



JUBCOR

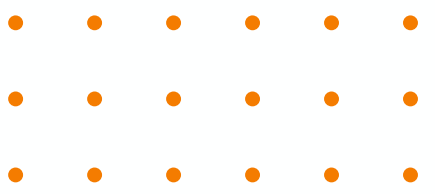
2024

CONFERENCE & EXHIBITION

INNOVATIVE SOLUTIONS FOR CORROSION CHALLENGES

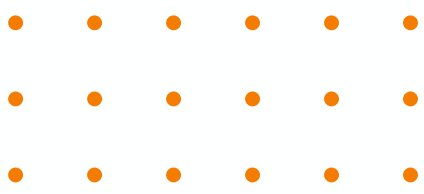
**Insulative Coatings
Fit For Purpose**

Presented By:
Arin Shahmoradian



Agenda

- **Fit For Purpose – Process Heat Vs. Solar Heat**
- **Conventional Insulation – Corrosion Under Insulation**
- **BP Review – Insulation Optimization Tactics**
- **New Testing Methods From AMPP/NACE**
- **Sample Applications – Thick Film Vs. Thin Film**
- **New Grant Programs and Boil Off Regulations**
- **New Thick Film Applications – Below Grade Piping**
- **Thin Film Insulative Coatings For LNG – Boil-Off Reduction**
- **New Dual Insulative Coating System – Thick + Thin**



Cost Of Corrosion



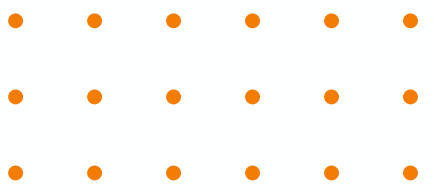
- Global estimated annual destruction responsible from corrosion equals \$2.5 trillion.
- 15% - 35% (\$375-875 Billion) could be saved by developing and implementing a multi step corrosion plan.
- \$10+ Billion is spent annually to remediate petrochemical and petroleum refinery equipment.

References:

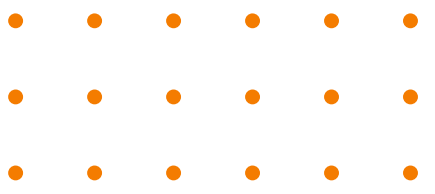
G. Koch, et al., "International Measures of Prevention, Application, and Economics of Corrosion Technologies Study" (Houston, TX: NACE International, March 1, 2016).

G. Koch, et al., "Corrosion Costs and Preventive Strategies in the United States," National Technical Information Service, FHWARD-01-156, 2002.

The Good News



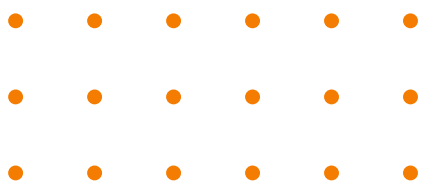
- **Insulative Coatings are now widely available through numerous manufacturers.**
- **Available in Epoxy, Acrylic, and Siloxane resins.**
- **Includes combinations of ceramics (low density), fibers, and glass hollow sphere beads.**



Three Forms Of Heat Transfer

Convection	Conduction	Radiation
The transfer of heat by 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 ceiling.	Example: Heat is transferred from warmer sections of the walls and ceilings to cooler sections	Example: Heat is transferred from roof to ceiling through “loading of heat”, then re-radiated from roof to ceiling.

Fit For Purpose – Process Heat (Thick Film)



1 Type of Coating

Hot insulating Coating System for carbon steel and stainless steel service

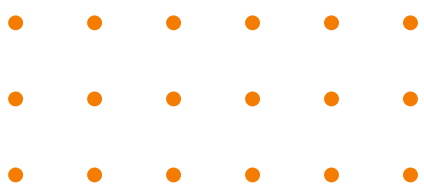
2 General Data

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)

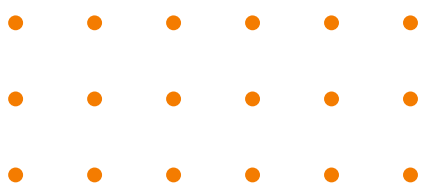


Corrosion Under Insulation



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

- Jacket insulation originally designed for safety, not insulation.
- Costly maintenance due to CUI.
- Corrosion occurs when insulation absorbs moisture, wets steel surface.
- Never designed to be air tight.
- Absorbs moisture, gains weight, sags or falls off pipe.
- Increases risk of leaks, fires, explosions.

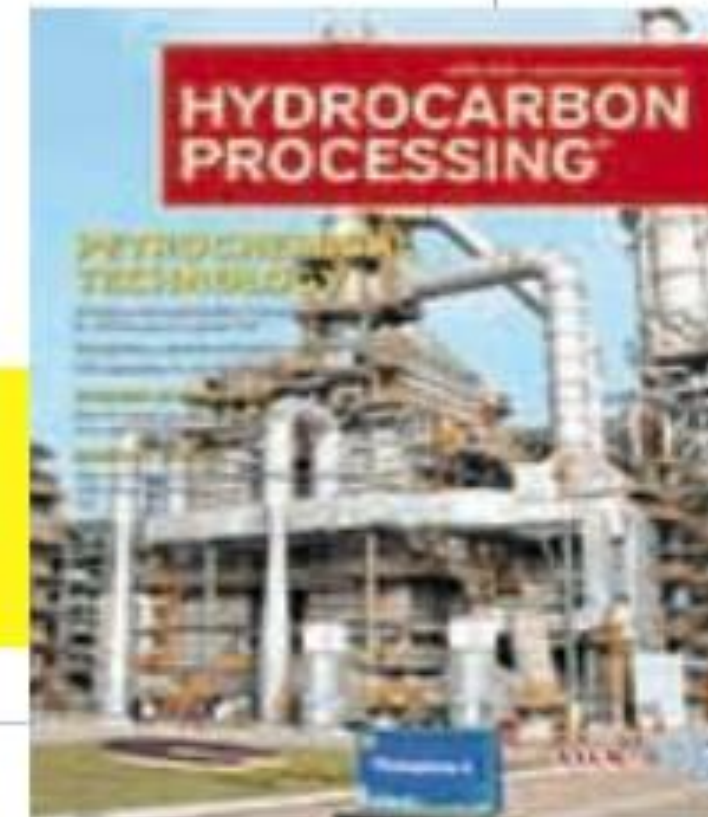


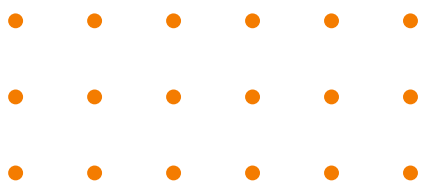
BP – NACE – June 2018

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

Hydrocarbon Processing, April 2018

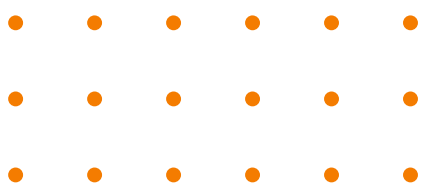




BP – Insulation Optimization

What's the easiest ways to prevent CUI?

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

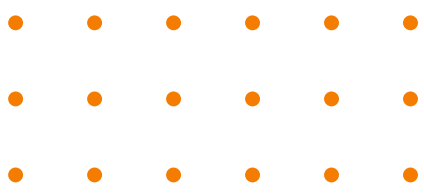


BP – Insulation Optimization

Why is there so much insulation?

The ~~need~~ “perceived need” for ...

- Heat conservation
- Personnel burn protection
- Noise reduction



BP – Insulation Optimization

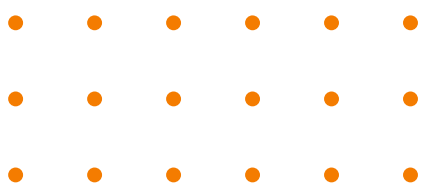
CUI Prevention Strategy

A. Perform insulation engineering review ...

- Heat Conservation Evaluation
- Personnel Protection Evaluation

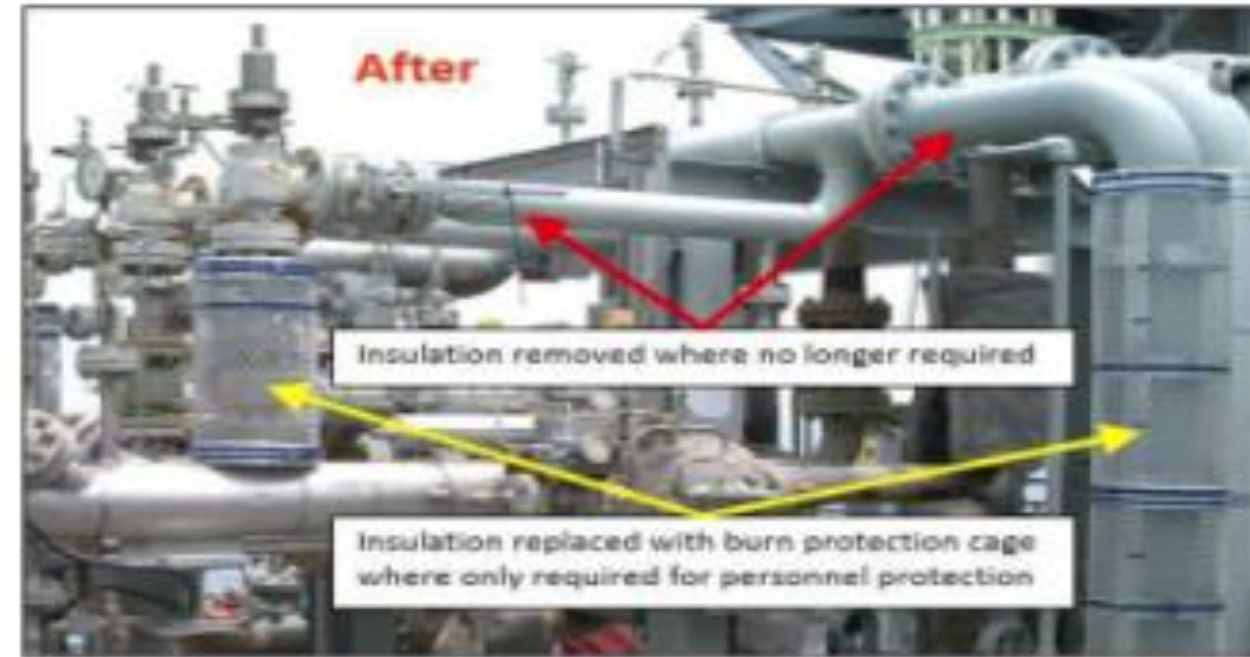
B. Aggressive inspection program ...

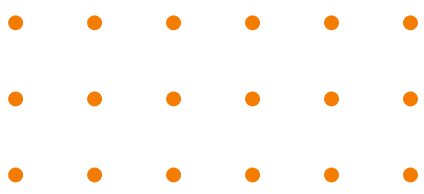
- where insulation is still required ...
- starting with highest consequence services ...



BP – Insulation Optimization

Implementation





BP – Insulation Optimization

Insulative Coatings



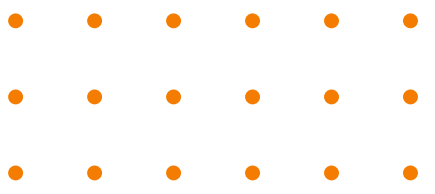
Active CUI



- After insulation removal
- Surface temp 340 F



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

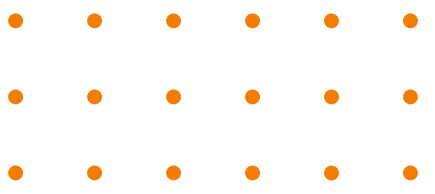


BP – Insulation Optimization

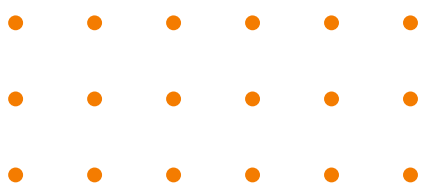
Conclusion

- 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 Insulative Coating Advantages



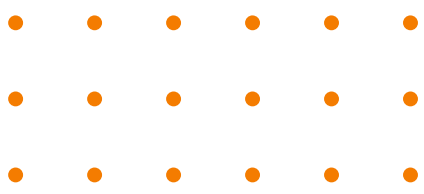
- * replaces wrap & jacketing
- * reduces CUI
- * no shutdown required
- * applied on hot or ambient surfaces
- * internal temp/pressure increase
- * reduce energy consumption
- * protects personnel
- * easy to inspect and repair



Before & After

BEFORE (bare pipe)	AFTER (30mm thickness)
463°C (865°F)	36°C (96°F)

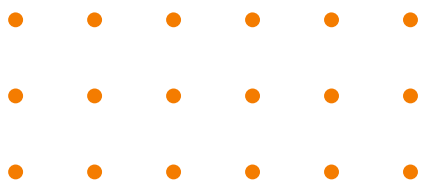




Competitive Cost, Faster Application



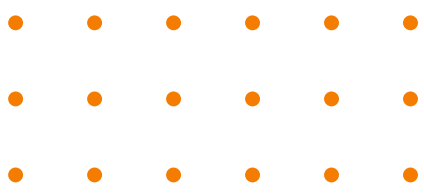
- Applied directly on valves and elbows, strainers, etc.



NACE TM 21423



- Personnel Protection
- Based on ASTM C1055
- 5 second touch rule, up to 59°C (138°F) which is the start of a 1st degree burn.

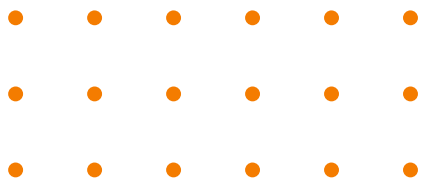


NACE TM 21431-2023

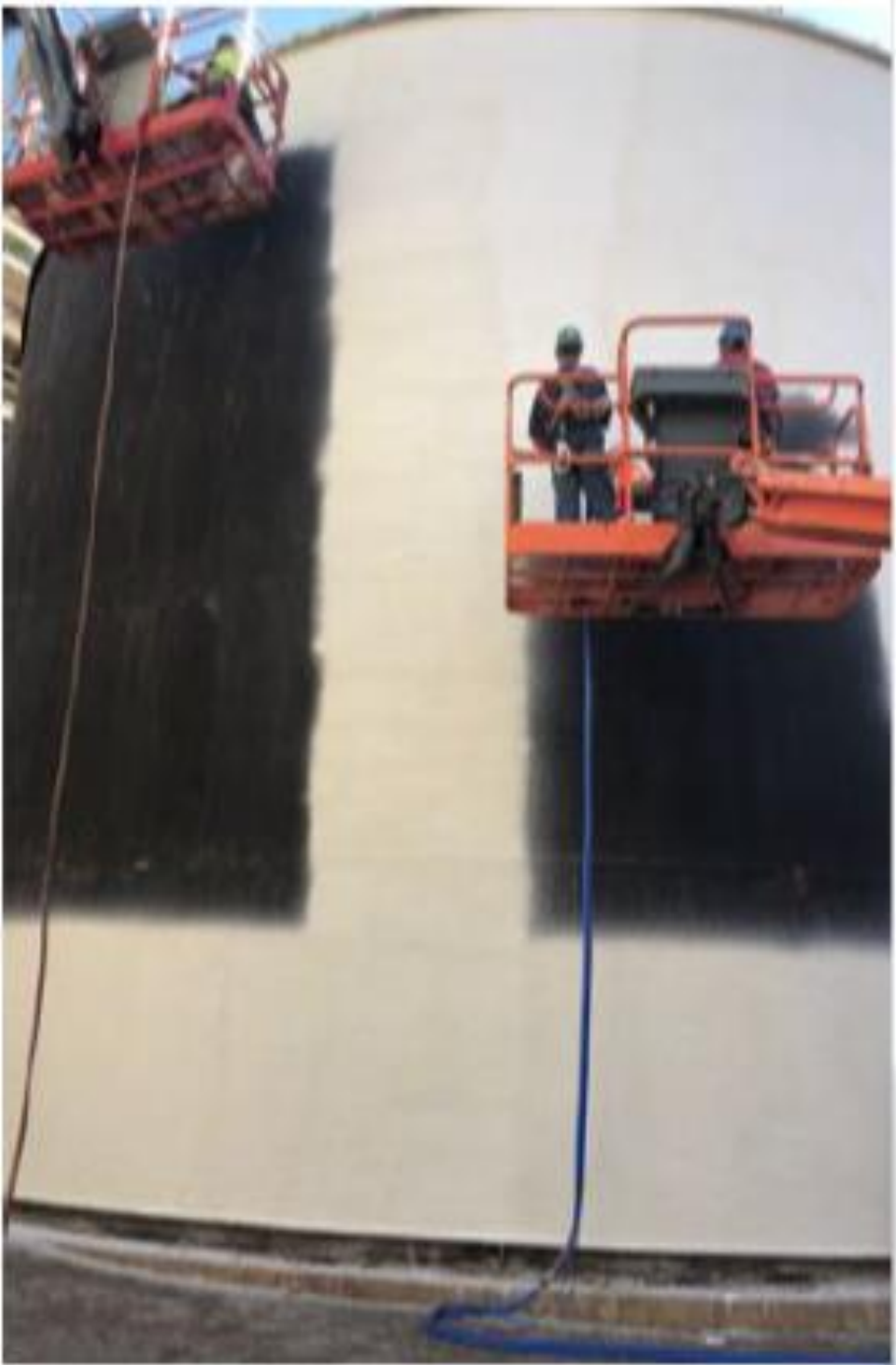
ASTM C177: Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.

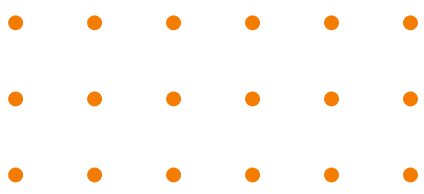
- Test method based on ASTM C177
- Measuring Thermal Conductivity @ 73.4°F / 23°C
- 300 mils DFT, 12x12 Al sheet

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



Heated Black Liquor Tanks





Heated Black Liquor Tanks



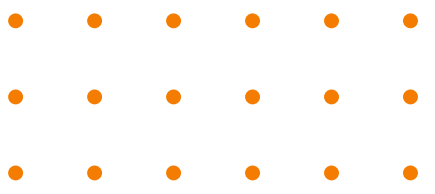
200 mils (5mm) DFT Insulative Coating

Top Coat: 100 micron DFT Polyurethane

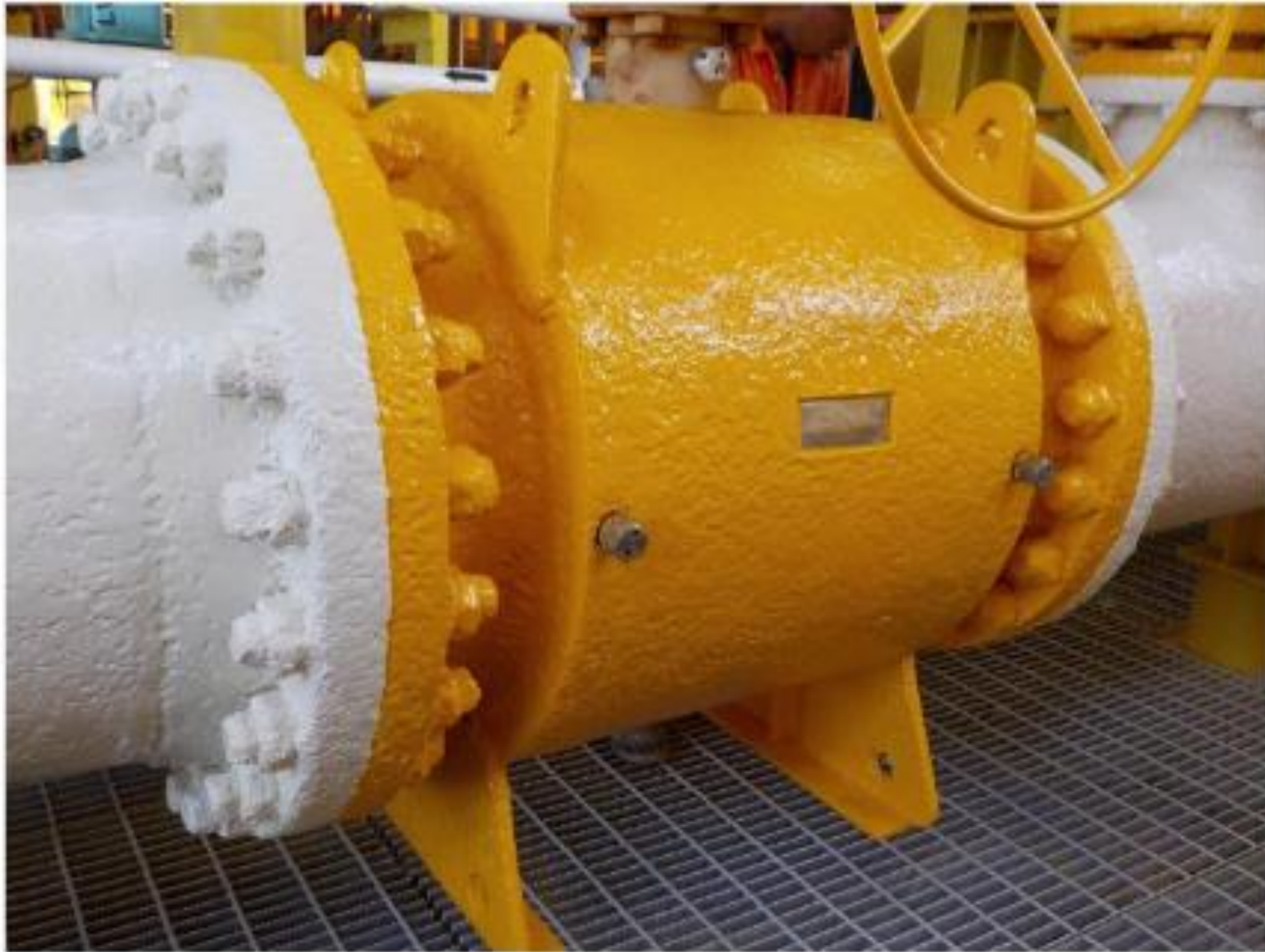
Before: 180°F (82.2°C)

After: 118.7°F (47.7°C)

Applied while online



Offshore Crude Pipes

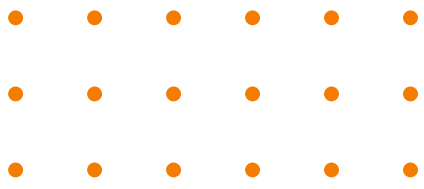


Crude Oil Pipe:

Applied over flanges and bolts

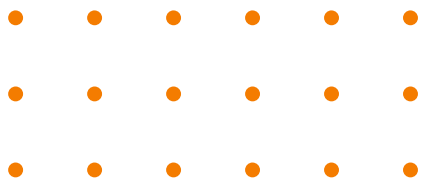
Polyurethane top coat

Acrylic based systems require topcoat for UV and climate protection.



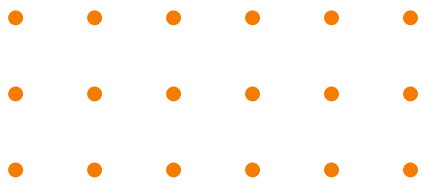
Offshore – 10 Years – Initial





Offshore – 10 Years – Aged

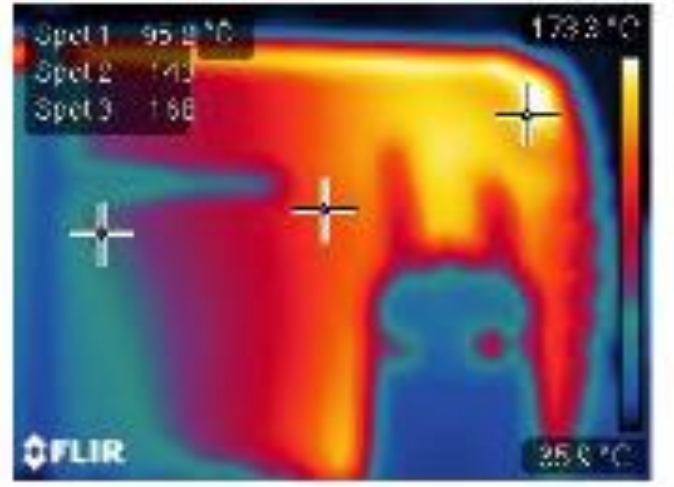




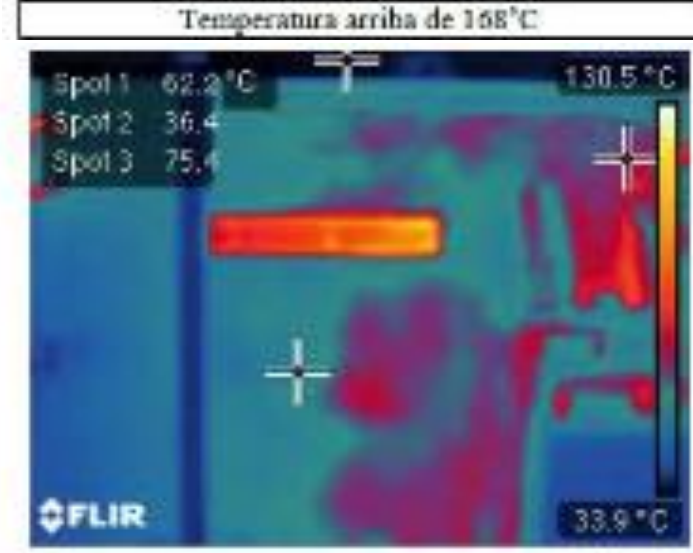
Offshore Compressor



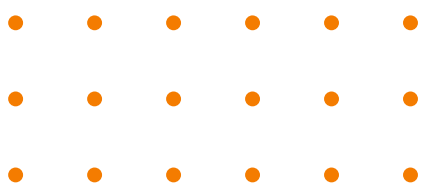
Surface Temperature:
Before: 334°F (168°C)



After: 167°F (75°C)



Temperatura Máxima de 75°C



Water Bath Heater

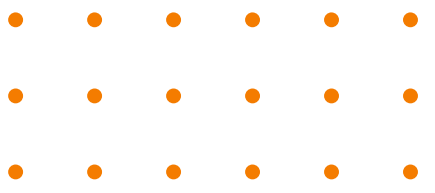


Before:

24" Diameter, 10' Length – 175°F (79.4°C)

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

Picture taken after NACE 4 surface preparation.



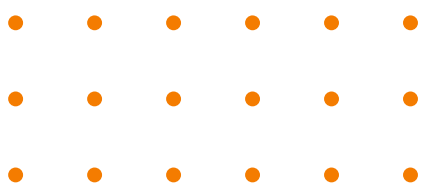
Water Bath Heater



After:

Applied while online – no shutdown

Insulation coating applied in 2 coats, less than typically 6mm to 12mm DFT, plus polyurethane top coat



Thermal Readings

Before: 174°F (78.8°C)

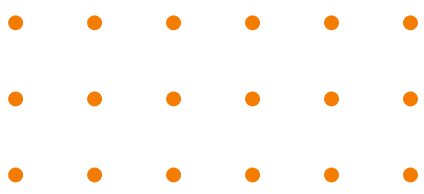


After: 204°F (95.5°C) Metal Temp.



Skin Temp: 101°F (38.3°C)





Water Temperature

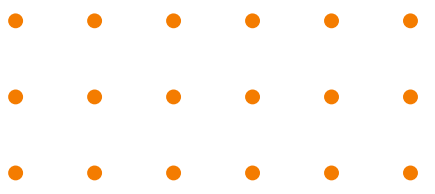
Before: 99°F (37.2°C) (water temp.)



After: 118°F (47.7°C) (water temp)



Steam Pipes



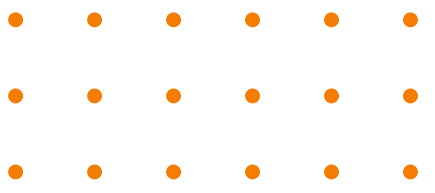
3,500 linear feet (1066.8 meters)

1-14" pipe diameter

Temperature Up to 240°F (115°C)

300 mils (7.62mm) DFT, applied online

Replaces Jacket Insulation for CUI
Protection



Personnel Protection - KSA



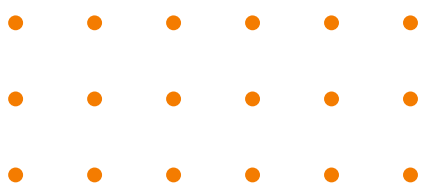
Personnel Protection:

Surface Temperature:

Before: 280°F (137.7°C)

After: 90°F (32.2°C)

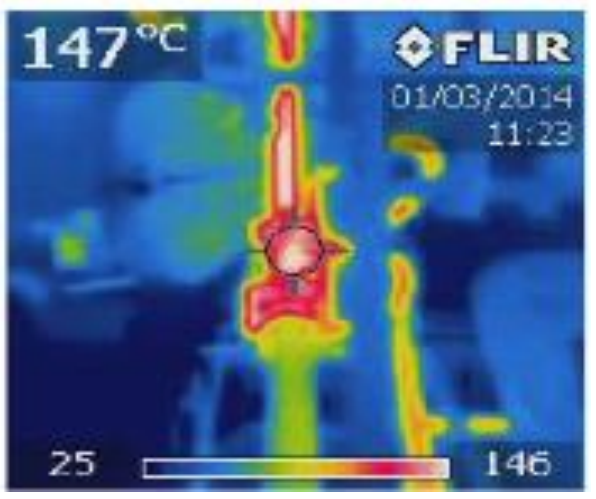
16 mm or 5/8" DFT



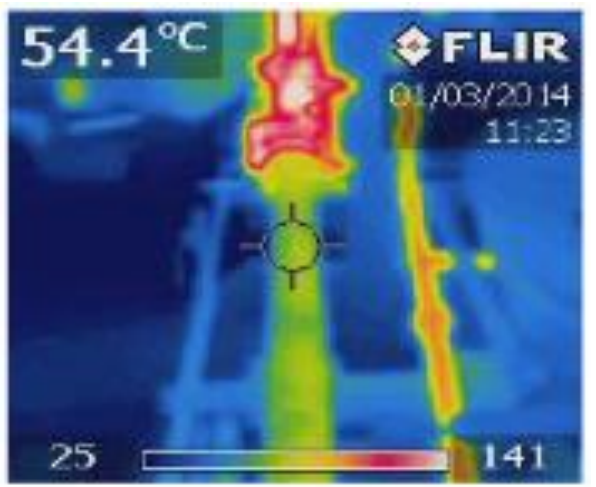
Sulfur Pipe/Tanks - KSA



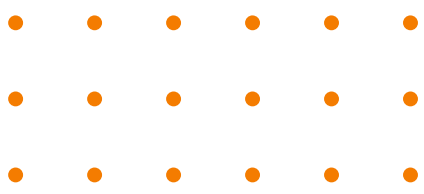
Uncoated 296°F



Coated 129°F



1/2" DFT (12.7mm)



Glycol Water Line – Below Grade



Glycol (water) Pipes

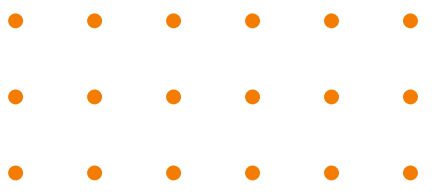
Winter Freeze Protection

600 linear feet, (182.8 meters)

4" pipe diameter

300 mils DFT (7.62mm)

Recycled glycol to heat up the pipe for accelerated curing.



Novel Field/Shop Application

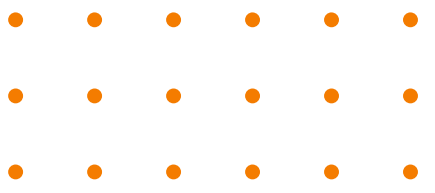


New Fuel Gas Piping

800 linear feet (243.8 meters)

Pre-heat pipes (torch or induction heating) for field/shop application.

New piping arrives pre-coated saving time & labor.



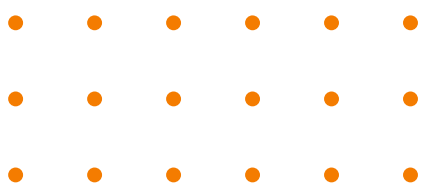
Power Generation



Bag House Ducts

1/4" (6.35mm) DFT Thick Film Insulative Coating

Replace Jacket Insulation



Equipment – Graco Texture Sprayer

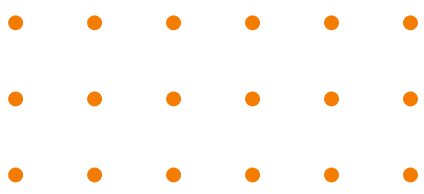


Equipment:

Graco GTX EX 2000

Thick Film Texture Sprayer

MSRP \$3,600 - \$3,900

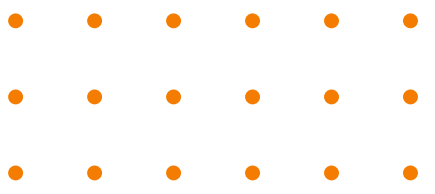


Inspection Ports



Inspection windows can be cut out of the coating film over weld joints for repeat non destructive inspection.

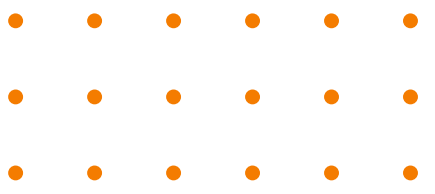
Simply place the square back in and apply silicone to edges until next inspection is required.



Tricks Of The Trade



In some cases, Insulative Coatings can be applied over fiberglass or rockwool wrapped around bolts which can then be cut to expose the bolts if needed.



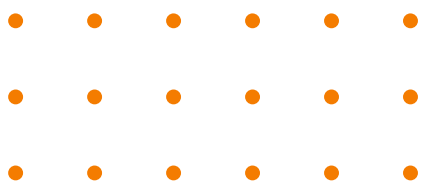
Advanced Strategies



Advanced Thick Film Strategies:

Varying thickness on stacked columns.

Prevents condensation inside stacks, reducing acids etc.



Fit For Purpose – Solar Heat (Thin Film)

1 Type of Coating

Radiant Heat Insulating Coating System.

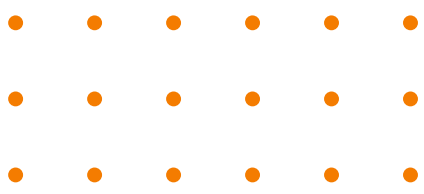
2 General Data

2.1 Typical Use

External top-coating system 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)



New CH4 Boil Off Tax - USA

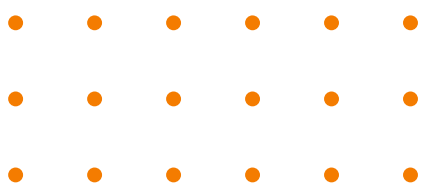
WHITE HOUSE NEW EPA RULE ANNOUNCEMENT Jan. 1 2024 implementation.

Regulating methane emissions from oil & gas production:

In addition to finalizing the new rule to reduce emissions from the oil and gas sector, EPA is also working to implement a **waste emission charge on methane emitted from applicable oil and gas facilities that emit over 25,000 metric tons of CO₂e.**

The waste emissions charge, authorized by President Biden's Inflation Reduction Act, will incentivize companies to ratchet up methane mitigation efforts by charging **\$900 per metric ton for emissions exceeding certain thresholds in 2024**, increasing to \$1,200 for 2025 emissions, and **\$1,500 for emissions in years 2026 and after.**

<https://www.epa.gov/inflation-reduction-act/waste-emissions-charge>



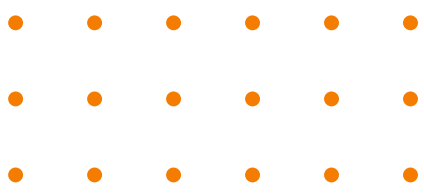
New Grants & Incentives



REFINERY GAS ENERGY EFFICIENCY PROGRAM

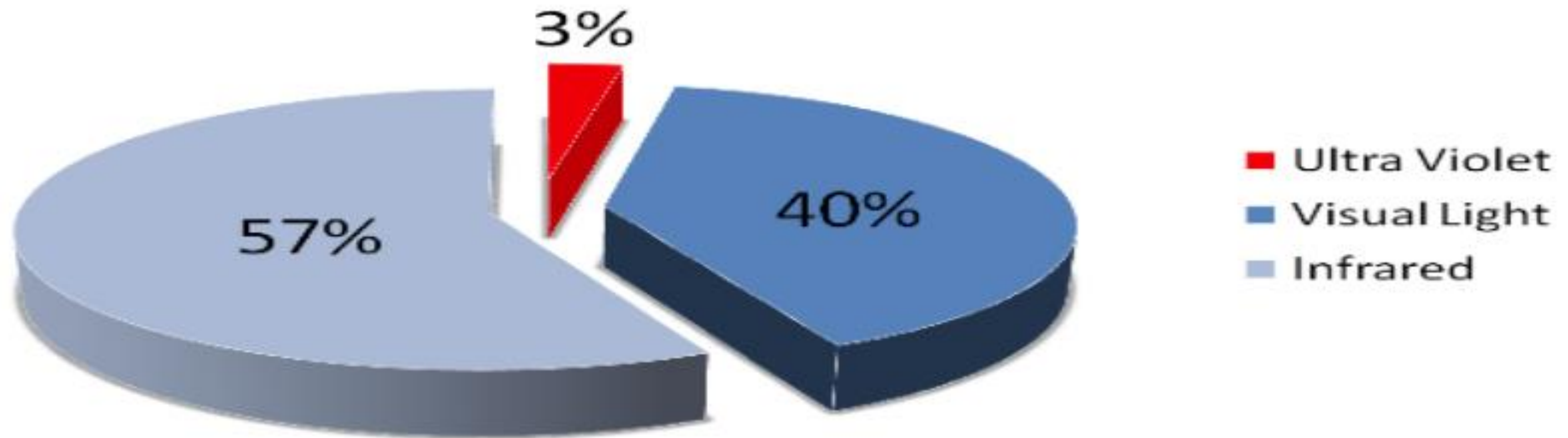


The Refinery Gas Energy Efficiency Program (RGEEP) is available to eligible SoCalGas refinery customers within the SoCalGas service territory. The RGEEP is designed to deliver comprehensive and sustained energy savings through downstream energy and operational savings while helping build a culture to support energy management excellence within the organization focused on operational efficiency.

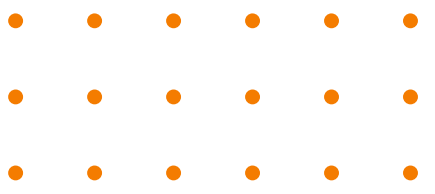


Radiation Heat

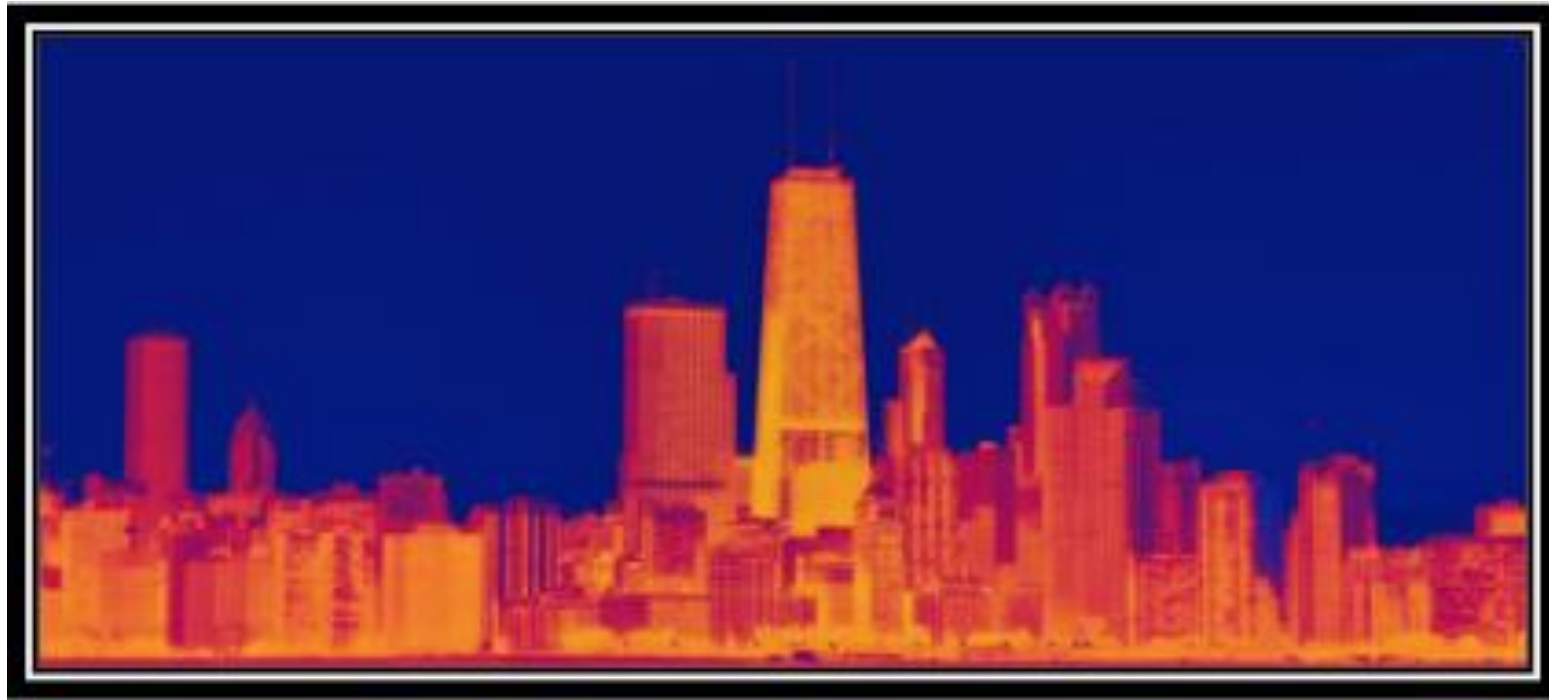
Sources of Heat from Radiation



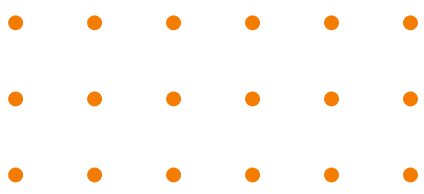
Calculated from data in "Reference Solar Spectral Irradiance: Air Mass 1.5". National Renewable Energy Laboratory. Archived from the original on September 28, 2013. Retrieved 2009-11-12.



Heat Load, Heat Transfer



- Heat must load/absorb before it is transferred
- Reduce heat load by focusing on...
- High Reflection
- High Specific Heat
- Low Absorptivity
- Low Diffusivity



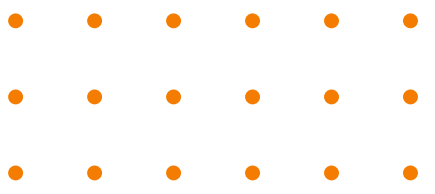
Solar Thermal Barrier Coating

1900's



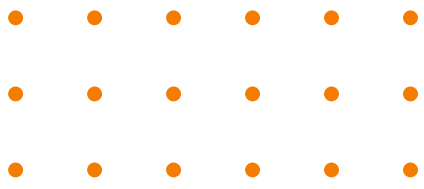
21st Century



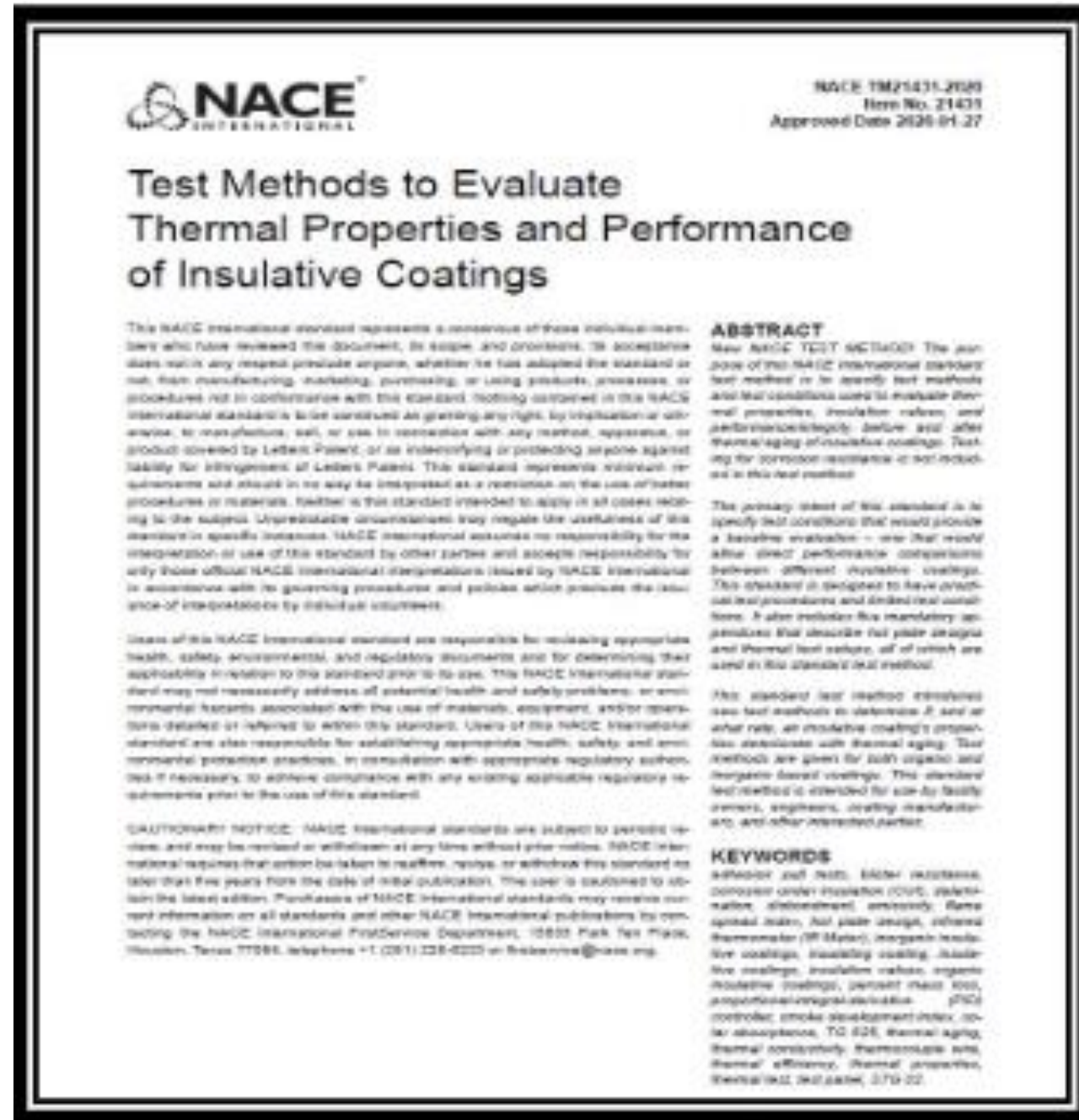


How It Works

- Stops Initial Heat Load By
 - Reflectivity – Blend of low density ceramics
 - Emissivity – Re-radiates 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

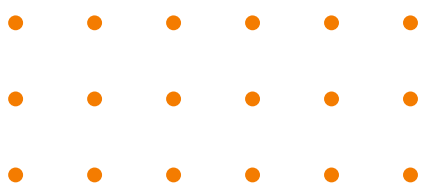


Lab Testing – NACE TM 21431-2023

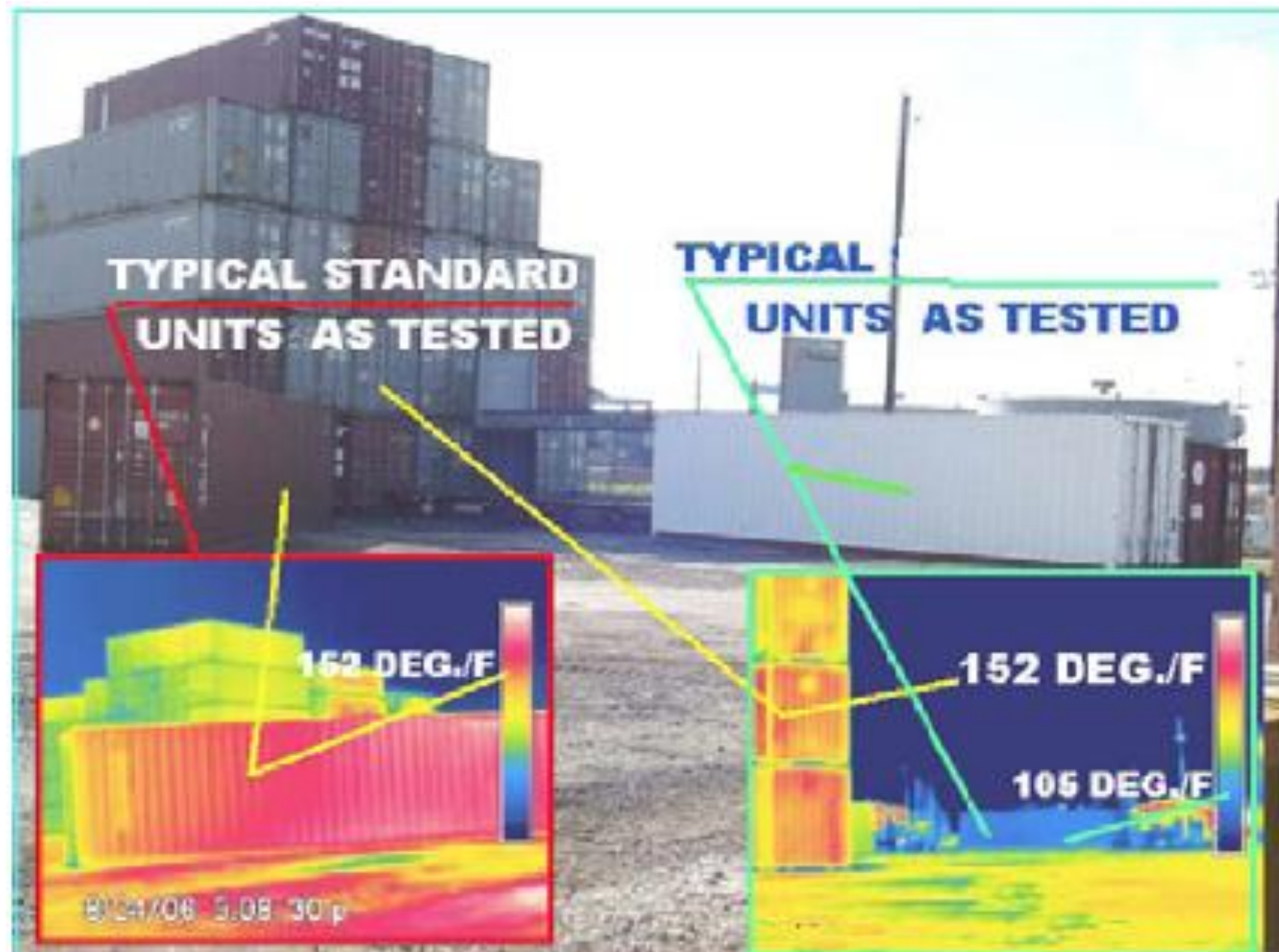


NACE TM21431-2023

- Reflectivity %
- Emissivity %
- ASTM E903 – Reflectivity
- ASTM E408 – Emissivity



US Department Of Energy – Texas



U.S. Dept of Energy:

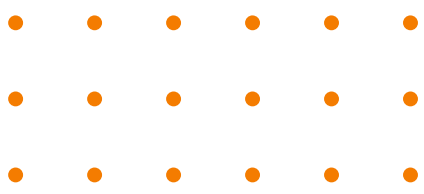
Uncoated: 152°F (66.6°C)

Coated: 105°F (40.5°C)

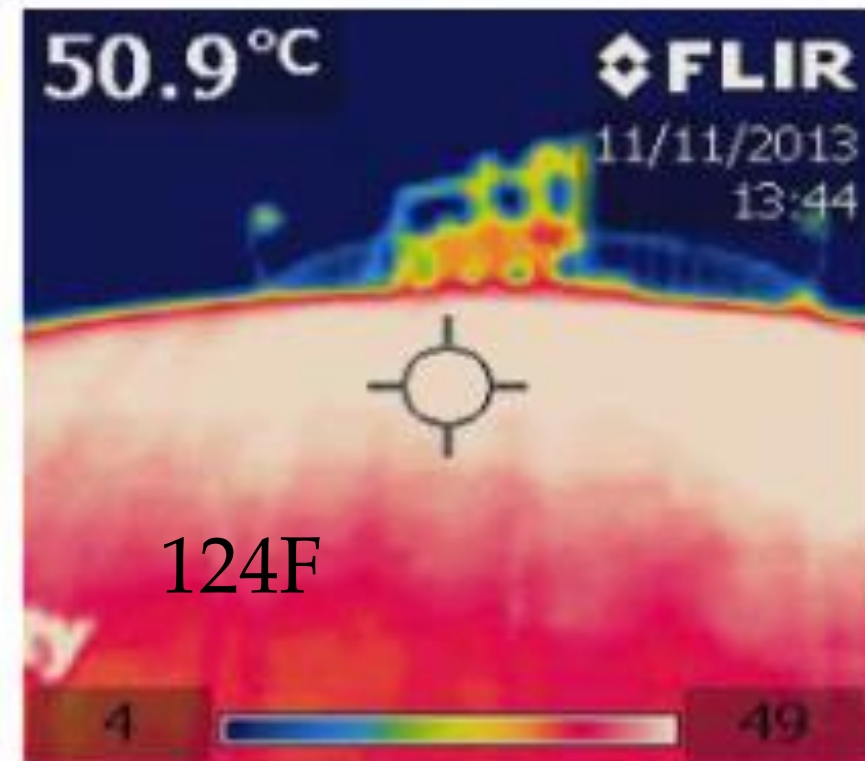
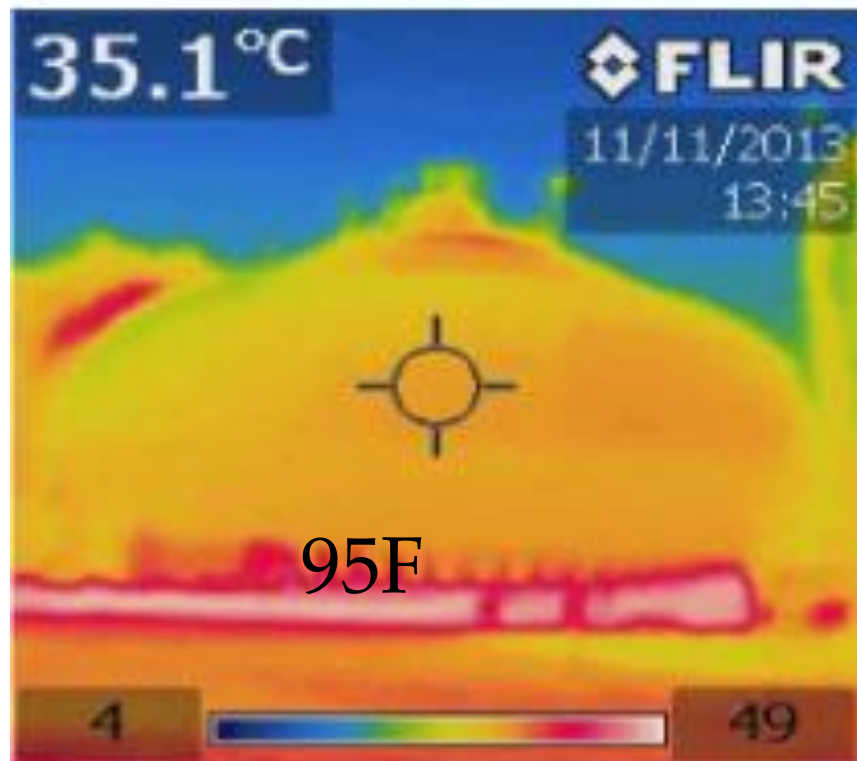
Ambient: 98°F (36.6°C)

10 mils DFT / 250 micron DFT

*results vary by location



LNG Spheroid Tank – CH4 – KSA

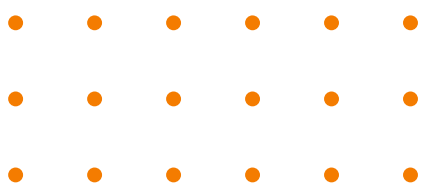


Reducing Boil Off:

Winter Temperature

Reduced evaporation of finished petrochemicals including light hydrocarbons.

*results vary by location



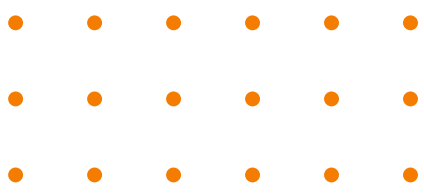
LNG Storage Tank – Iowa, US



Reducing Boil Off:

Reduced evaporation of finished petrochemicals including light hydrocarbons.

*results vary by location



Gasoline Tanks – Osaka, Japan



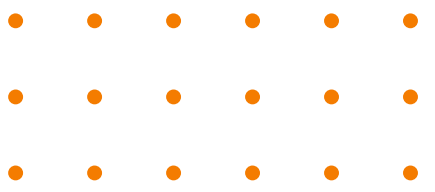
Reducing Boil Off:

Reduced evaporation of finished petrochemicals including light hydrocarbons.

Reduced interior condensation/corrosion

*results vary by location

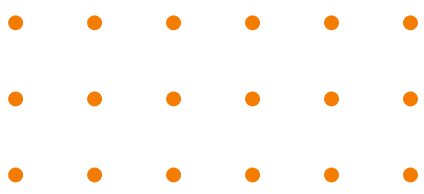
Interior Tank Wall Corrosion– Kazakhstan



Interior Corrosion:

Reduced interior condensation results in reduced interior corrosion on tank walls.

*results vary by location

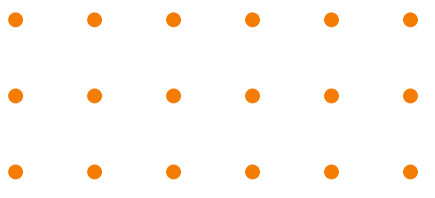


Petrochemical - Netherlands



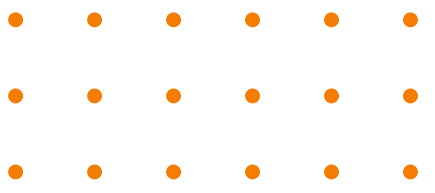
Application by roller + rope access:

Different manufacturers recommend different thicknesses and application methods.



Jet Fuel Tank- KSA





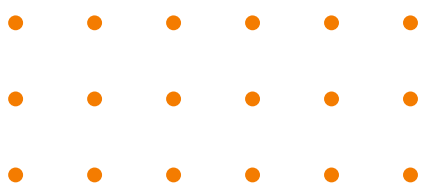
Feedstock Tank - KSA



Reduce Solar Heat Load

Improve efficiency by cooling down metal in summer time.

*results vary by location



Water Tanks- KFUPM - KSA

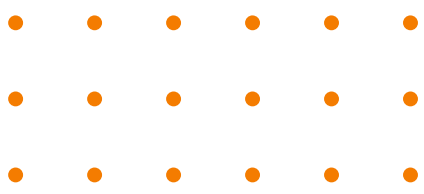


Reduce Solar Heat Load

Improve efficiency by cooling down water temp in summer time.

*results vary by location





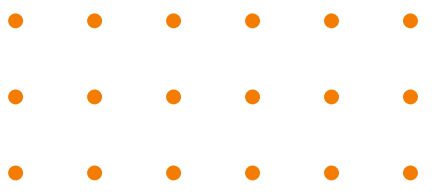
Cooling Fans / Inlet Towers - USA



Reduce Solar Heat Load

Improve efficiency by cooling down metal in summer time.

*results vary by location

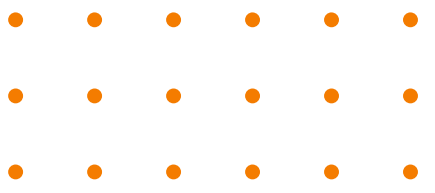


Concrete Mixing Truck - Oman



Reducing Heat Load:

Increase the range of concrete trucks

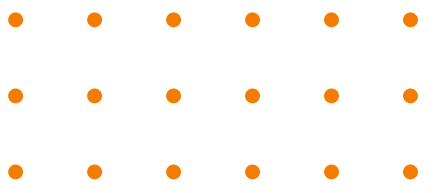


Truck/Rail Transport



Reducing Heat Load:

Reduce Evaporation During Transport

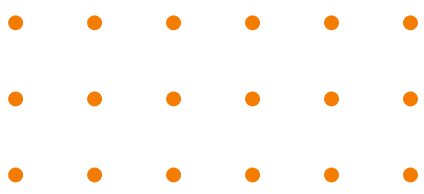


Marine LNG Tanks



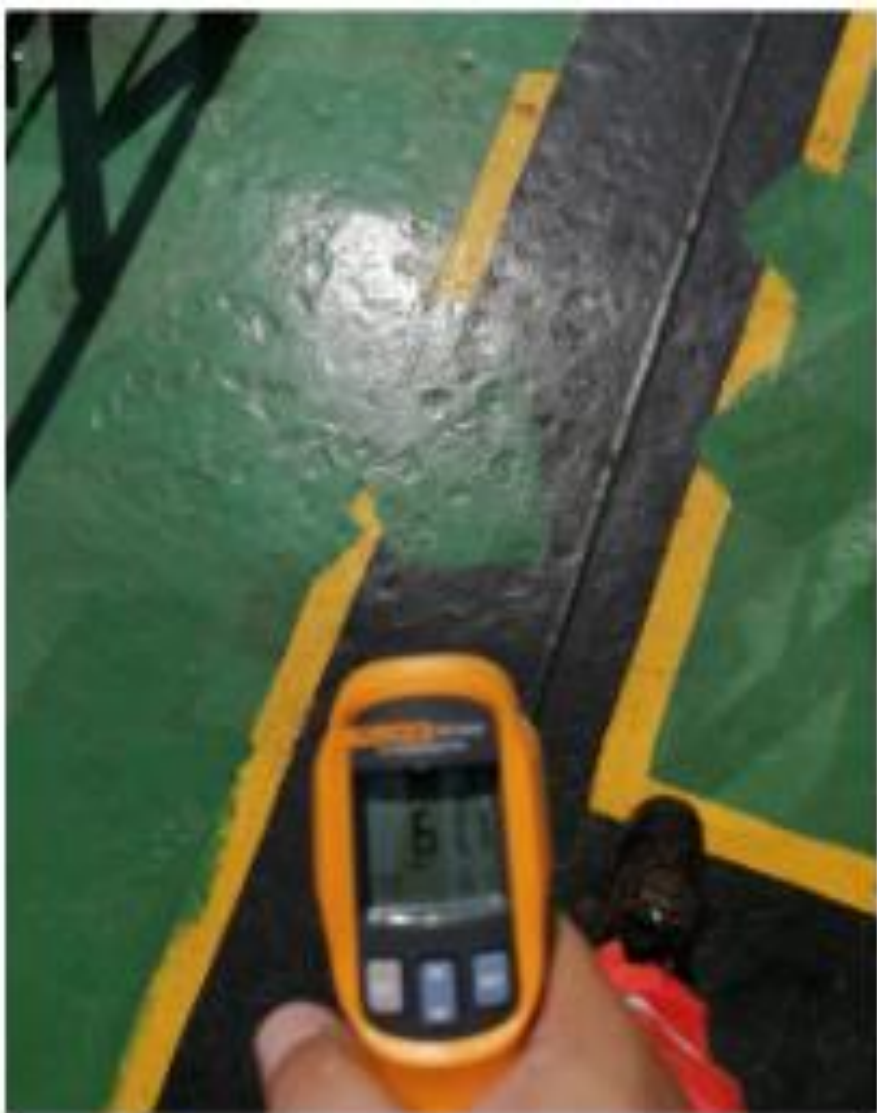
Reducing Heat Load:

Reduce Boil Off



Marine Solar Radiant Barrier Top Coat

Normal Paint – 142°F (61°C)



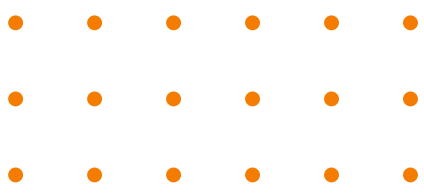
Radiant Barrier – 98°F (37°C)



Back Side – 91°F (33C)



Qatar in July

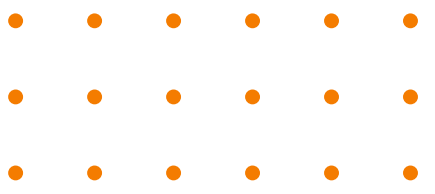


US Air Force – Aircraft Preservation



Long-Medium Term Preservation:

Reduce solar heat load damage to sensitive electronics in desert climates.



Infrastructure - Airports

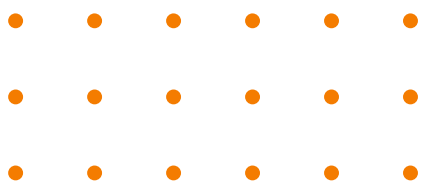


Energy Conservation:

Reduce heat load into roof.

Reduced expansion and contraction.

*results vary by location



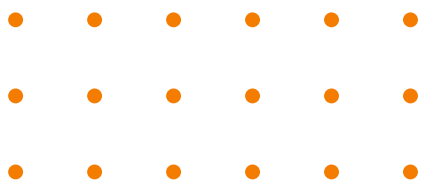
Passenger Boarding Bridges



Reducing Heat Load:

Improve energy efficiency and comfort.

*results vary by location



Cool Roofing

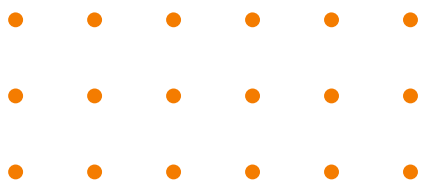


Cool Roofing / Personnel Protection

Safety for workers exposed to hot climates.

Blocked re-radiation of a heat loaded metal roof.

*results vary by location



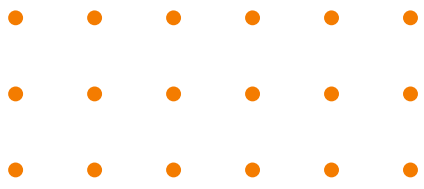
Cool Roofing – Dubai UAE



Cool Roofing

Blocked re-radiation of a heat loaded metal roof.

*results vary by location



Cool Roofing – KSA

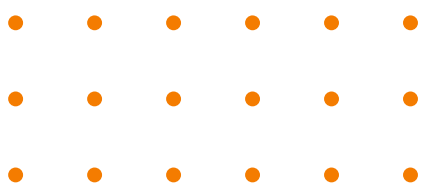


69.8 C



38.2 C



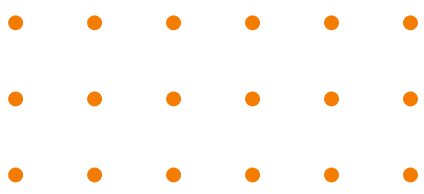


Fire Safety / Flame Spread



Fire Resistance:

ASTM E84 Flame Spread widely specified for water borne insulative coatings.



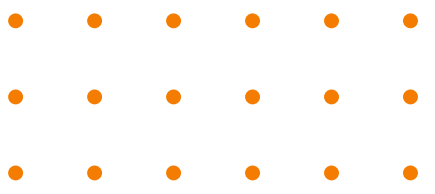
Iso Butane Sphere – Thick + Thin Film



Thick Film + Thin Film Insulative Coating System

Previous foam system causing severe CUI.

In the winter heaters are needed, in the summer boil off is required. Medford OK



Iso Butane Sphere - Primer

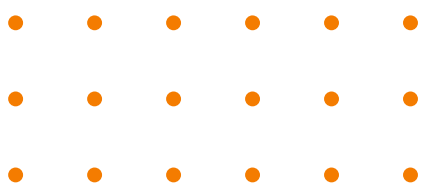


2 coats of DTM MCU polyurethane

Fast cure in humid environments.

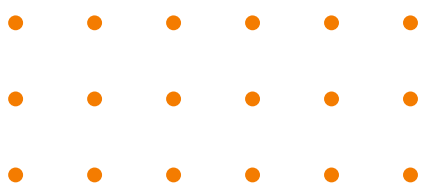
PDO PCS 1A Primer

Iso Butane Sphere – Thick Film Application



Thick film insulative coating applied at 7mm total DFT in two coats.

QA/QC tool is a moisture meter. Only topcoat when coating film has less than 5% moisture.

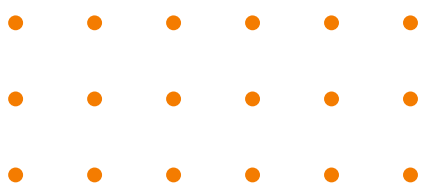


Iso Butane Sphere – Thick Film Application



Provides superior insulation and CUI protection.

In the cold windy winters, HPC will reduce the heating demand to save energy and improve safety.

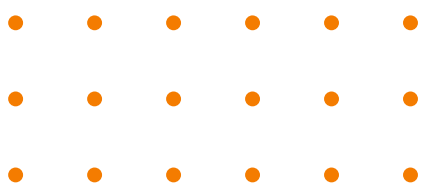


Iso Butane Sphere – Thin Film Application



1 coat applied at 250 micron DFT to both seal the thick film, and provide UV protection.

Thin film insulative coatings are designed to block solar heat lead and reduce boil off through the summer.

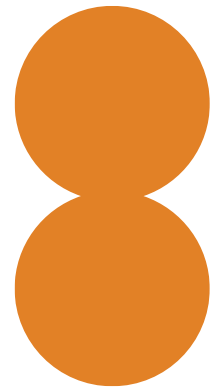


Iso Butane Sphere – Top Coat Application



2 Part Polyurethane Enamel

Applied at 100 micron DFT for gloss finish.



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CONFERENCE & EXHIBITION

2024

INNOVATIVE SOLUTIONS FOR CORROSION CHALLENGES



THANK YOU

KSA – Zamil Industrial Coatings



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