Million$ to be Saved Through Insulation Optimization

- **Muhannad Rabeh**, B.Sc., BP America – GoM DW
- **Shawn O'Hearn**, P. Eng., API 510/570, BP America – GoM DW
- **Jonathan Petersen**, CEng, IMechE, BP America – GoM DW

Corrosion Under Insulation (CUI)

Severe CUI

- 4” CS pipe
- Natural Gas
- 400 psig
- Located at support
- Mineral wool insulation

What’s the easiest ways to prevent CUI?

- *don’t install insulation!!*
- *get rid of insulation!!*

Why is there so much insulation?

The need “perceived need” for …

- Heat conservation
- Personnel burn protection
- Noise reduction

CUI Prevention Strategy

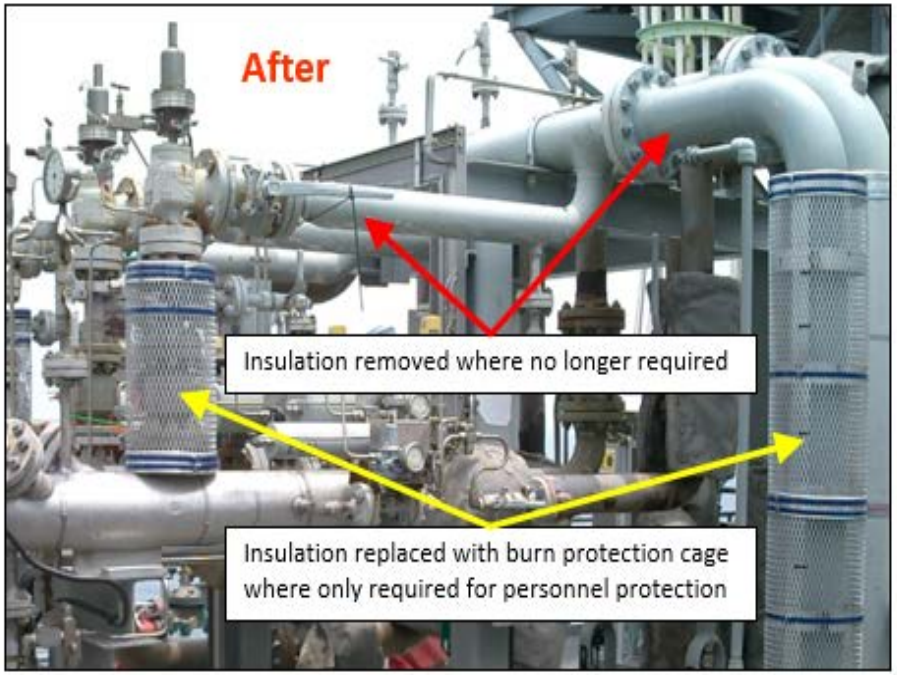
A. Perform insulation engineering review …

- Heat Conservation Evaluation
- Personnel Protection Evaluation

B. Aggressive inspection program …

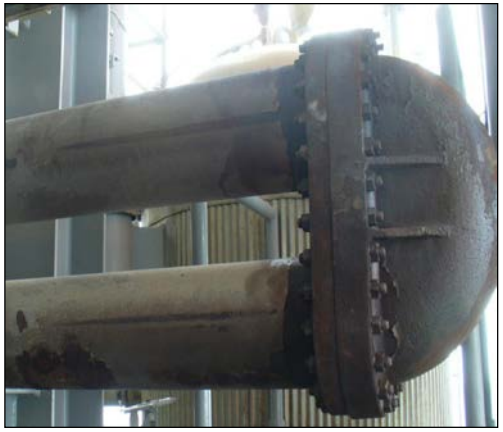
- where insulation is still required …
- starting with highest consequence services …

Implementation



Insulative Coatings

Active CUI



- After insulation removal
- Surface temp 340 F

- Thermal insulative coating system applied in place of conventional insulation
- Surface temp < 140 F

Conclusion

- Applied across GoM facilities
- A significant number of insulated lines can have insulation permanently removed
- A significant number of insulated lines can have insulation replaced with cage or coating
- ***Where possible, remove insulation to prevent CUI***

Thick Film Insulation Coating

Hot Insulating Coating System

Fit for Purpose

APCS - 5B

1 Type of Coating

Hot Insulating Coating System for carbon steel and stainless steel service

2 General Data

2.1 Typical Use

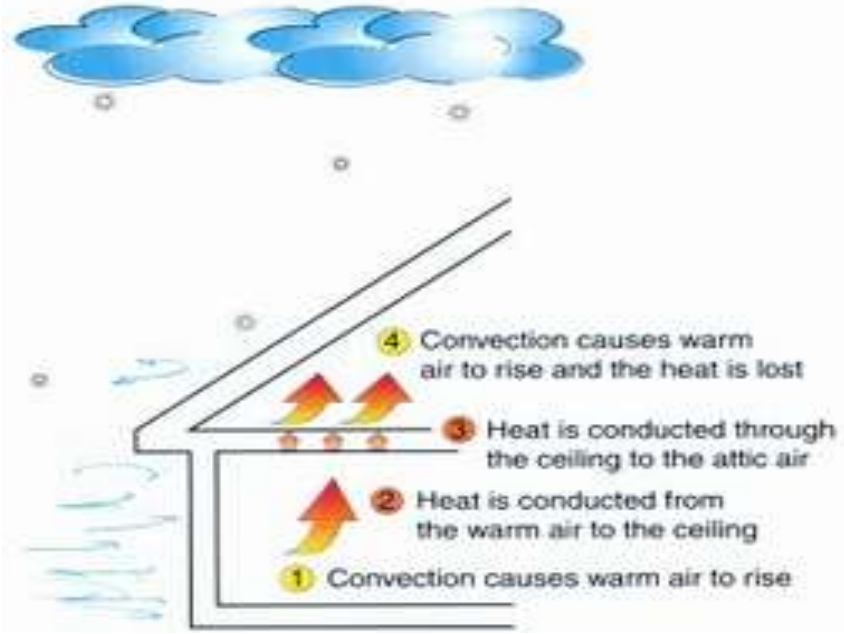
Alternative to conventional bulk insulations for energy conservation in hot services. Used for personal protection on hot piping.

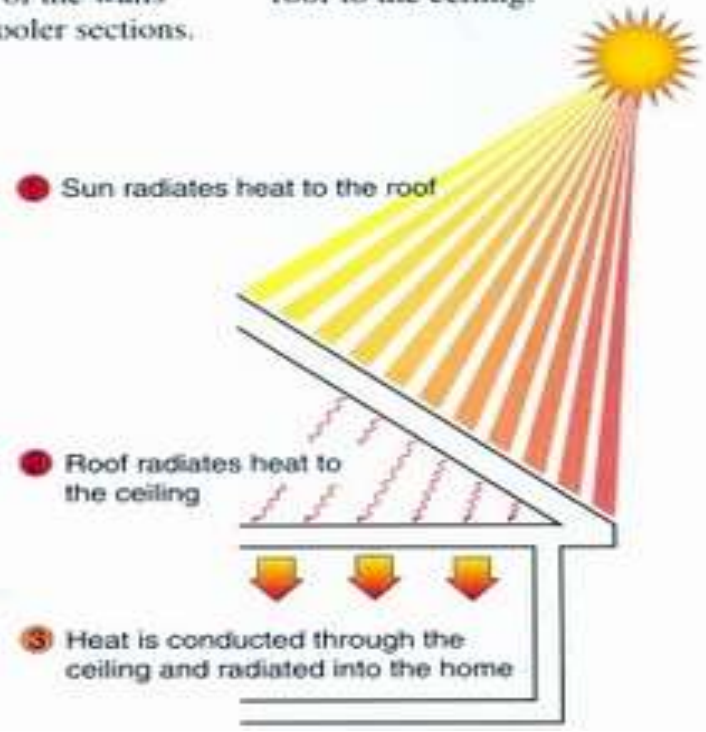
2.2 Service Condition Limitations

Maximum Service Temperature: 500°F (260°C)

3 Forms of Heat Transfer

	Convection	Conduction	Radiation
Definition:	The transfer of heat by moving air.	The transfer of heat through a solid material.	The transfer of heat in the form of electromagnetic waves.
Example:	Warm air rises and transfers heat to the ceiling	Heat is transferred from warmer sections of the walls and ceilings to cooler sections.	Heat is transferred from the roof to the ceiling.





Conventional Pipe Insulation

How it works:

- Uses small pockets of air that only slow conductive heat transfer.
- Heat will be absorbed and transferred to the cooler side, at an accelerated rate.

Corrosion Under Insulation

- Costly maintenance due to CUI, low return investment.
- Designed for safety first.
- Insulation was always secondary.
- Never designed to be air tight.
- Absorbs moisture, gains weight, sags and falls of large pipes.

Rockwool, fiberglass, or other traditional types of insulation promote corrosion, and also act as a carrier and spread the corrosion to other areas of the pipeline

Advantages – Insulative Coatings

- replaces wrap & jacketing
- significantly reduces CUI
- no shutdown required
- applied on both hot / ambient surfaces
- internal temp/pressure increase
- reduces energy consumption
- protects personnel
- easy to inspect and repair

Before & After

BEFORE => AFTER

463C Bare Pipe Temp. => 36C Skin Temp

Applied at 30mm – No Shutdown

Low Cost, Easy Application

- Applied directly on valves and elbows

Superior Safety

30MM Thickness

NACE TG 525 (2019)

ASTM C177 – Standard Test Method for Steady State Heat flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus

Measuring Thermal Conductivity @ 96F / 30C

160 or 300 mils DFT, 12x12 AI sheet

Primer YES or NO

Mean temperature °C	Thermal conductivity W/(m.K)
-10	0.059
0	0.060
10	0.061
20	0.062
30	0.063
50	0.066
100	0.071
200	0.083
300	0.094
400	0.106
500	0.117

CUI Testing for Insulative Coating

ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus

Minimum 500 hours up to 3,000 hours depending on manufacturer and requirement

Black Liquor Tank

Heated Tank

Black Liquor Tank

Heat Exchanger

LNG – Water Heaters

Water Heater – 24” Diameter, 10’ Length – 175F

Challenge: Corrosion Under Insulation. Failure of insulation materials, due to moisture penetration.

Solution: 10-12mm or ½ inch dry film of waterborne, non-toxic, non-flammable, ceramic based insulation coating applied directly to heater while online.

Results: Monolithic jacket providing corrosion under insulation protection. Significant heat loss reduction as seen in before and after photos. No space for rodents to hide in.

LNG – Water Heaters

<u>BEFORE</u>

Coating application:

Picture taken after NACE 4 surface preparation.

LNG – Water Heaters

<u>BEFORE</u>

Coating application:

Picture taken after NACE 4 surface preparation.

LNG – Water Heaters

AFTER:

Insulation coating application

&

Polyurethane top coat

LNG – Water Heaters

AFTER:

Insulation coating application

&

Polyurethane top coat

LNG – Water Heaters

Details:

Angled profiles using handheld razor to discourage ponding water

LNG – Water Heaters

Before: 174 F

After: 204 F

Skin Temperature: 101 F

LNG – Water Heaters

Before: 85F

After: 95F

LNG – Water Heaters

Water Temp:

Before

Below 99 F

After

Above 118 F

LNG – Water Heaters

Equipment: Graco GTX EX 2000

LNG – Water Heaters

Water Heater – 96” Diameter, 18’ Length – 180F

Challenge: Severe Corrosion Under Insulation. Failure of insulation materials, due to moisture.

Solution: 10-12mm or ½ inch dry film of waterborne, non-toxic, non-flammable, ceramic based insulation coating applied directly to heater while online.

Results: Monolithic jacket providing corrosion under insulation protection. Significant heat loss reduction. No space for rodents to hide in.

LNG – Water Heaters

BEFORE

Picture taken after NACE 4 surface preparation.

Operating surface temperature is 120F max without insulation.

LNG – Water Heaters

Primer:

Applied to body only, not ends.

LNG – Water Heaters

AFTER:

Insulative coating application:

LNG – Water Heaters

TOP COAT:

Polyurethane to waterproof

LNG – Water Heaters

OVER SPRAY REPAIR: Immediate Hand Trowel, no material lost.

LNG – Water Heaters

TRASH:

Conventional
Jacket Insulation

Visible Corrosion

LNG – Pipelines

3,600 linear feet of hot piping – Most below 200F

Challenge: Moderate corrosion under insulation. No abrasive blasting…only 3,000 psi power pressure wash to clean piping surface. Ambient surface temperature application, which takes longer to cure.
Piping ranging form 1” - 14” diameters.

Solution: 8 mm or 1/3 inch dry film of waterborne, non-toxic, non-flammable, ceramic based insulation coating applied on ambient piping during shutdown.

Results: Corrosion protection, improved insulation and energy savings plus personal protection. 50 linear feet per day, per Graco sprayer unit at ambient temperatures.

LNG – Pipelines

BEFORE:

Only surface preparation 3,000 psi power wash,

No abrasive blasting

LNG – Pipelines

BEFORE: Bare Pipe

AFTER: HPC Coating

LNG – Pipelines

AFTER:

Insulative coating application.

Prior to top coat

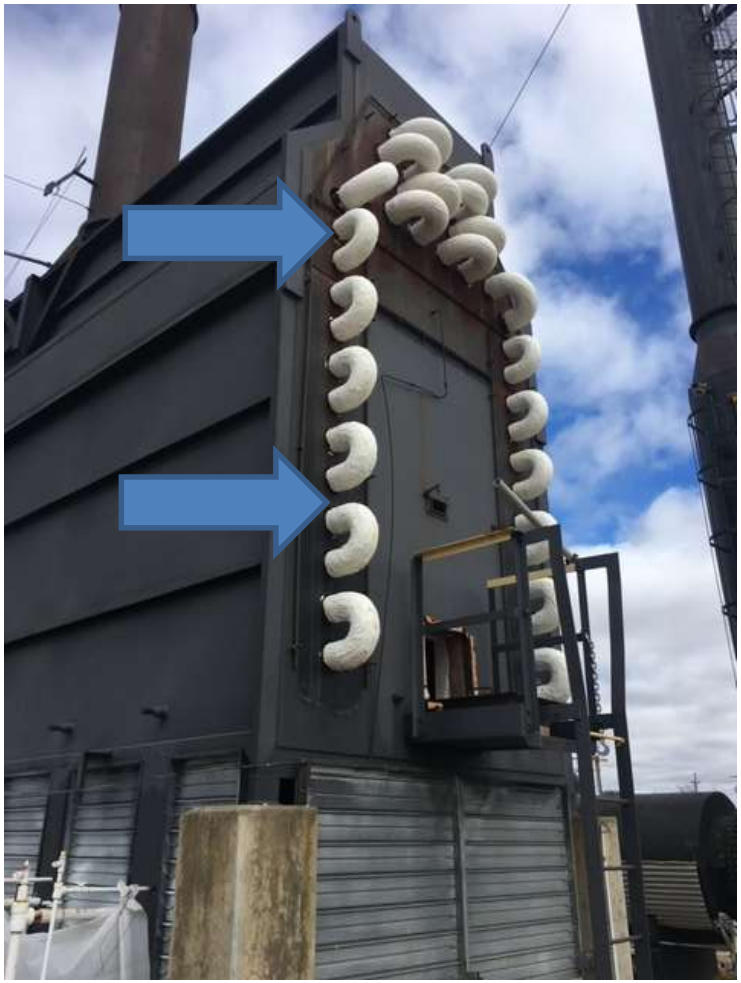
LNG – Pipelines

AFTER:

Overhead piping required less thickness

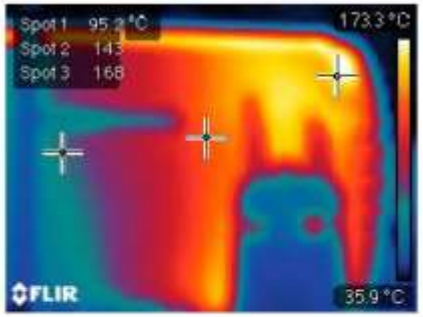
LNG – Pipelines

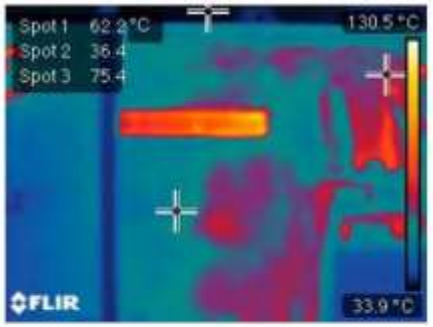
Previously not possible to insulate effectively using conventional jacket insulation



Offshore – Gulf of Mexico

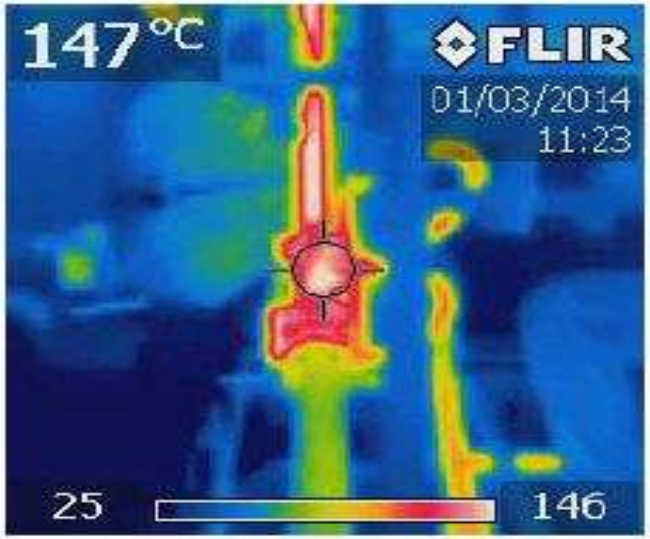
Offshore Equipment





Temperatura arriba de 168°C	Temperatura Máxima de 75°C

Sulfur Pipes – Saudi Arabia



Gulf of Mexico

MDEA Gas Scrubber

Smooth finishes available.

GDF SUEZ

Incinerator - Korea

Incinerator Before: 180℃

Incinerator After: 50℃

Flange, Korea

Flange Before coating: 185℃

Flange After coating: 55℃

Tank Terminal, Belgium

Valves & Flanges

109 C

48.9 C

International Paper

Comparison

Rockwool / Fiberglass	Hot Insulative Coating (thick film)
INSTALLATION	
Must be shutdown during install and repair. Slow Install	Applied online on surfaces up to 480F, or during shutdown. Faster Install
INSULATION EFFECT	
Deteriorates when wet, causing negative insulation.	Insulates permanently.
CRACK DETECTION	
Entire jacket must be removed.	Inspected directly on spot. UT scan ok (non metallic) Easy to remove.
CONDENSATION	
High due to wetting of Fiberglass / Rockwool	No condensation, air tight.
CORROSION	
Notorious for causing CUI.	Truly protects against CUI, moisture proof system.
REPAIR AND MAINTENANCE	
High. Must shut down to repair.	Low. Sprayed online without shut down.


Thin Film Insulation Coating
Radiant Heat Insulating Coating System

Fit for Purpose

APCS - 5A

1 Type of Coating

Radiant Heat Insulating Coating System.

2 General Data

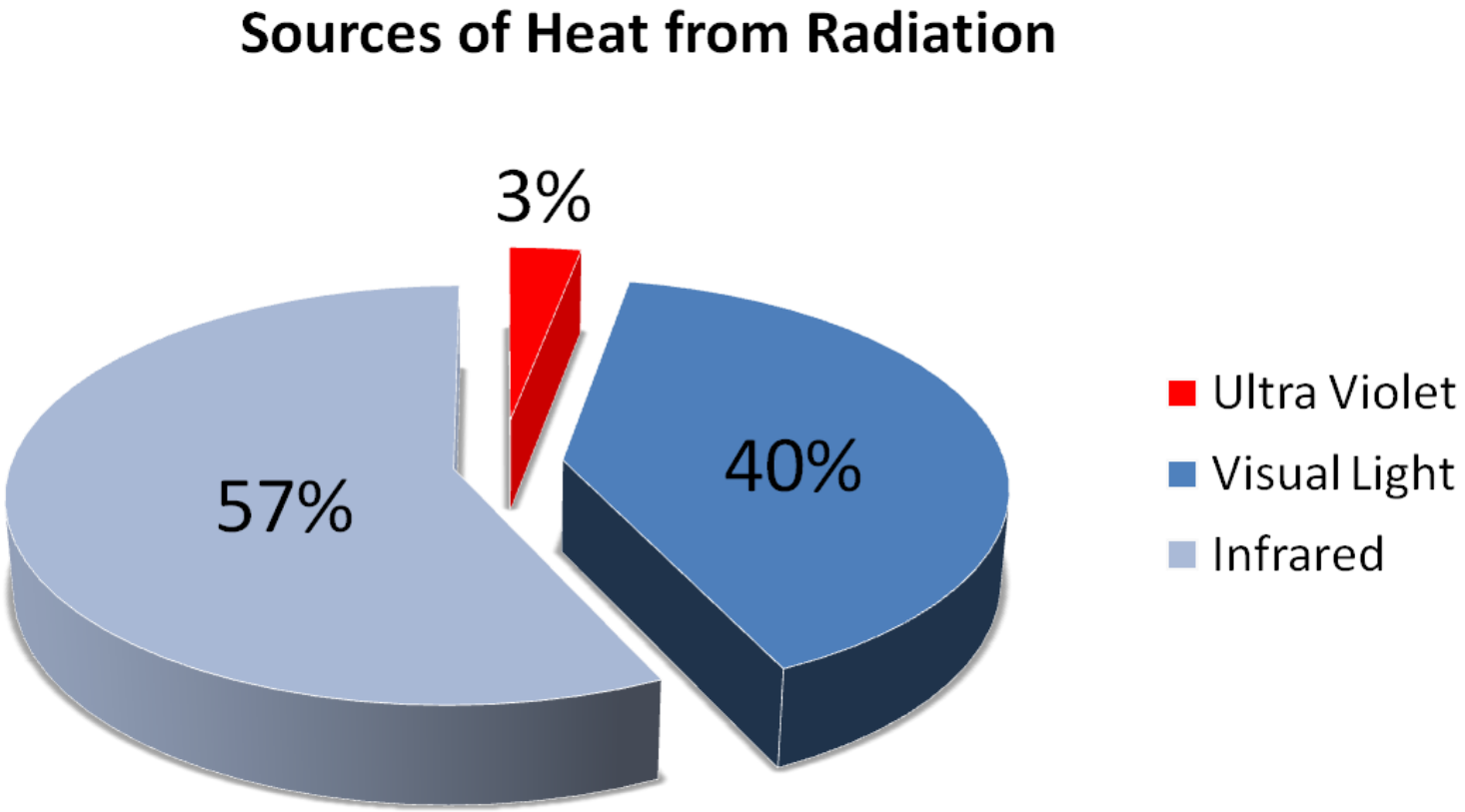
2.1 Typical Use

External top-coating system for petroleum tanks, vessels and drums to reduce the solar heat gain and to minimize the evaporation losses. It can be used on cooling water piping, gas and crude piping to reduce the solar heat gain and temperature rise.

2.2 Service Condition Limitations

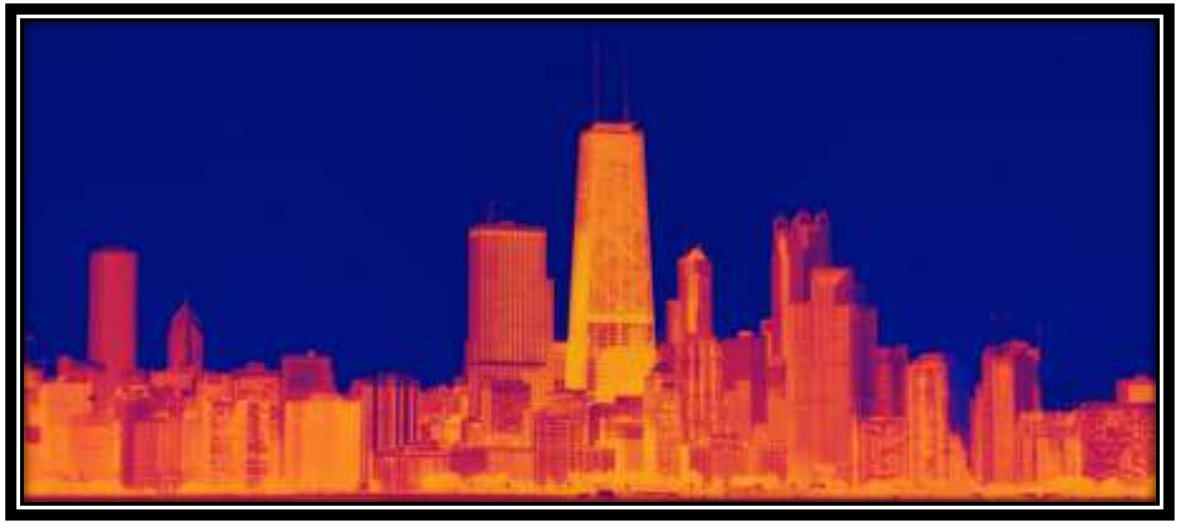
Maximum Service Temperature: 350°F (177°C)

Radiation Heat



Heat Load = Heat Transfer

- Heat must load before it is transferred
- By reducing heat load, you reduce heat transfer
- Using extreme low-density materials prevents the absorption and loading of heat



Solar Thermal Barrier

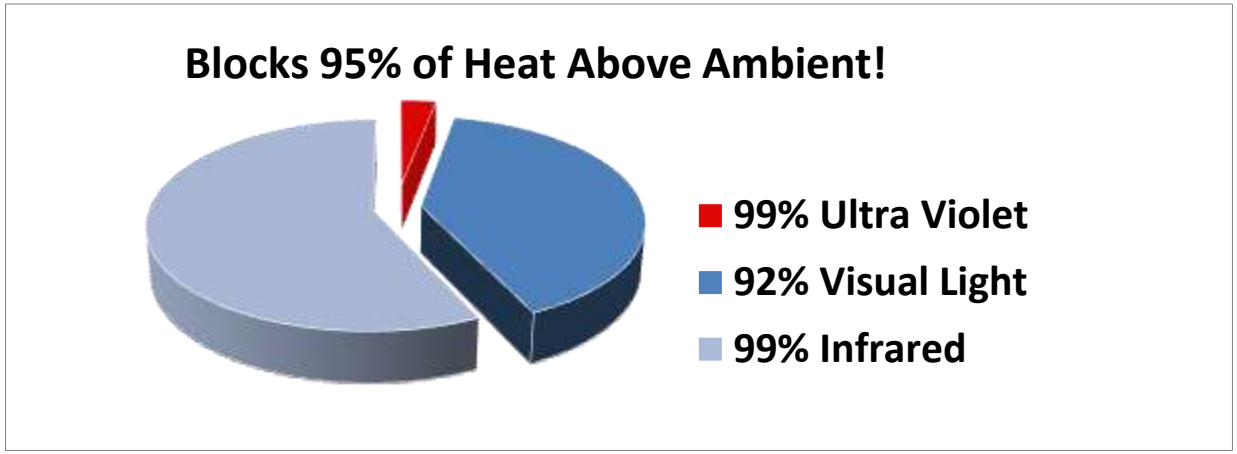
1900's

21st Century

How it Works

- **Stops initial Heat Load by**
  - Reflectivity – Blend of 4 unique low density ceramics
  - Emissivity – Reradiates heat off the surface
  - Ceramic particle size must match the size of the vibration wave of each heat wave to effectively block and repel it back into the atmosphere

- **Combats all sources of Heat Transfer**
  - Radiation, Conduction, Convection



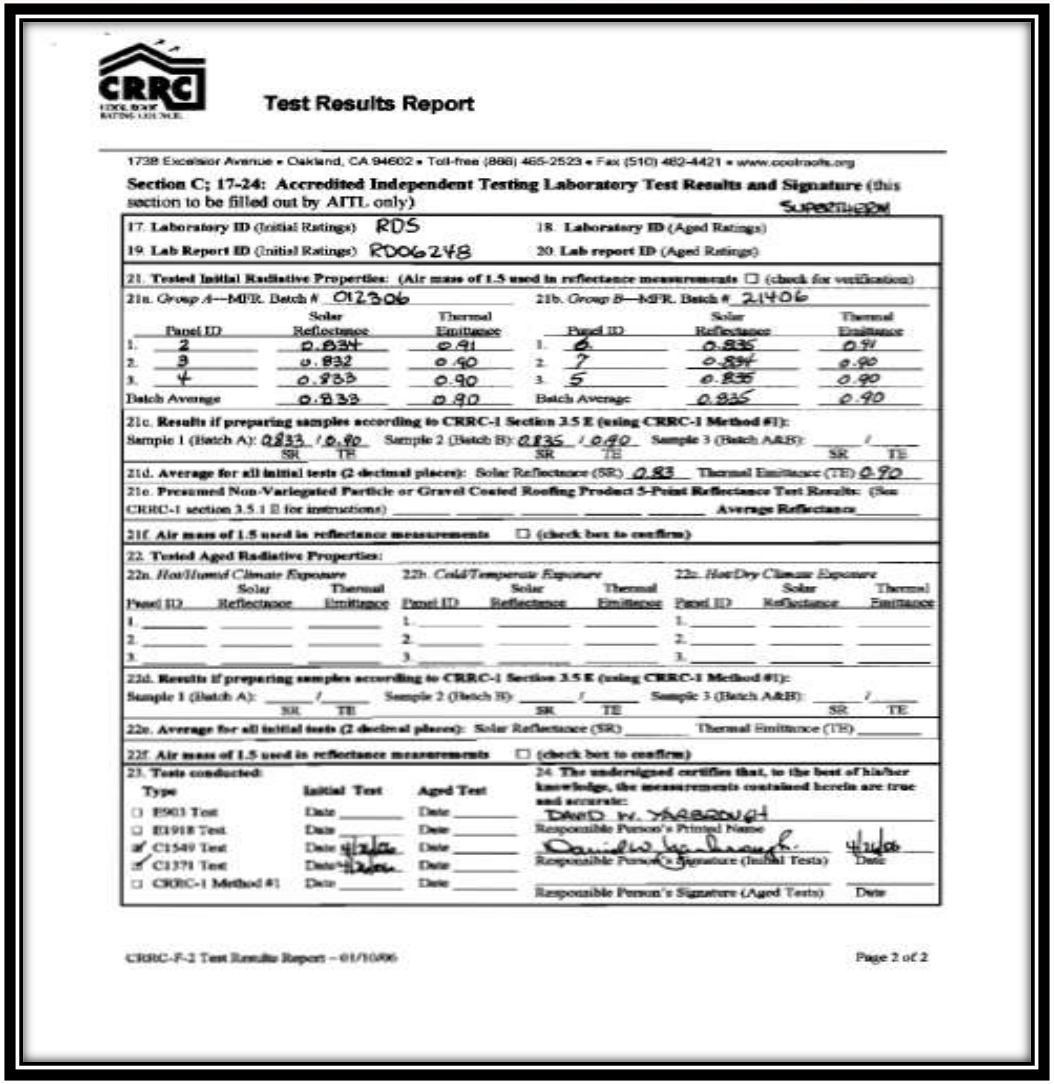
Testing

Cool Roof Rating Council CRRC

- Reflectivity %
- Emissivity %
- Solar Reflective Index

- The United States, Federal and State governments subsidies

- To view programs, visit - www.coolroofs.org



CRRC

Test Results Report

1738 Excelsior Avenue • Oakland, CA 94602 • Toll-free (888) 465-2523 • Fax (510) 482-4421 • www.coolroofs.org

Section C: 17-24: Accredited Independent Testing Laboratory Test Results and Signature (this section to be filled out by AITL only) SUPERSEDED

17. **Laboratory ID** (Initial Ratings) RDS — 18. **Laboratory ID** (Aged Ratings)

19. **Lab Report ID** (Initial Ratings) RD06248 — 20. **Lab report ID** (Aged Ratings)

21. **Tested Initial Radiative Properties:** (Air mass of 1.5 used in reflectance measurements ☐ (check for verification)

21a. *Group A*—MFR. Batch # 012306

Panel ID	Solar Reflectance	Thermal Emittance
1. 2	0.834	0.91
2. 3	0.832	0.90
3. 4	0.833	0.90
Batch Average	0.833	0.90

21b. *Group B*—MFR. Batch # 21406

Panel ID	Solar Reflectance	Thermal Emittance
1. 6	0.835	0.91
2. 7	0.834	0.90
3. 5	0.836	0.90
Batch Average	0.835	0.90

21c. **Results if preparing samples according to CRRC-1 Section 3.5 E (using CRRC-1 Method #1):**
Sample 1 (Batch A): 0.833 / 0.90 (SR / TE) — Sample 2 (Batch B): 0.835 / 0.90 (SR / TE) — Sample 3 (Batch A&B): ___ / ___ (SR / TE)

21d. **Average for all initial tests (2 decimal places):** Solar Reflectance (SR) 0.83 — Thermal Emittance (TE) 0.90

21e. **Presumed Non-Variegated Particle or Gravel Coated Roofing Product 5-Point Reflectance Test Results:** (See CRRC-1 section 3.5.1 E for instructions) _____ Average Reflectance _____

21f. **Air mass of 1.5 used in reflectance measurements** ☐ (check box to confirm)

22. **Tested Aged Radiative Properties:**

22a. *Hot/Humid Climate Exposure* Panel ID	Solar Reflectance	Thermal Emittance
1.		
2.		
3.		

22b. *Cold/Temperate Exposure* Panel ID	Solar Reflectance	Thermal Emittance
1.		
2.		
3.		

22c. *Hot/Dry Climate Exposure* Panel ID	Solar Reflectance	Thermal Emittance
1.		
2.		
3.		

22d. **Results if preparing samples according to CRRC-1 Section 3.5 E (using CRRC-1 Method #1):**
Sample 1 (Batch A): ___ / ___ (SR / TE) — Sample 2 (Batch B): ___ / ___ (SR / TE) — Sample 3 (Batch A&B): ___ / ___ (SR / TE)

22e. **Average for all initial tests (2 decimal places):** Solar Reflectance (SR) _____ Thermal Emittance (TE) _____

22f. **Air mass of 1.5 used in reflectance measurements** ☐ (check box to confirm)

23. **Tests conducted:**

Type	Initial Test	Aged Test
☐ E903 Test	Date	Date
☐ E1918 Test	Date	Date
☑ C1549 Test	Date 4/16/06	Date
☑ C1371 Test	Date 4/16/06	Date
☐ CRRC-1 Method #1	Date	Date

24. **The undersigned certifies that, to the best of his/her knowledge, the measurements contained herein are true and accurate:**
DAVID W. YARBROUGH
Responsible Person's Printed Name
Responsible Person's Signature (Initial Tests) — Date 4/16/06
Responsible Person's Signature (Aged Tests) — Date

CRRC-F-2 Test Results Report – 01/10/06 — Page 2 of 2

Product Sectors

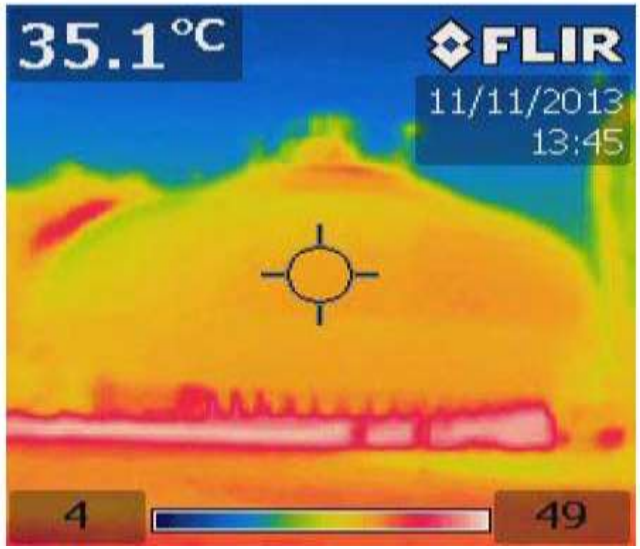
- Construction
- Oil/Gas
- Marine
- Military

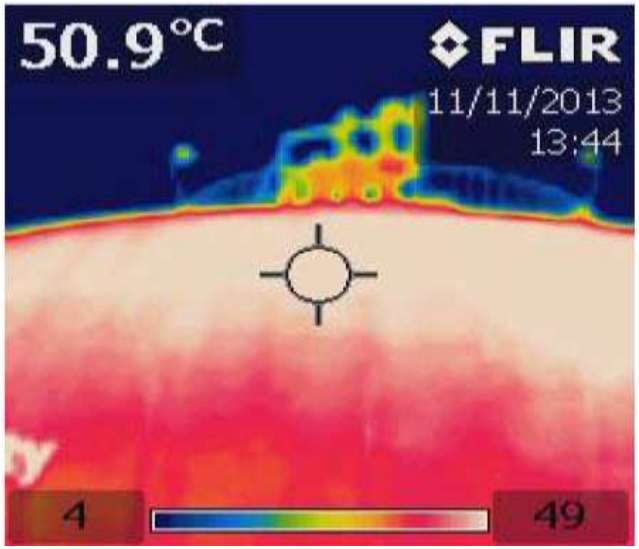
Oil and Gas Terminals

Osaka, Japan

- Reduced evaporation of finished petrochemicals
- Reduced maintenance costs
- Extended paint life
- 17 Year longevity

LNG Tanks – CH4





LNG Storage Tank, USA

LNG Tank – Garner IA
- Reduce Boil Off
- Reduce Emissions

Cooling Fans

Cooling Fans
- Reduce Heat Load

Buildings
- Improve Comfort
- Save Energy

Pipelines
- Light Hydrocarbons

Petro-Chemical

Petro-Chemical

<u>Petrochemical Plant</u>
Dammam, Saudi Arabia

- Reduced Heat Load
- Stopped Condensation

Water Tanks

KFUPM Khobar, Saudi Arabia

Two Insulative Coatings Compared

Crude Tanks, Kazakhstan

PetroKazakhstan - Crude Storage Tanks
Kazakhstan

Reduced Condensation inside Tanks

Offshore

Occidental Petroleum

Qatar

- Reduced heat load in summer

Sent: Saturday, August 11, 2018 4:30 AM
To:
Cc:
Subject: P34 Container Temperatures

Please find below P34 Container Temperatures Inside and outside.

FLUKE 62MAX IR THERMOMETER used

CONTAINER NO	OUTSIDE TEMPERATURE IN degC	INSIDE TEMPERATURE degC
TRANSFORMER ROOM	37.4	35.3
LV SWITCH ROOM	38	36.6
ISS-06	39.2	34.8
ISS-08	38.9	32.0
ISS-09	36.7	32.2
ISS 13/14	38.4	34.2

Marine

Blue Chip Vessel
Mississippi City, U.S.A

- ABS Class Vessel
- Reduced Heat Load
- Reduced Expansion and Contraction
- Stopped Condensation

Airports

<u>Tucson International Airport</u>
Arizona, U.S.

- 22% Overall Energy Reduction
- 44% HVAC Savings

Airport

<u>Las Vegas International</u>

Passenger Transfer Bridges

- Reduce Heat Absorption
- Reduce AC Usage
- Improve Comfort

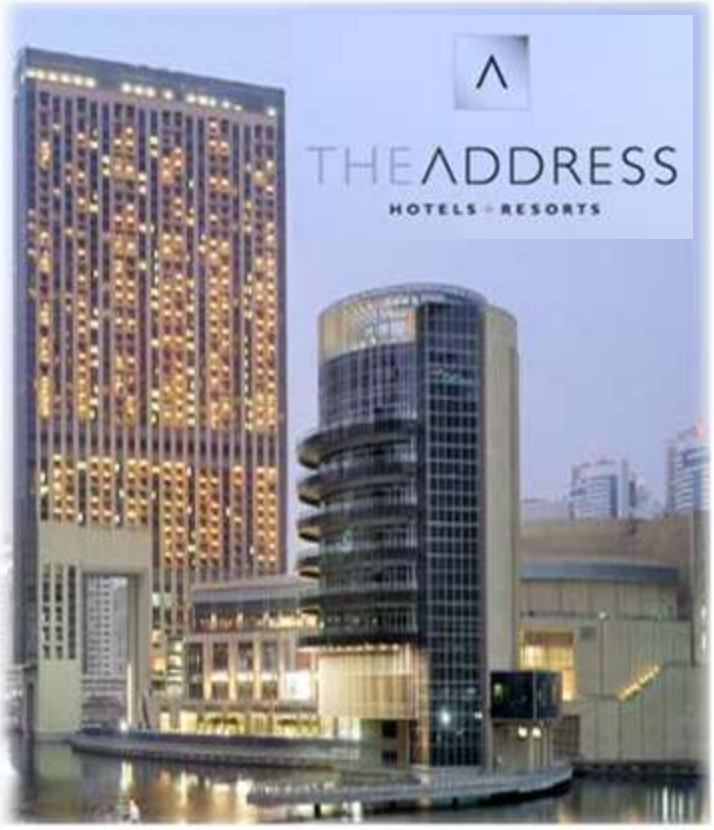
Chengdu International Airport

Chengdu International Airport
Chengdu, China

- Home of the Giant Pandas!

Cool Roof Dubai

<u>Address Hotel – Dubai Marina</u>
Dubai, U.A.E.



Metal Roofs

<u>Chicago Bridge & Iron (CBI)</u>
Houston, Texas

- Reduced Heat Load into fabrication facility.

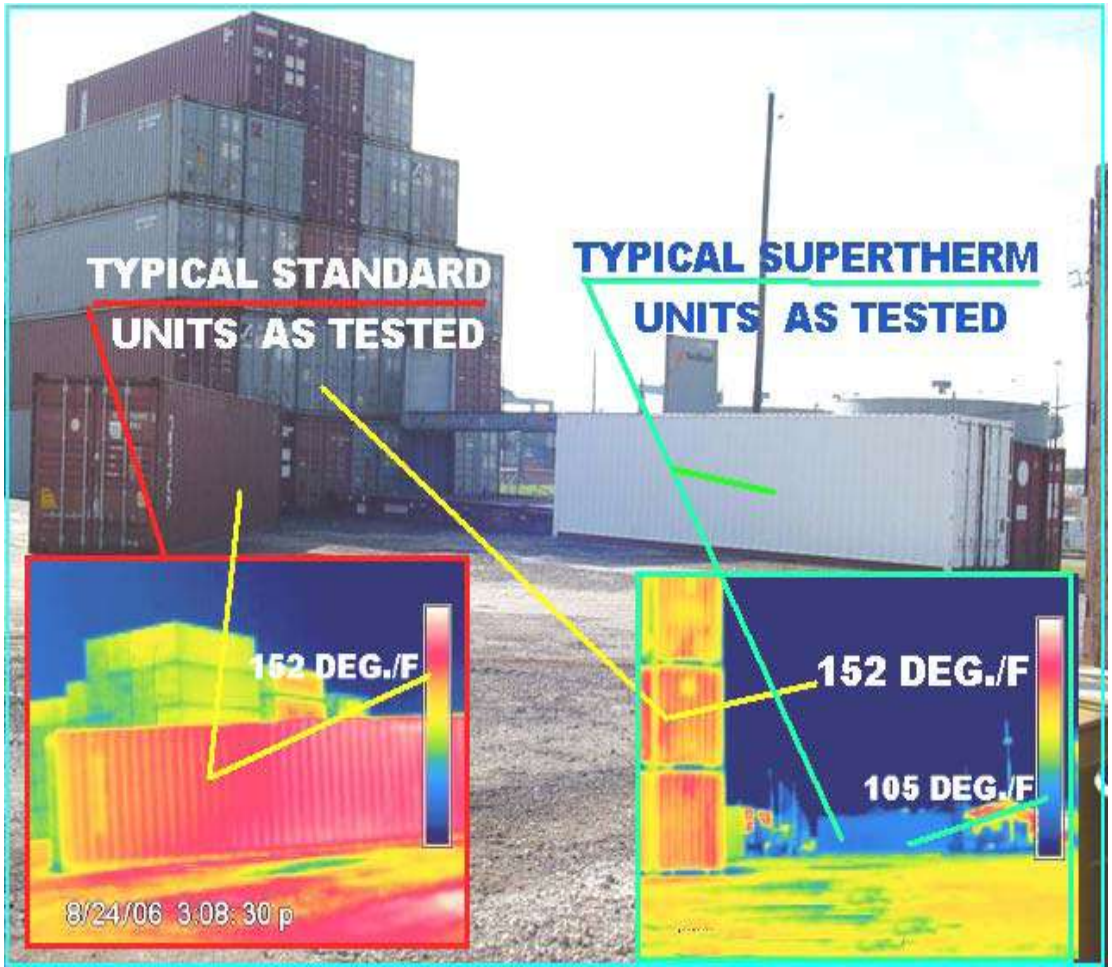
Air Conditioning Units

10% BTU Energy Savings – Just from painting AC unit shell

Testing

U.S. Department of Energy - Texas

- Surface conduction related energy loads were reduced approximately 46 to 52%
- Inside ambient temperature 22F degrees cooler
- External Surface temp 47F degrees cooler
- Internal moisture level 28.5% dryer



Fire Safety

ASTM E84 Flame Spread Testing

Conventional Insulation is High Flammable

Insulative Coatings are Fire Resistant

Does Not Contribute to Flame Spread.

Fiberglass vs. Insulative Coatings

Traditional Insulation	Solar Radiant Barrier Coating (thin film)
Conductive heat only	Conduction, Radiation, Convection
100% Heat Load	95% heat blocked before it's loaded
Affected by age	Designed for longevity
Designed and tested for 75F	Real world testing and design
Flammable	Class A rated, Non Flame Spread
Affected by moisture and air	Blocks moisture and air

Regulator Pipes

Insulative Coatings to Reduce Noise & Corrosion

Acoustic Insulation

Noise & vibration can be some of the largest drawbacks of using regulators in any gas system.

Incidentally, sound waves and heat waves ride in the same type of wave.
The ceramic blend we use is very light in density “and” of the crystalline structure to block waves, both heat and sound.

Normally, as a sound wave contacts a wall density, it causes the density to vibrate resulting in sound continuation. If the density of the surface is so low that it cannot cause it to vibrate, then the sound is deadened and results in the sound changing to a very small heat release as you cannot kill energy, so it changes.

When sound waves hit the surface of the low density ceramics it will not allow vibration and therefore resist any continuation. It also blocks any bounce-off called reverberation. Reverberation is what you hear in a indoor swimming pool where a lot of people are talking and yelling. If we coated the interior walls, this reverberation would stop and the noise level would drop 4 fold.

Contact Us

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arinshah@spicoatings.com

“ The Preferred Industrial Coating”