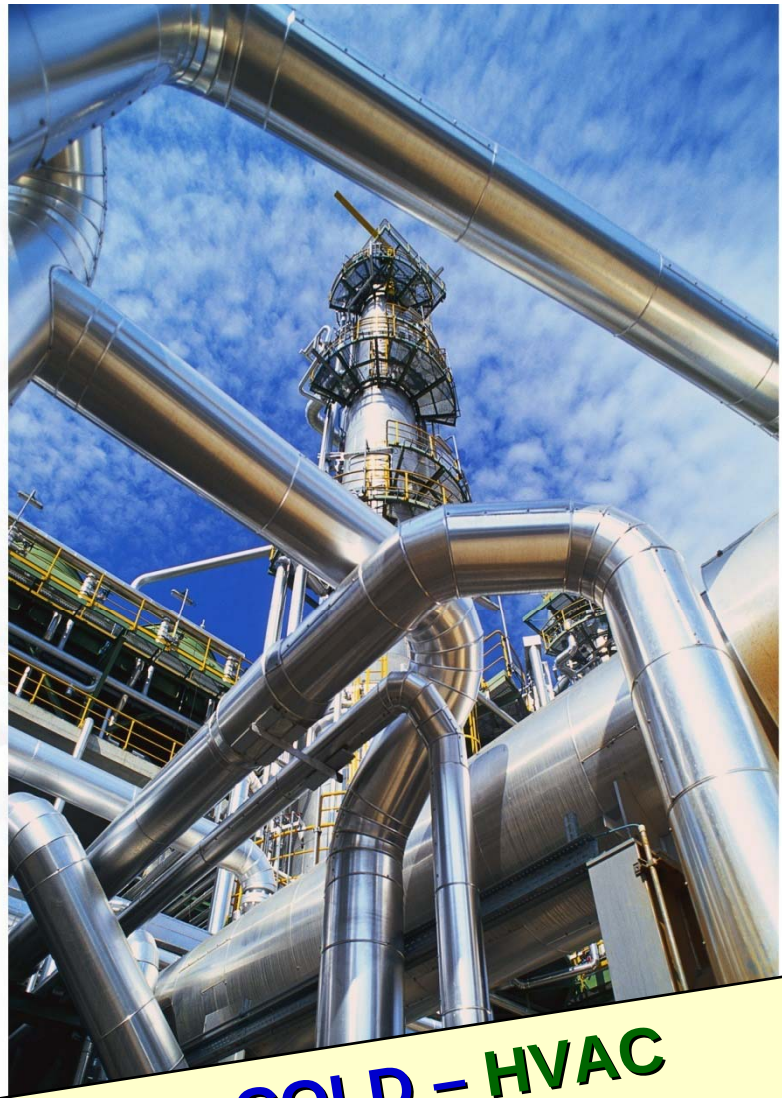
How Big is the Opportunity?

What about Commercial Facilities?

What About Industrial and Manufacturing Facilities?

IT'S BIG!

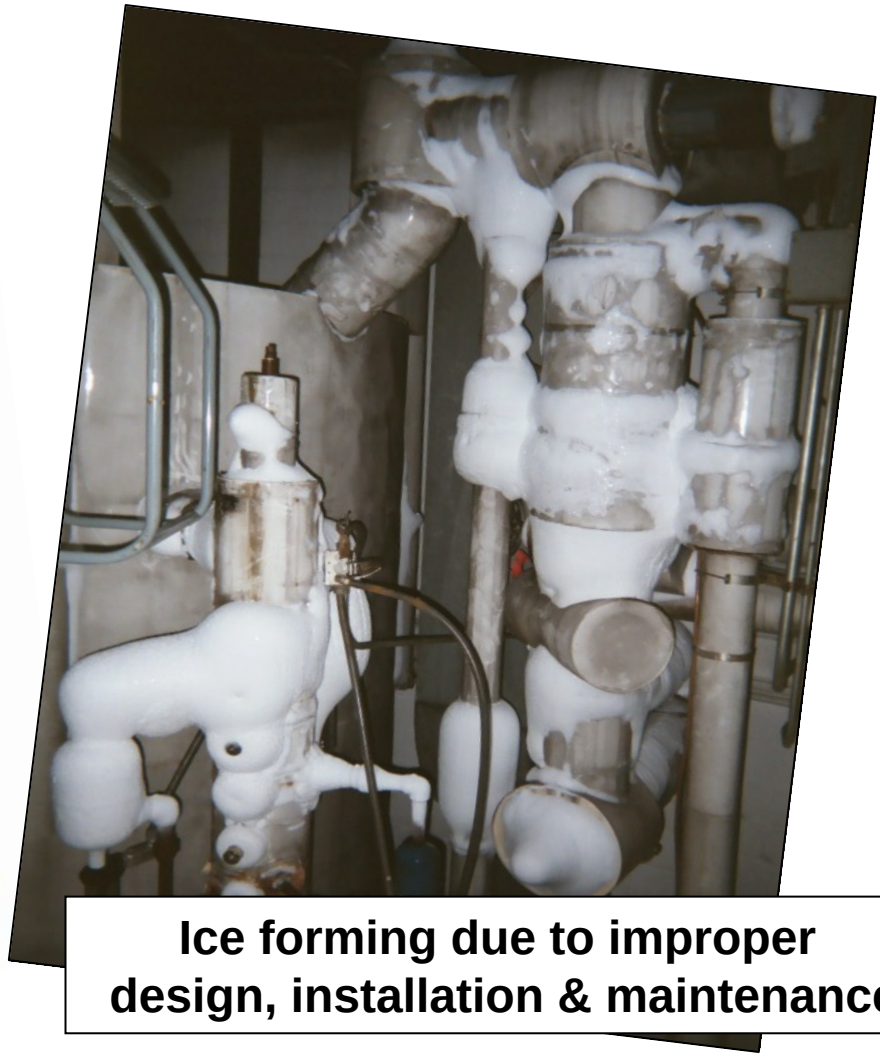
YET, MECHANICAL INSULATION GETS LITTLE RESPECT!



HOT – COLD – HVAC
IT IS CLEARLY A BIG OPPORTUNITY

Are these examples a normal occurrence?

350 F Un-insulated pipe



Ice forming due to improper design, installation & maintenance

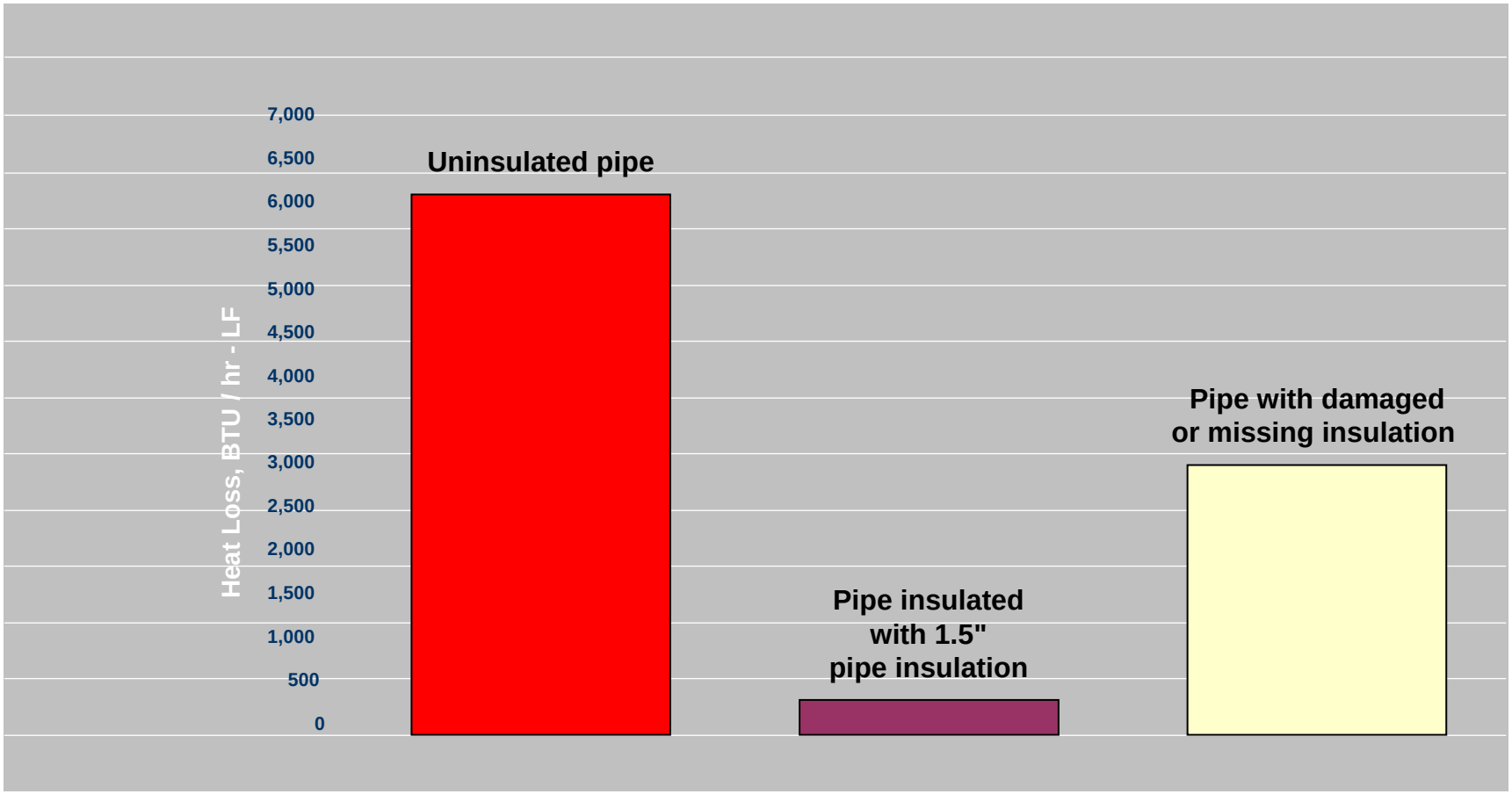
Did you know?

It has been estimated that between 10% & 30% of all mechanical insulation is missing or damaged!

Petroleum Segment– 21% Chemical Segment – 19%

This same characterization applies to basically mechanical insulation in all applications, some greater than others

Oil Refinery Illustrative Example Heat Loss Analysis



1.87 million lineal feet of insulated pipe, 21% of insulation is missing or damaged, 8” NPS @600 F Operating Temperature with 60 F Ambient Temp. w/ 5 MPH wind and 1 ½ “Mineral Fiber insulation system

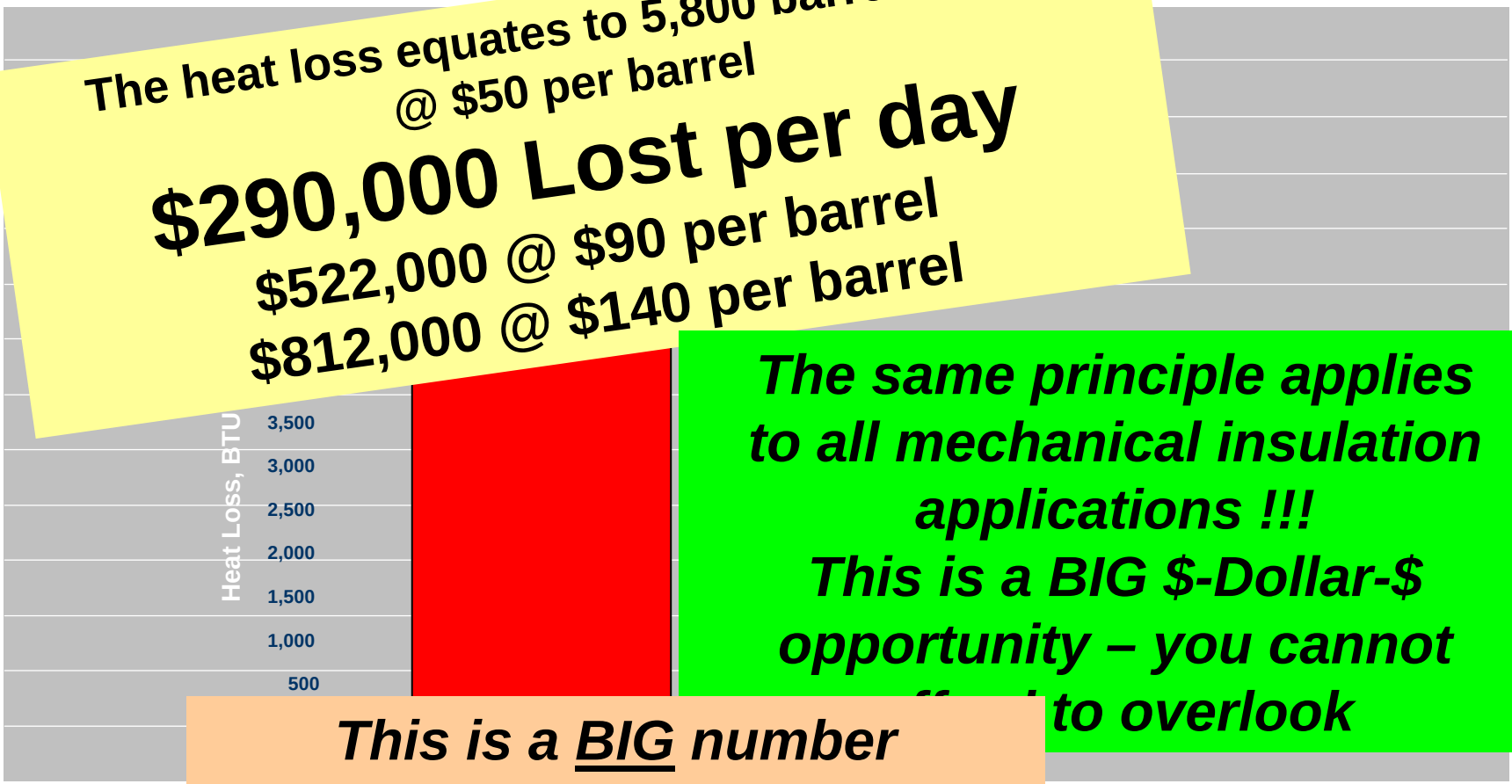
Oil Refinery Illustrative Example
Heat Loss Analysis

The heat loss equates to 5,800 barrels of oil @ $50 per barrel

$290,000 Lost per day

$522,000 @ $90 per barrel

$812,000 @ $140 per barrel



The same principle applies to all mechanical insulation applications !!!

This is a BIG $-Dollar-$ opportunity – you cannot afford to overlook

This is a <u>BIG</u> number

Cut it in half, cut it by 75%

This remains a <u>BIG</u> number

Oil Refinery Illustrative Example
Heat Loss Analysis

The heat loss equates to 5,800 Barrels of Oil @ $50 per barrel

$290,000 Lost per day

$522,000 @ $90 per barrel

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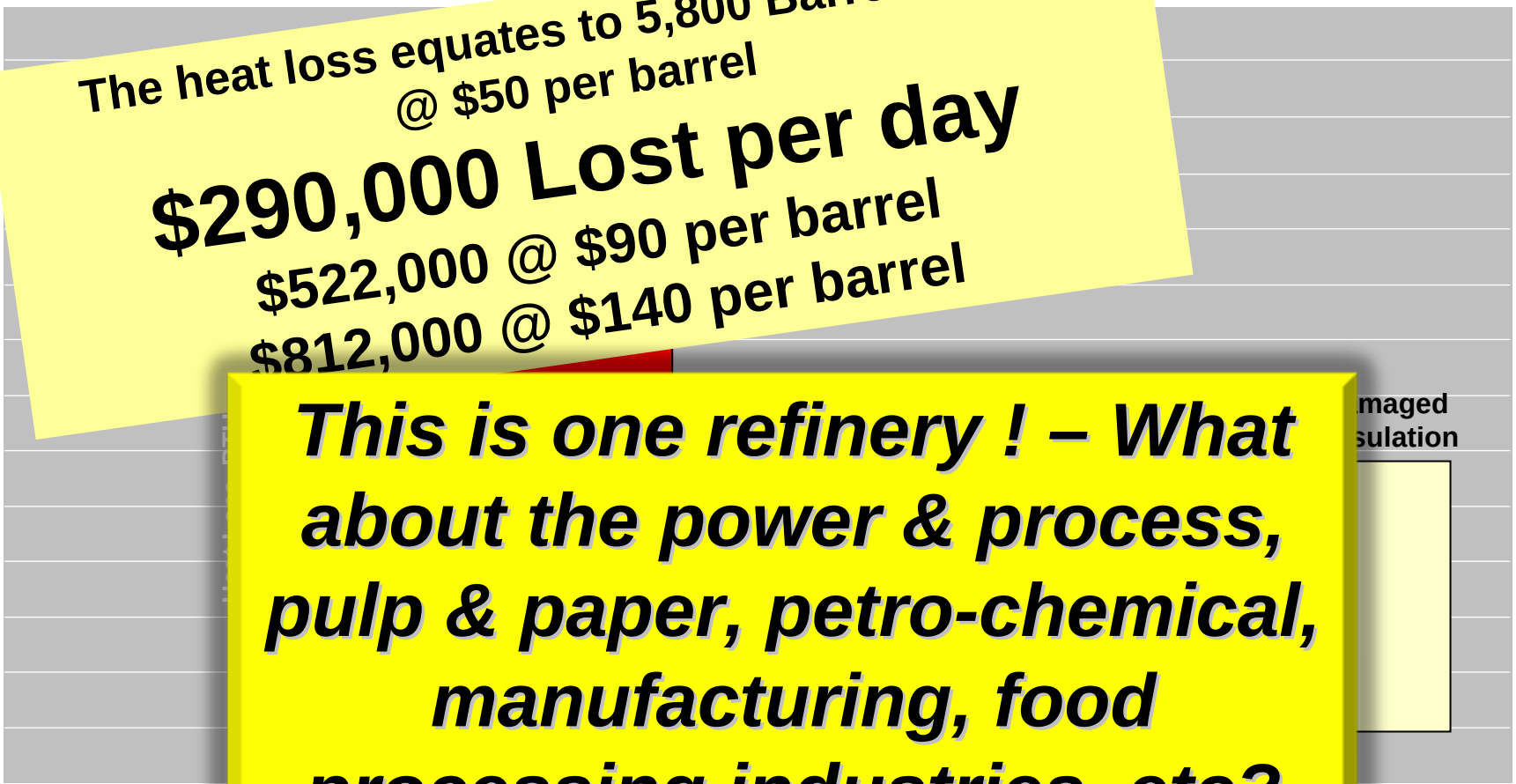


This is one refinery ! – What about the power & process, pulp & paper, petro-chemical, manufacturing, food processing industries, etc?

SAVE ENERGY NOW
INDUSTRIAL TECHNOLOGIES PROGRAM

(Individual Facility Published results reviewed July 22, 2008)

- **717 Assessments complete** (January 2, 2009)
- **180 Public Reports Issued**

  51% have specifically mentioned insulation
- **Total potential annual energy savings & emission reduction for all initiatives**
  - **$937 Million in energy cost savings**
  - **87.2 Trillion BTU natural gas savings**
  - **7.9 Million metric tons potential carbon dioxide – CO_2 emissions reduction**

Save ENERGY Now

SAVE ENERGY NOW INDUSTRIAL TECHNOLOGIES PROGRAM

(Published results as of July 1, 2008)

Insulation References

Near Term (<1 yr. return)	**82%**
Medium Term (<3 yr. return)	**15%**
Long Term (>3 yr. return)	**3%**

Missing, damaged, or uninsulated	**70%**
Upgrade or improve	**30%**

SAVE ENERGY NOW
NEAR TERM Insulation Initiatives

BAYER (2 Steam Plants), Institute, WV

By improving and replacing missing insulation on the steam and condensate lines – Potential savings $926,000 per year

BOISE CASCADE (Paper Mill), Jackson, AL

By replacing missing pipe insulation – Estimated savings $80,000 per year, cost to complete the work $25,000 = Payback in 3.2 months

DOW CHEMICAL (Chemical Plant), Hahnville, LA

By replacing, repairing and improving insulation on steam system - Potential savings of $811,000 per year

GENERAL MOTORS (Power Plant), Pontiac, MI

By replacing missing insulation and repair others – Estimated savings of $298,000 per year

SAVE ENERGY NOW
NEAR TERM Insulation Initiatives

GOODYEAR Union City, TN

A significant number of process units are partially insulation

Potential savings = $402,000 per year. Estimated cost to insulate ranges between $80-$200,000 = payback in 2 – 5 months. "This same opportunity can be applied to other company facilities"

MEAD WESTVACO, Silsbee, TX:

Commissioned an "insulation strike team" to go through the plant to repair areas of poor, damaged or missing insulation. They determined that reducing insulation heat loss by 10%, the savings would be over $486,000 per year.

UNITED STATES STEEL, Gary, IN:

Estimated that by using proper type, size and thickness of insulation and improving maintenance of the insulation systems Potential energy savings could be in excess of $1,500,000 per year

SAVE ENERGY NOW

NEAR TERM Insulation Initiatives

MITTAL STEEL, Weirton, WV

Hot water washing tanks are located throughout the facility, 50,000 SF of surface area. The surface temperature of these tanks is 140 F

Assuming ½ the heat loss can be saved with an inexpensive – simple insulation system, the annual savings would be $371,000 + per year

FRITO-LAY, Frankfort, IN

Adding insulation to bare pipes and fittings –

$150 M estimated cost = annual savings of $80 M

= simple payback of 1.88 years – medium term project

SAVE ENERGY NOW
NEAR TERM Insulation Initiatives

- **Coors Brewery,** Golden, CO
- **Dairyman's Land O' Lakes,** Tulane, CA
- **Foremost Farms,** Richland, WI
- **Leprino Foods,** Lemoore, CA
- **Welsh Foods,** North East, PA

Replace, repair and improve insulation

Associated Milk Producers – Con Agra Foods – Hormel – Imperial Sugar – Kraft

Estimated energy savings, emission reduction and jobs created with improved maintenance and focus on mechanical insulation

A portion of the

Industrial – Maintenance Segment

Plant Size Large Plant >500BBtu/yr Medium Plant 26-500BBtu/yr Small Plant <26BBtu/yr	Energy Savings Billions ($)/year	CO Reduction Billion Lbs/yr	Payback (Months) ROI (*) (20 yrs)	Jobs (*) Created Preserved
Large & Medium	> $ 1.9	> 45.6	12.0 / 103%	12,069
Small (*)	> $ 0.6	> 15.9	9.6 / 135%	2,930
Total	> $ 2.5	> 61.5	11.3 / 109%	14,999
Distribution (*)				1,533
Total	**> $ 2.5**	**> 61.5**	**11.3 / 109%**	**16,532**

* Estimated by NIA

A simplistic view

Insulation, a better option than a light bulb?

Energy Conservation Option	Energy Savings, MMBtu/yr (1)
1 ft of insulation on 350°F pipe	14.4
1 car, 5% increase in mpg	3.7
1 compact florescent light bulb	0.9
1 ft of insulation on 180°F pipe	0.9
1 ft of insulation on 42°F pipe	0.6

Energy conservation with the use of mechanical insulation -"Low Hanging Fruit" - is simply an OPPORTUNITY that should not be overlooked

It is an investment that may have few rivals from a return perspective.

(1) Equivalent energy savings in Millions of Btu/yr (MMBtu/yr) of primary fuel

Insulation Reduces Polluting Emissions

Insulation reduces plant greenhouse gas emissions by reducing plant energy consumption

This is a great example of why we need to think about insulation differently

How USA's Electricity is Generated

COAL	**48.3%**
NATURAL GAS	**21.3%**
NUCLEAR	**19.2%**
HYDRO-POWER	**6.9%**
SOLAR & OTHER	**3.3%**
WIND	**1.0%**

U.S. Department of *Energy* *(2008 through September)*
Houston Chronicle, January 11, 2009

Insulation, Is "Greener" than Trees

Carbon Reduction Option	Lbs of CO_2 per Year
1 ft of insulation on 350°F pipe	2,308
1 car, 5% increase in mpg	570
1 compact florescent light bulb	130
1 ft of insulation on 180°F pipe	109
1 ft of insulation on 42°F pipe	88
1 tree	50

There is no question!

Insulation CAN HELP Reduce Polluting Emissions and Increase Available Carbon Credits

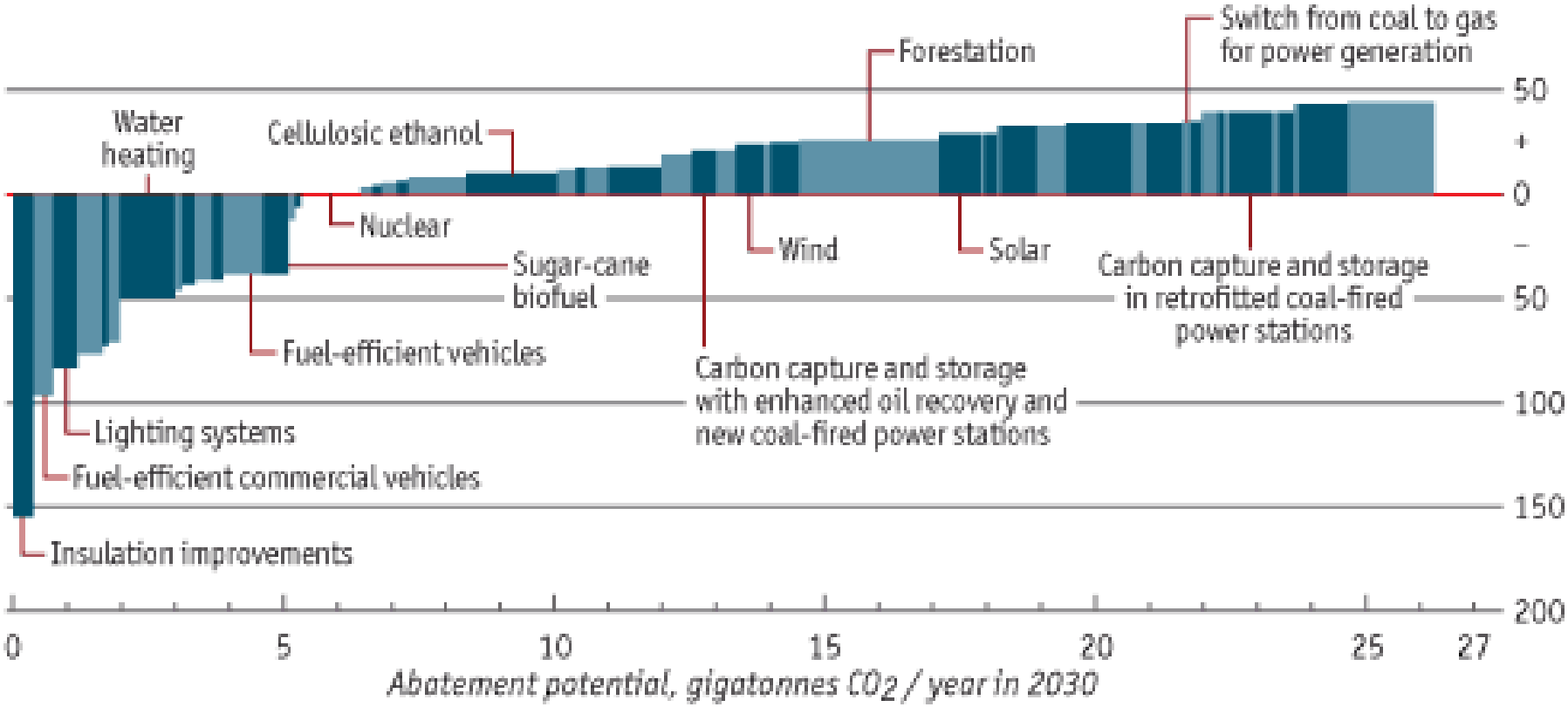
The environment, along with energy conservation, is going to be, if they are not already, center stage in the financial and political arenas for years to come

One credit is considered equivalent to one ton of CO_2 emissions

3

The cost of cutting carbon in different ways

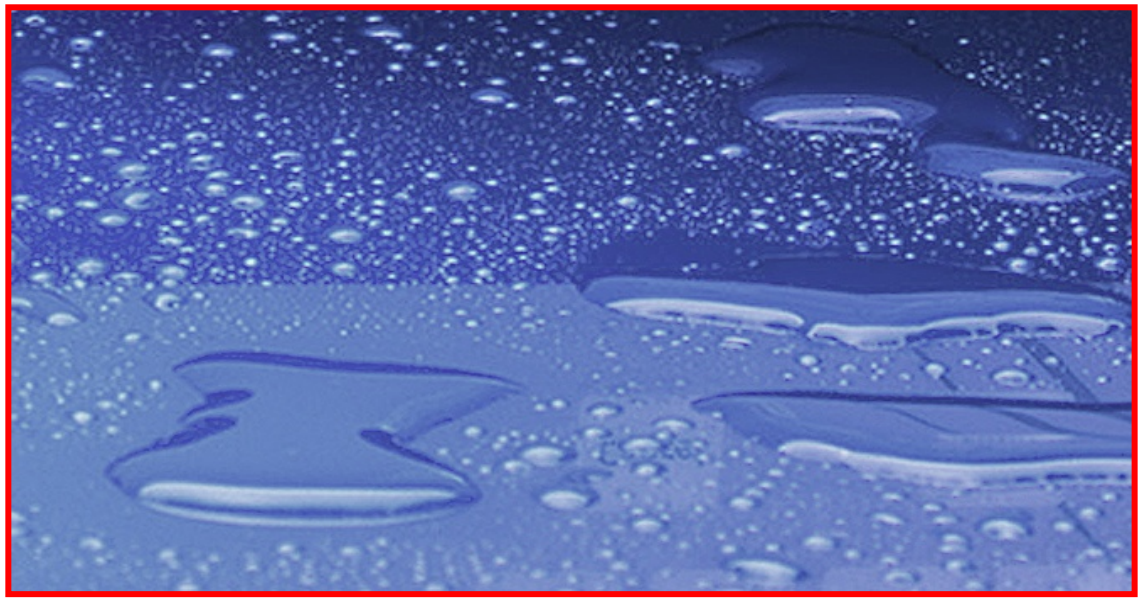
Marginal cost of abatement, examples €/t CO_2



Source: Vattenfall

Properly designed, installed and maintained insulation can

- **Prevent condensation, which can be a major factor in mold growth and potentially be a safety hazard**
- **Condensation or moisture intrusion can contribute to corrosion under insulation (CUI)**

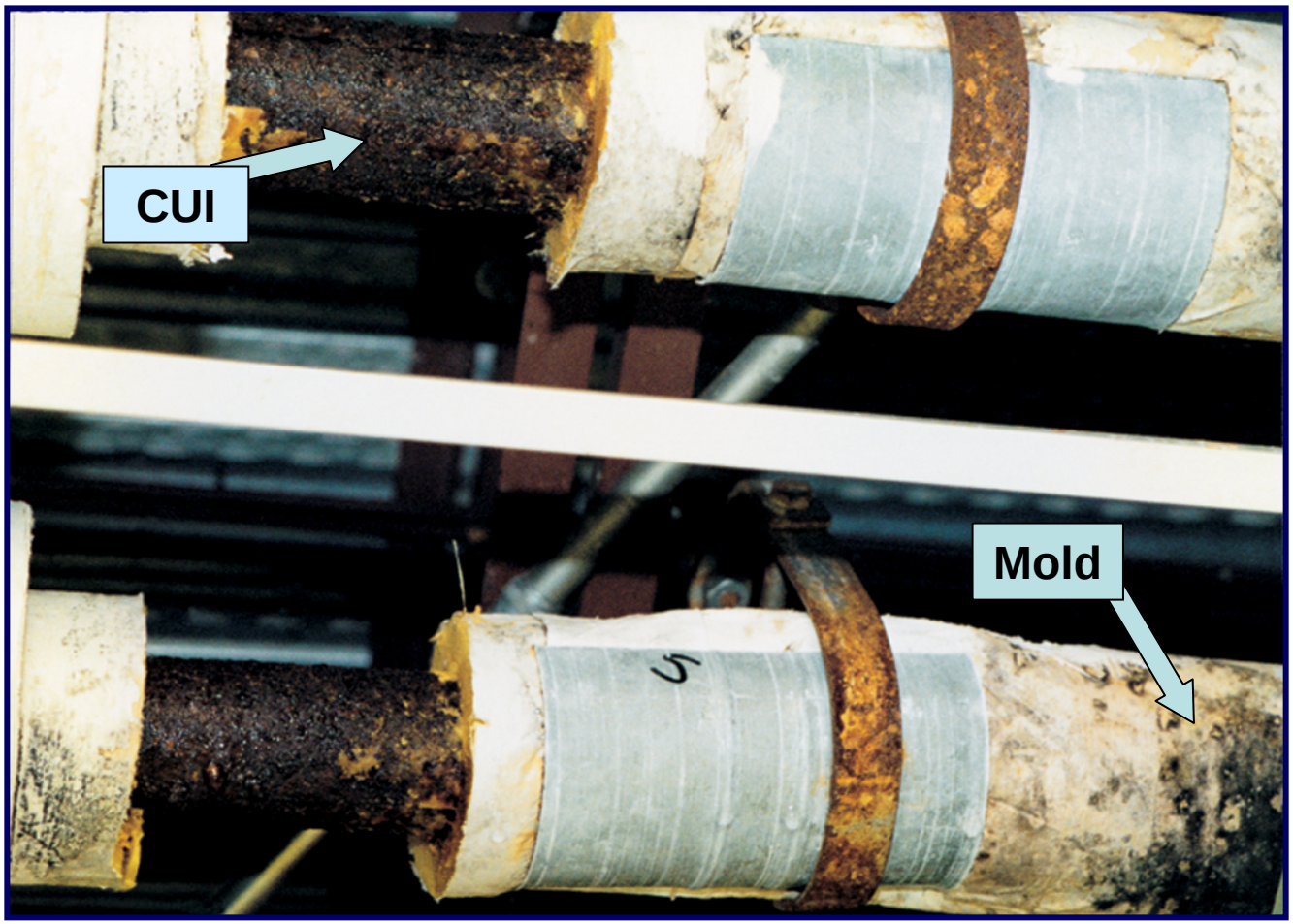


The insulation system must be designed to maintain the surface temperature above the dew point!!

Design the system under the worst case scenario not the best or normal and maintain the system in a timely and correct manner !

MOISTURE IS A ENEMY

CONDENSATION, MOLD OR CORROSION UNDER INSULATION, INCREASED OPERATING COST

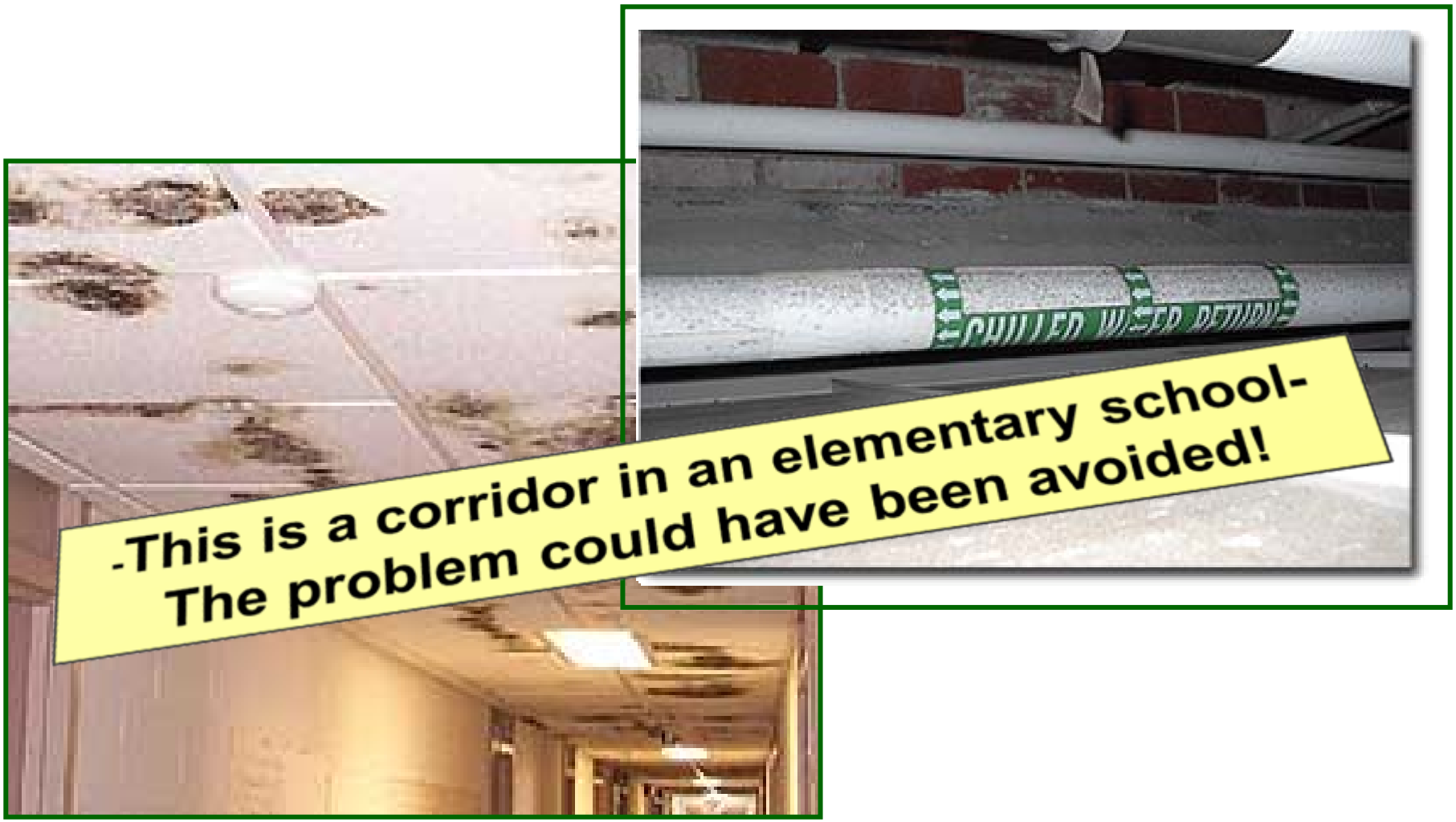


Condensation problems are real and can lead to other problems!

Mold – Indoor Air Quality - Safety

Condensation problems are real and can lead to other problems!

Mold – Indoor Air Quality - Safety

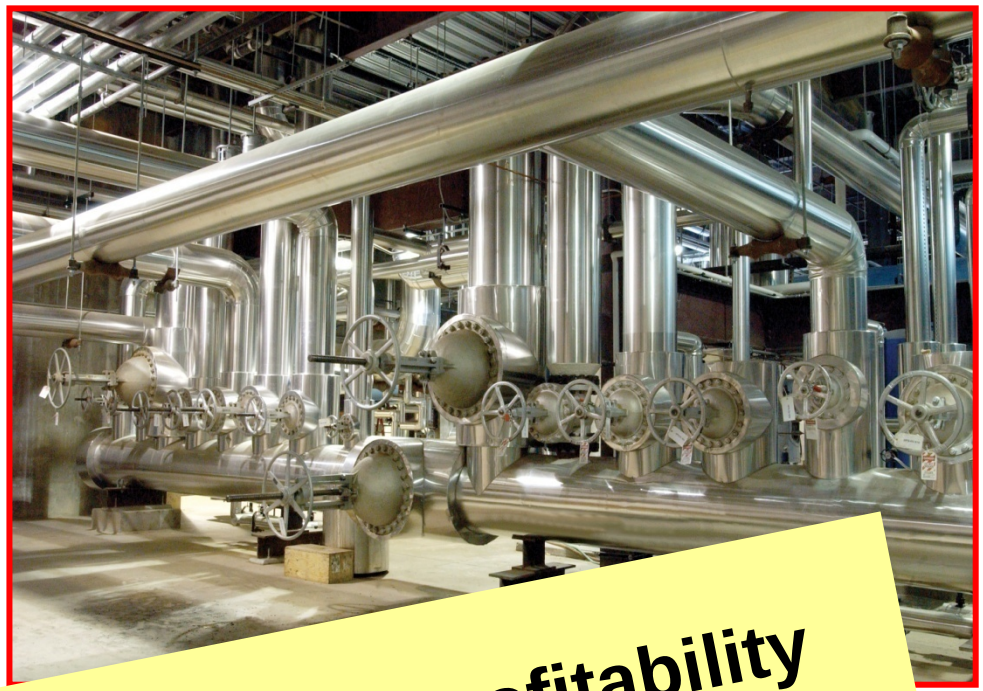


MOISTURE IS A ENEMY !

YESTERDAY – TODAY TOMORROW

Insulation Improves Process Control

- **Helps maintain design process temperatures**
- **Improves product throughput**
- **Maintains product quality and**
- **Lowers cost with lower energy consumption**



Increased Profitability In Manufacturing

We need to think about insulation differently !

Insulation Provides Personnel Protection

Protecting personnel from coming in contact with hot/cold surfaces or excessive equipment or other work place noise and life safety applications should be a focus of any Safety Program!

PERSONNEL PROTECTION? SAFETY?

What better example than safety to Think About Insulation Differently

LIFE SAFETY
FIRE PROTECTION

Building Code Objectives:

- **Prevent progressive building collapse – contain the fire to the area of origin**
- **Provide safe occupant egress**
- **Provide firefighter entry/operations/safety**

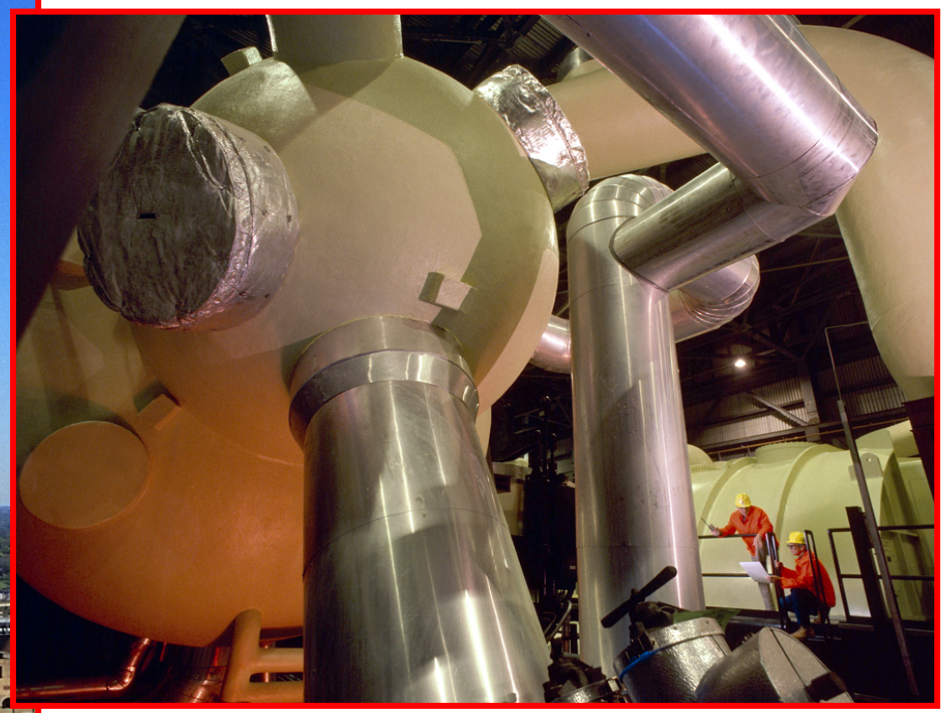
Fire Resistance Rated Shafts/Enclosures

Protection of Ducts & Air Transfer Openings

LIFE SAFETY
FIRE PROTECTION IS SERIOUS BUSINESS

- **Supply & Return Ducts**
- **Chemical Fume Exhaust Ducts**
- **Commercial Grease Ducts**
- **Linen/Laundry/Rubbish Chutes**
- **Stairwell Pressurization Ducts**

“Fire stopping” – Penetrations & wall - Ceiling Joints



Insulation Can Improve Facility Life Cycle Costs

Insulation is a time tested and proven energy conservation investment

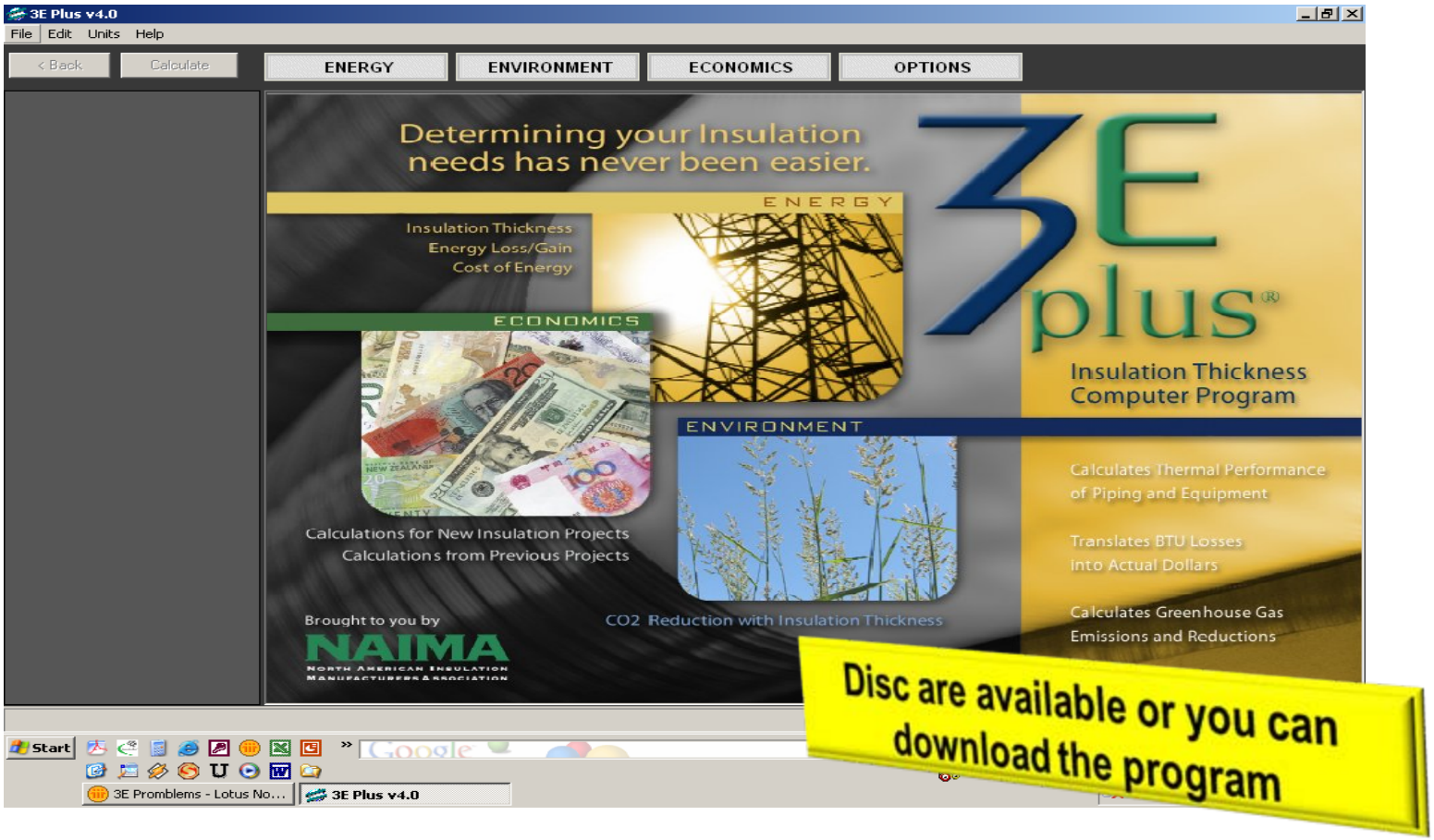
Insulation Can Provide a Significant Return on Investment (ROI)

Many times in less than 1 year and faster than nearly any other energy efficiency investment

That all sounds good

but how can you quantify the savings and return ?

3E Plus Insulation Thickness Computer Program



www.pipeinsulation.org

Developed by
North America Insulation Manufacturers Association (NAIMA)

ENERGY
- Heat Loss/Gain
- Surface Temperature
  - Personnel Protection
  - Condensation Control

ECONOMICS
- Cost of Heat Loss/Gain
- Economic Thickness
- Payback Period

ENVIRONMENT
- Greenhouse Gas Emissions

Available for downloading at
www.pipeinsulation.org

Developed by
North America Insulation
Manufacturers Association (NAIMA)

Inputs Required:

Operating and Ambient Temperatures

Wind Speed

Type & Cost of Fuel, etc

Insulation Selection Options:

Geometry

Type & Thickness of Insulation

Finish (Aluminum etc)

Available for downloading at
www.pipeinsulation.org

EXAMPLE

Heat Loss – Energy Conservation

- **8” NPS Steel Horizontal Pipe**
- **350°F Process and 75°F Avg. Ambient Temperature**
- **8 MPH Average Wind Speed**
- **Fuel Source – Natural Gas @ $10/mcf**
- **Operating Hours – 8,320/yr**
- **Insulation – Mineral Wool System with Aluminum Jacket**

EXAMPLE

Heat Loss – Energy Conservation

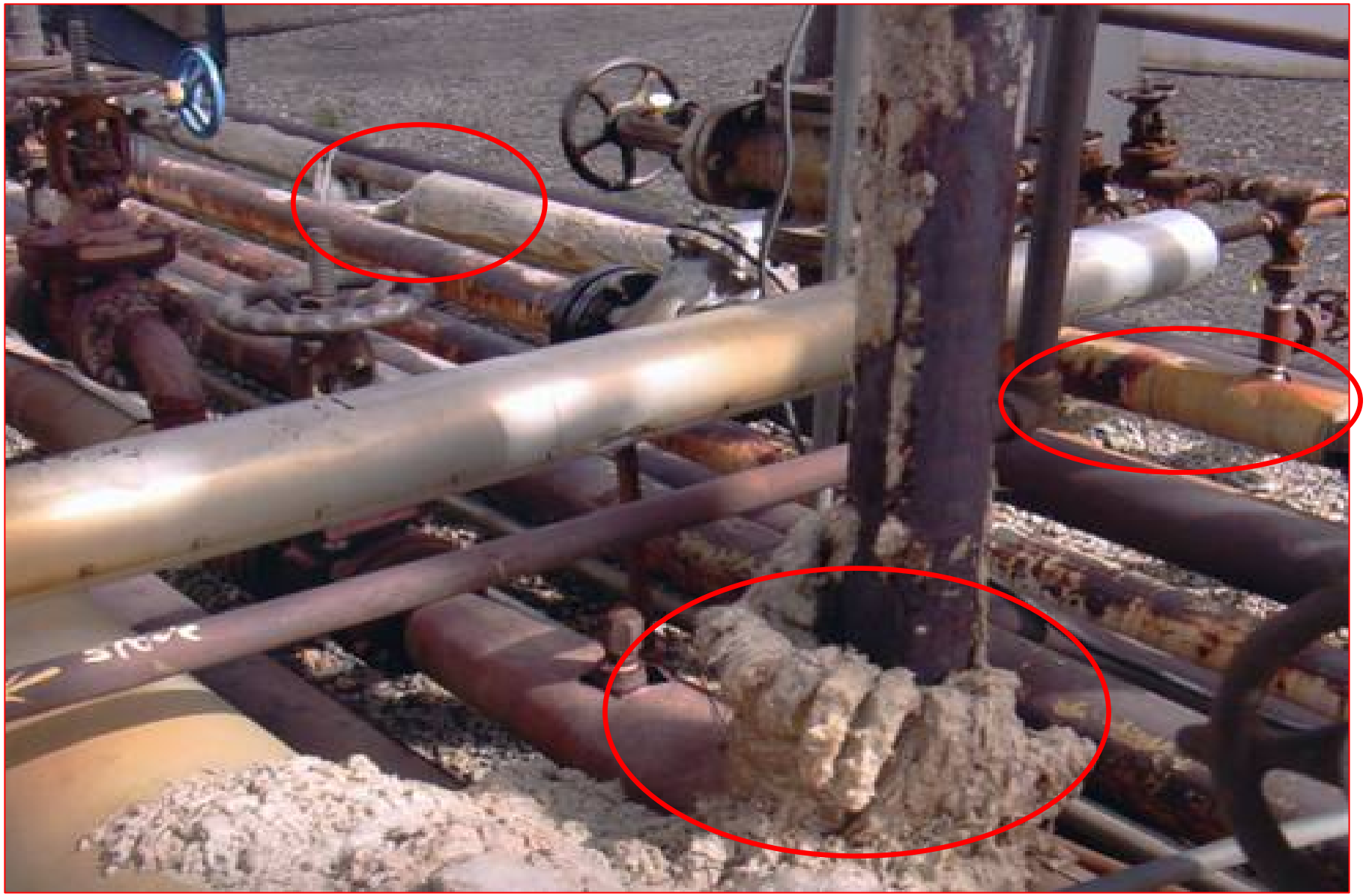
VARIABLE INSULATION THICKNESS	HEAT LOSS (BTU/FT/YR)	ESTIMATED INSULATION COST ($/LF)	ANNUAL COST SAVINGS ($/LF)	PAYBACK (MONTHS)	CO2 EMISSION (LBS/FT/YR)
BARE	23,180,000				3,376
1.5 INCH	1,200,000	$17.87	$267.80	0.8	174
2 INCH	954,900	$21.00	$270.80	0.9	139
3 INCH	679,100	$29.35	$274.10	1.3	98

Why is insulation maintenance looked at differently yet the evidence of its value is overwhelming and opportunity is so great?

- ***Reactive vs Proactive approach – Time & Resources***
- ***Lack of Knowledge -"No Respect" – for Return on Investment or potential risk not recognized in short or long term***
- ***Just not a* high priority – "status quo"**
- ***Damage not identified early enough and repairs are often not done timely and correctly***

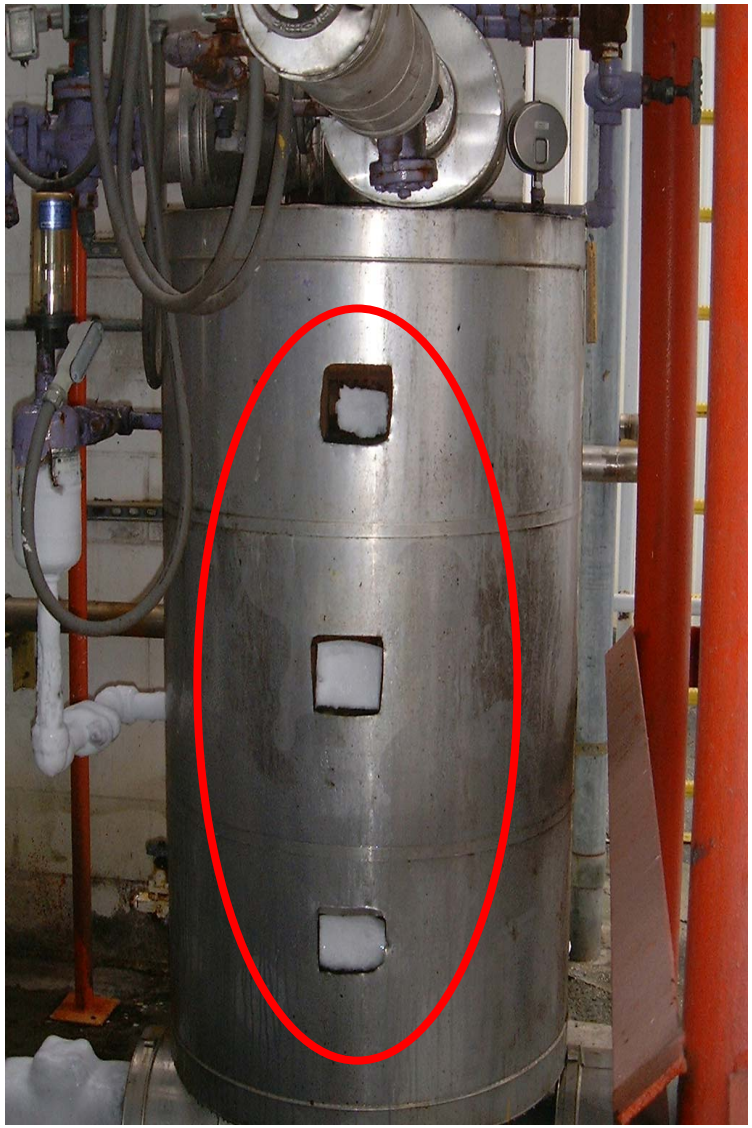
10-30% Missing or Damaged

Typical – Neglect Example, or Not?



“Non – Destructive Testing”

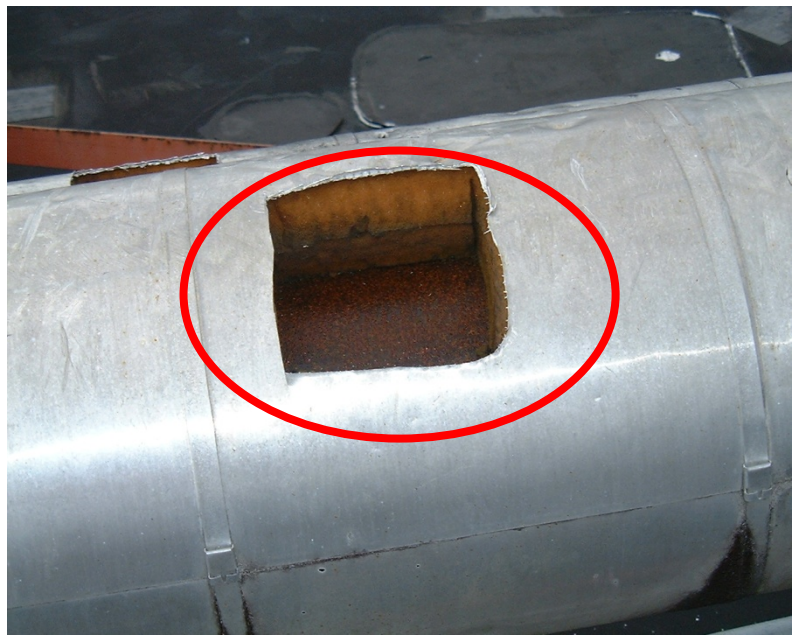
Non Destructive or Destructive?



Penetrating an Insulation under <u>any</u> circumstances

Is a risk !

Not immediately repairing the area is just like throwing money out the widow



Typical - Damage Example, or Not?

Are there risks in not timely and properly maintaining an insulation system? - YES

What are the "Risks" ?

The lack of or timely and proper maintenance can lead to a failed insulation system, which is problematic for many reasons:

Safety:

- **Corrosion of the substrate (CUI) which could result in an release of the pipe or equipment contents**
- **The increased weight of potential wet insulation could potentially cause the piping, equipment etc to exceed the structural design of the support systems**
- **Dripping of water from the insulation could create personnel safety concerns**

What are the "Risks" ?

Productivity:

The reduced efficiency of the insulation system is not allowing the equipment or process to function as designed thus resulting in decreased plant productivity and or increased cost of production.

What are the "Risks"?

Cost of Operations – Return on Investment:

A failed insulation system is increasing annual operating cost and life cycle cost verses the purpose for which it was intended:

- **Increased energy consumption**
- **Increased production cost – lower throughput**
- **Corrosion under the insulation is decreasing the life of the substrate thus increasing life cycle and annual maintenance cost in multiple areas**
- **Deceasing the life of the equipment due to operational demands and the affect on the surrounding work area**
- **Creating unnecessary risk in multiple areas including employee and community safety and regulatory concerns.**

MECHANICAL INSULATION

A TIME TESTED

AND PROVEN

TECHNOLOGY

BUT.. IT MEANS CHANGE

AND YES,

THERE ARE BARRIERS TO CHANGE

Think About Insulation Differently

BARRIERS TO CONTINUOUS IMPROVEMENT WITH MECHANICAL INSULATION

- **Needs a "Champion"**
- **Management – the decision makers need motivation to allocate attention and resources**
- **People resources seem to be always a problem**
- **Energy is often not a line of specific accountability and not integrated with other business objectives**
- **Slow uptake on energy savings projects and implementing technical or specification recommendations**
- **The damage or cost caused by reduced focus on mechanical insulation is often not identified**
- **Lack of detailed knowledge on mechanical insulation systems**
- **Pressure from competing and often more "glamorous" initiatives**
- **Good or best practices in one unit/plant are not easily and widely diffused in organizations**
- **Insulation is not considered part of continuous improvement process**

There has never been a better time than now to think about insulation differently

THE NEED FOR EDUCATIONAL AND AWARENESS PROGRAM AS TO THE "VALUE OF INSULATION"

National Insulation Association
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OUTREACH INITIATIVE TO PARTNERS IN KNOWLEDGE

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MECHANICAL INSULATION DESIGN GUIDE

Launched January 2008

Mechanical Insulation Design Guide

A web-based resource intended to assist users with design guidance for mechanical insulation systems

www.wbdg.org/midg

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MECHANICAL INSULATION DESIGN GUIDE

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The Mechanical Insulation Design Guide

- Developed jointly by:
  - **The National Institute of Building Sciences**
  - **The National Insulation Association**

National Institute of BUILDING SCIENCES

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National Insulation Association
www.insulation.org

National Institute of BUILDING SCIENCES

- **A non-profit, non-governmental organization.**
- **Brings together representatives of government, the professions, industry, labor, and regulatory agencies**
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MIDG is part of the NIBS "Whole Building Design Guide"

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- **The Whole Building Design Guide (www.wbdg.org) is an evolving web based resource intended to provide users with design guidance, criteria and technology for buildings**

- **The WBDG and MIDG are continually augmented with updated and new information and is structured as a "vertical portal", enabling users to access increasingly specific information as they navigate deeper into the site**

The WBDG and MIDG
are available on a "no-cost" basis to all users

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MECHANICAL INSULATION DESIGN GUIDE

National Institute of BUILDING SCIENCES

Six Main Sections:

1. Introduction
2. Design Objectives
3. Materials & Systems
4. Installation
5. Design Data
6. Resources

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"On Line Calculators"

1. Service Temperature, By Product Type
2. Estimated Time for Fluid to Freeze in an Insulated Pipe
3. Temperature Drop – Fluid Flowing in a Duct or Pipe
4. Simple Thickness
5. Simple Heat Flow
6. Rate of Return on Investment & Emission Reduction

MIDG is the most extensive mechanical insulation resource developed in decades and it is free

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MECHANICAL INSULATION DESIGN GUIDE

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MECHANICAL INSULATION DESIGN GUIDE

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Six Sections:

1. Introduction
2. Design Objectives
3. Materials
4. Installation
5. Design Detail
6. Resources

www.wbdg.org/midg

Live demonstration

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Summary

- MIDG is the most comprehensive resource on Mechanical Insulation available today
- MIDG is available at no cost
- Access MIDG at www.wbdg.org/midg

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Good For Business!

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We need to think about insulation differently!

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