CHROMALOX

Advanced Thermal Technologies

ADVANCED THERMAL TECHNOLOGIES
ENGINEERED FOR THE WORLD'S TOUGHEST
INDUSTRIAL HEATING APPLICATIONS

INDUSTRIAL HEATERS & SYSTEMS

COMPONENT TECHNOLOGIES

HEAT TRACE

Unique Thermal Management Platform

Chromalox combines advanced thermal technologies with industry-leading application engineering to solve the most demanding heating problems

Who We Are

- Heating and control technology company delivering process heating and temperature management solutions for customers in energy and industrial segments
- Founded in 1917 and headquartered in Pittsburgh, Pennsylvania with approximately 1,200 employees globally and manufacturing facilities in USA, Mexico, China, and France

What We Do

- Provide advanced thermal technologies engineered for the world's toughest industrial heating applications
- Design and manufacture the world's largest and broadest line of electric heating and control products
- Develop innovative new products and technologies
- Pursue attractive growth opportunities, focusing on energy and heavy industrial segments across select geographies

Our Core Business Segments

Industrial Heaters & Systems

Process heating solutions for industrial processes

Component Technologies

Component heating solutions for industrial equipment manufacturers

Heat Trace

Temperature management solutions for piping systems, valves, and tanks

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Leader in Advanced Thermal Technologies

	Industrial Heaters & Systems (IH&S)	Component Technologies (CT)	Heat Trace (HT)
Business Segment Description	▪ Delivers process heating solutions for mission-critical industrial processes ▪ Products include heat transfer systems, boilers, and a range of process heating equipment, including circulation heaters, immersion heaters, tank heaters, air heaters, and control systems ▪ Provides engineering and site services, unlike most competitors	▪ Delivers component heating solutions for industrial equipment manufacturers ▪ Products include heating elements such as tubular, strip, ring, band, nozzle, cartridge, and flexible heaters as well as temperature controls, power controls, and temperature sensors ▪ Provides the technological foundation for more complex industrial heaters and systems	▪ Delivers temperature management solutions for piping, valves, and tanks ▪ Products include a range of heat trace cables (self-regulating, mineral insulated, and constant wattage) and control / sensor systems for de-icing, frost prevention, and hot water maintenance ▪ Provides project management, engineering, and site services
Position	#1 U.S., #1 Global	#2 U.S., #3 Global	#4 Global

Representative Product Applications

Strip heaters used to maintain temperatures in resin kettles

Flanged immersion heaters used to maintain lube oil temperatures in natural gas turbines

Tank heating systems and controls used by biodiesel terminal to maintain temperature

Circulation heaters used to heat Silicon Tetrachloride (STC) in polysilicon manufacturing process

Self-regulating heat tracing used to maintain temperatures in gas and steam turbines

Heat trace used throughout oil refineries for freeze protection

Product Overview

Industrial Heaters & Systems

- Provides process heating, air heating, and temperature control solutions, supplying a variety of heaters, heating processes, and engineered systems
- Offers broad global experience in a variety of applications and industry segments
- Focused on attractive industry segments, including oil & gas, power generation, petrochemical, and chemical
- Engineered systems and services represent over 60% of the business line
- Leading position in fragmented market

Component Technologies

- Focused on industrial equipment manufacturers and commercial applications; products sold broadly through distributors and directly to OEMs
- Provides the foundation for more complex industrial heaters and systems
- Represents a continuing source of advanced heating technology and significant cash generation
- #3 player globally; #2 player in North America
- Exited less attractive product lines and largely consolidated manufacturing in Mexico, resulting in improved profitability

Industrial Heaters & Systems

Immersion Heaters

Circulation Heater

Large Tank Heater

Heat Transfer Systems

Engineered Skid System

Power Control Panel

Air Heaters

Steam Boiler

Component Technologies

Cartridge Heaters

Tubular Heaters

Band and Nozzle Heaters

Strip and Ring Heaters

Flexible Heaters

Temperature Controls

Sensors and Accessories

Product Overview

Heat Trace

- Provides temperature management solutions for piping systems, valves, and tanks
- Primary industry segments include oil & gas, power generation, petrochemical, chemical, and industrial
- Developed capability to pursue larger projects in combination with engineering & site services offering
- Increased marketing investment and added 11 key people in sales and downstream project management, resulting in accelerated growth

Heat Trace

Self-Regulating Heat Tracing

Jacketed Heat Tracing for Hazardous Areas

Controls and Accessories

Heat Trace Digital Thermostat

MI Heat Tracing

MI Heat Tracing Termination

Control Panel

Supervisory Software

Third Party Certifications

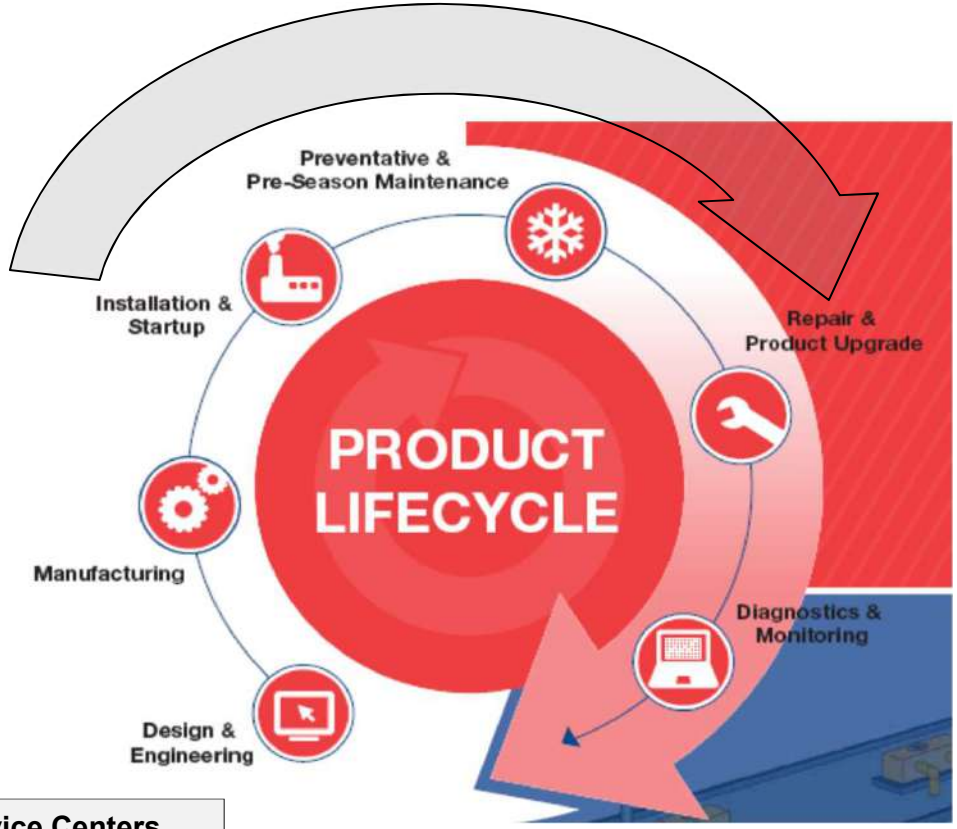
- Chromalox's unparalleled array of product approvals and design certifications enables the company to serve customers in nearly all countries and industry segments

Hazardous Areas	Pressure Vessels	General Electrical
Approval	**Approval**	**Approval**
ATEX	ASME	CCC
BASEEFA	ASMERKBLATT	CE
BKI	CODAP	CSA
CCE	PED	CSTB
CENELEC	Selo	DEMKO
CMAT	STOOMWEZEN	DNV
CQST		EVPU
FM		GB
LCIE		GOST/PCT
SAA		Kosha
IECEx		PTB
		UL/Listed
		UL/Recognized
		VDE
		VERITAS

Expanding Engineering & Site Services

Engineering & site services represents a growth opportunity that differentiates Chromalox by improving the total customer experience

- Focuses on startup and installation to minimize future issues
- Delivers field repair and troubleshooting support
- Offers site audits to evaluate existing installations, which provides an opportunity for replacement sales
- Holds site training to support maintenance staff, including formalized and documented custom training
- Provides attractive extended warranty programs
- Complements service offering through web tools and enhanced online capabilities



Global Service Centers

- **LaVergne, TN**
- **Croydon, UK**
- **Shanghai, China**
- **Chonburi, Thailand**

Strategic Manufacturing Footprint

Global footprint facilitates strategic sourcing, optimized manufacturing, an attractive margin profile, and strong customer service

Ogden, Utah	
Size (sq. ft.):	184,000
Ownership:	Owned
Products:	IH&S
Operations:	Manufacturing, Engineering, Distribution
Employees:	208

Pittsburgh, Pennsylvania	
Size (sq. ft.):	22,000
Ownership:	Leased
Operations:	Administration, Sales, Engineering
Employees:	60

Soissons, France	
Size (sq. ft.):	150,000
Ownership:	Owned
Products:	IH&S
Operations:	Manufacturing, Engineering, Distribution
Employees:	115

Nuevo Laredo, Mexico	
Size (sq. ft.):	113,000
Ownership:	Leased
Products:	IH&S and CT
Operations:	Manufacturing, Engineering, Distribution
Employees:	383

La Vergne, Tennessee	
Size (sq. ft.):	143,000
Ownership:	Leased
Products:	Heat Trace and stocked products
Operations:	Manufacturing, Engineering, Distribution
Employees:	100

Wujiang, China	
Size (sq. ft.):	28,000
Ownership:	Leased
Products:	Heat Trace
Operations:	Manufacturing, Engineering, Distribution
Employees:	29

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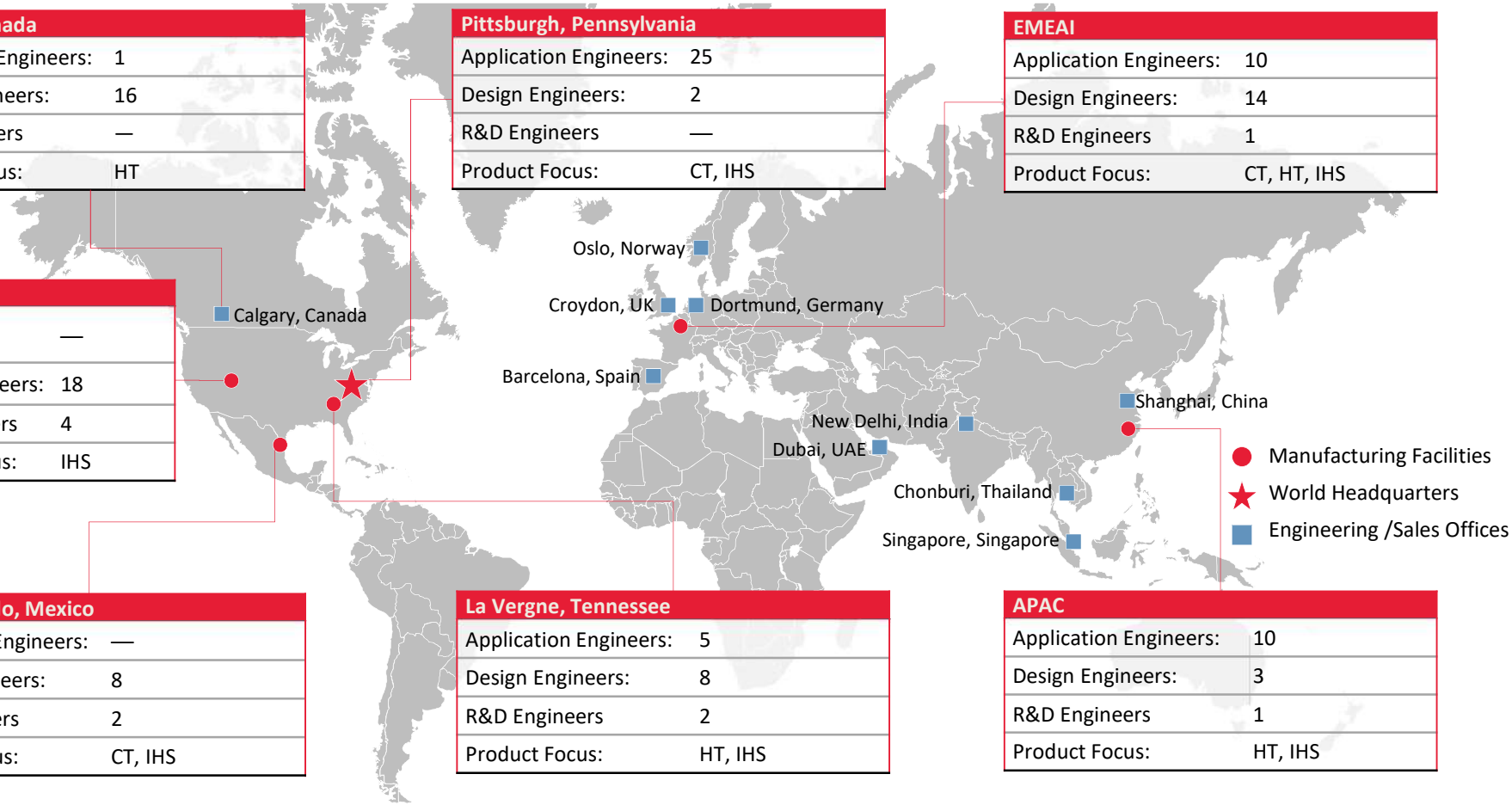
Global Engineering Footprint

Calgary, Canada	
Application Engineers:	1
Design Engineers:	16
R&D Engineers	—
Product Focus:	HT

Pittsburgh, Pennsylvania	
Application Engineers:	25
Design Engineers:	2
R&D Engineers	—
Product Focus:	CT, IHS

EMEAI	
Application Engineers:	10
Design Engineers:	14
R&D Engineers	1
Product Focus:	CT, HT, IHS

Ogden, Utah	
Application Engineers:	—
Design Engineers:	18
R&D Engineers	4
Product Focus:	IHS



Nuevo Laredo, Mexico	
Application Engineers:	—
Design Engineers:	8
R&D Engineers	2
Product Focus:	CT, IHS

La Vergne, Tennessee	
Application Engineers:	5
Design Engineers:	8
R&D Engineers	2
Product Focus:	HT, IHS

APAC	
Application Engineers:	10
Design Engineers:	3
R&D Engineers	1
Product Focus:	HT, IHS

- **Application Engineer:** Develops thermal solutions for customer inquiries, estimates costs, and develops quotations. In some regions AE serves a dual role in sales
- **Design Engineer:** Completes detail engineering, design, BOM, and routing for production. May also perform new product development and value engineering

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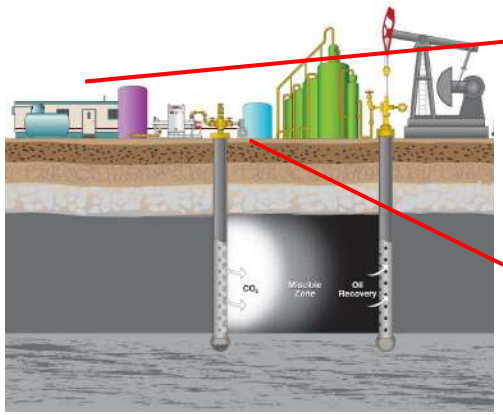
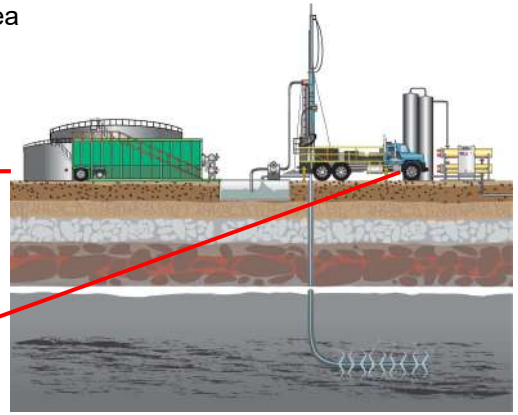
Representative Product Applications – Oil & Gas Exploration (Onshore)

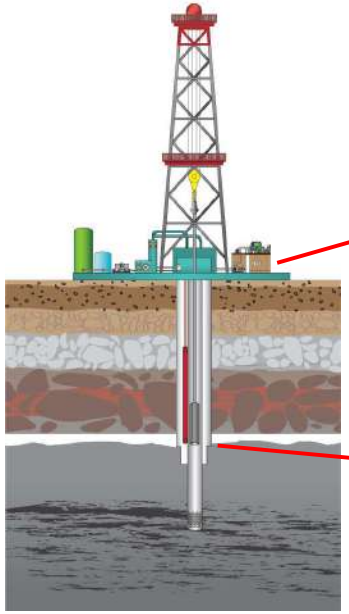


Hazardous Room Heaters
Warming personnel in dangerous work area

Tank Heaters
Warming of potable water for on-site use;
chemicals freeze protection in colder drilling sites

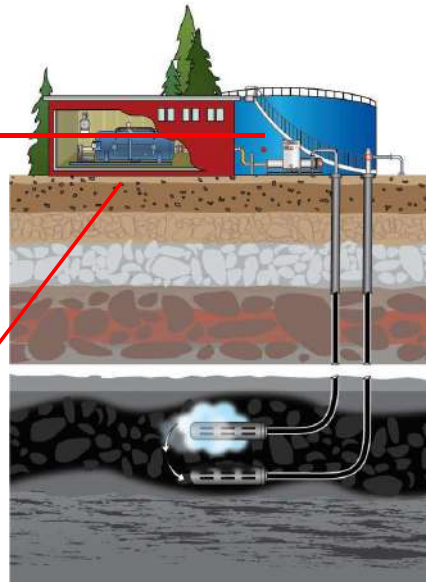


Circulation Heaters
Warm carbon dioxide for injection in enhanced oil recovery;
frac tank manifold heating to avoid freezing in cold climates



Flange Heaters
'Knock-Out Drum' Heating - create
temperature stratification for
separation of water, drilling mud, and
chemicals

Packaged Skids
Separation of gas
NGLs prior to
pipeline transport



Component Heaters (Maxi-Zone)
Warm waxy crude for decreasing viscosity for
down-hole applications

Steam Boilers
Used as auxiliary supply for Steam
Assisted Gravity Drainage (SAGD)

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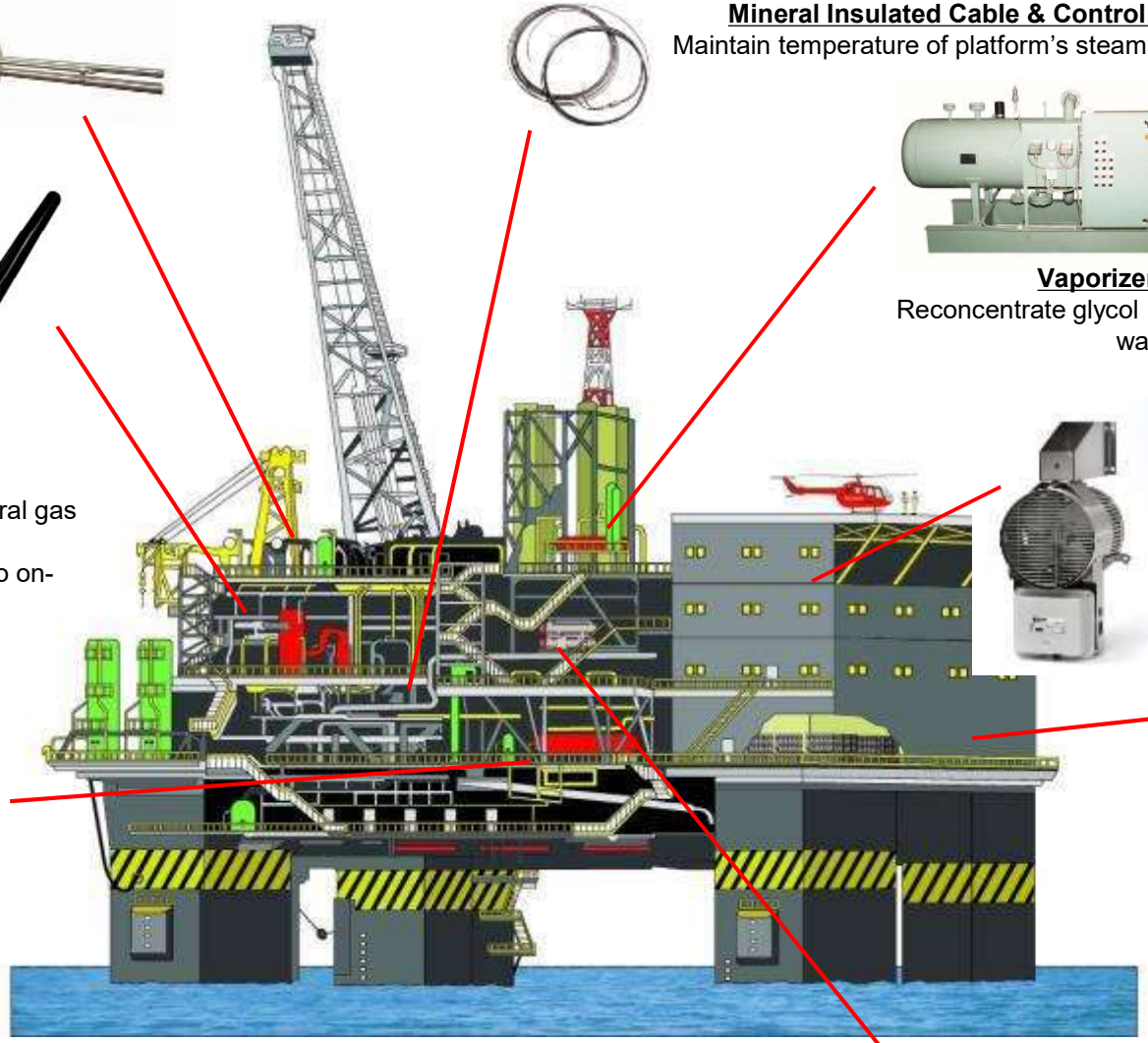
Representative Product Applications – Oil & Gas Exploration (Offshore)

Tank Heaters
Warming of potable water for on-site use;
sump heating during sludge collection in drains

Flange Heaters
Raise temperature of liquid natural gas during distribution;
heat water in calorifiers prior to on-board use

Packaged Skids
Knock-out Drums separate gas, oils, and water during extraction;
dry out gas stream to prevent corrosive condensation



Mineral Insulated Cable & Control Panels
Maintain temperature of platform's steam line network

Vaporizer Heaters
Reconcentrate glycol mixtures by boiling off water

Blower Heaters
Warming personnel in office space, living space, and hazardous enclosed spaces

Convection Heaters
Reduce humidity in storage areas such as battery compartments or food storage

Circulation Heaters & Control Panels
Warm waxy crude during extraction to aid in pump efficiency and pipeline distribution

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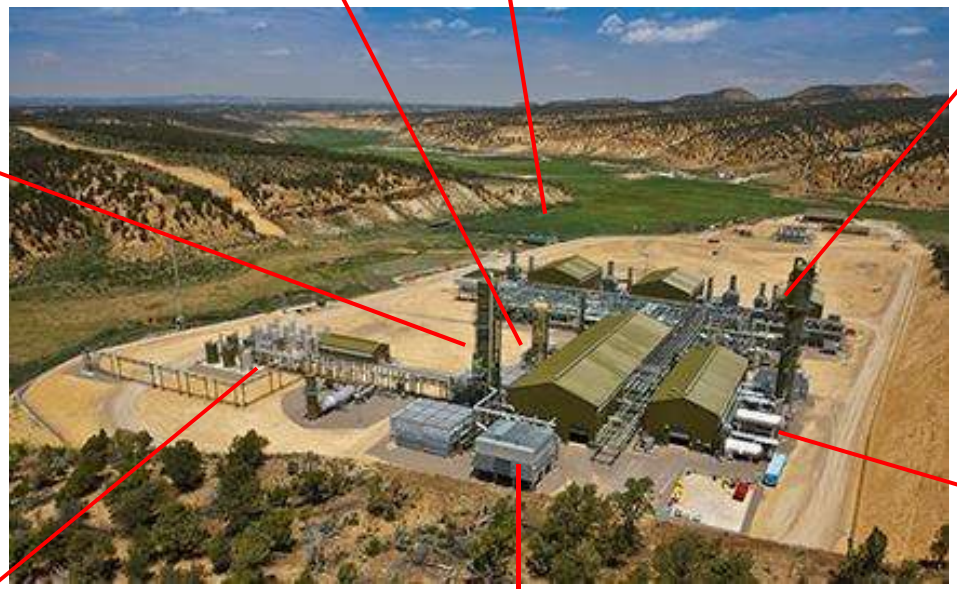
Representative Product Applications – Oil & Gas Midstream (Processing)

Tank Heaters
Replace open-flame heaters in knock-out tanks comply with EPA regulations

Skin Effect Heating & Control Panels
Maintain temperature over miles of pipes, underground, overground, and undersea

Heat Transfer Systems
Heating of distillation columns for separation of hydrocarbons



Seal Gas Heater
High pressure design to warm compressor shaft seals to prevent gas leakage

Packaged Skids
Vaporization of separated cryogenic natural gas liquids hydrocarbons such as butane, propane, pentane, etc.

Circulation Heaters
Nitrogen heating for absorbent drying (removal of sulfur from wet natural gas)

Gas Dew Point Heaters & Control Panels
Treat separated natural gas stream to remove moisture content prior to pipeline transport

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Representative Product Applications – Oil & Gas Downstream (LNG Terminal)

Long Line Cable & Control Panels
Temperature maintenance of wax lines running to dock facilities

Vaporizers
Used to boil liquid NGLs for pipeline distribution

Tank Heaters
Flare Knockout Drum Heaters to remove liquid from waste gas streams

Steam Boilers
Localized steam used for heat-exchanger during main boiler shut-downs

Packaged Skid
Used to treat natural gas for on-site power generation

Industrial Gas Heater & Control Panels
Air heating to prevent frost build-up from vaporization; gas regeneration heaters for regeneration of absorbent beds

Explosion-Proof Air Heaters
Warming personnel in hazardous locations

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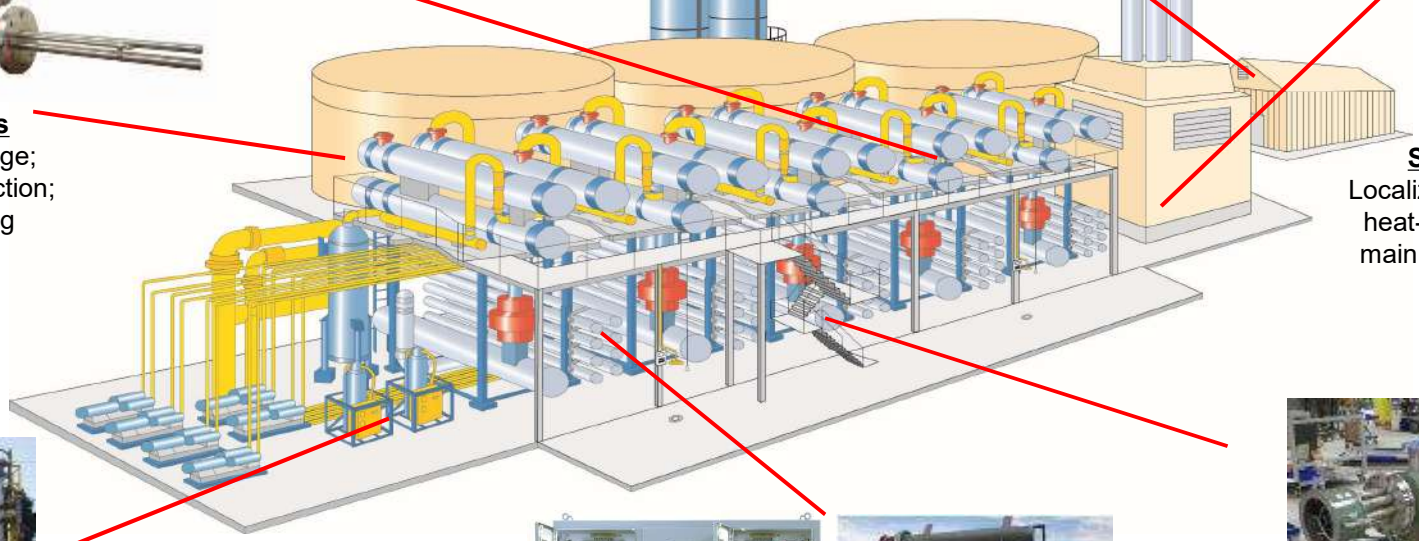
Representative Product Applications – Petrochemical Refining

Heat Trace, Tube Bundles & Control Panels
Keeping steam "dry" during long piping runs, preventing heat loss;
water line freeze protection during winter months

Explosion-Proof Air Heaters
Warming personnel in hazardous locations

Tank Heaters
Fire water storage;
oil viscosity reduction;
lube oil heating



Steam Boilers
Localized steam used for heat-exchanger during main boiler shut-downs

Packaged Skid
Regenerate absorbents used in molecular sieves

Industrial Gas Heater & Control Panels
Heat oxygen or similar gases used for hydro-carbon cracking process

Circulation Heaters
Decrease viscosity of waxy-crude oil for pumping

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XtremeDuty™ products are engineered to withstand harsh uses and perform in the most difficult operating locations

- Engineered thermal solutions that feature proprietary control technologies designed for the most extreme environmental and process conditions
- Vertically integrated manufacturing allows for customized solutions that match the requirements brought on by any climate or process
- Key advantages include:
  - Lower maintenance
  - Superior performance
  - Safer operation (no open flame)
  - Corrosion resistance
  - Faster start-up
  - Moisture resistance
  - Hazardous area approved

XtremeDuty™ Application Environments

Processes

- Extreme temperature applications from -225°C to 1100°C
- Extreme pressure applications from full vacuum to 7500psig / 517 barg
- Corrosive heating such as with hydrochloric acid
- Temperature sensitive fluids, e.g. sulfur processing where +/-5°F is critical
- Hazardous applications, e.g. fuel gas superheating or hydrocarbon vaporization

Environmental

- High / low temperatures: -60°C (arctic) to 55°C (desert)
- Corrosive areas, e.g. salt air, wind and rain
- Hazardous locations: refineries, chemical storage, gas turbine enclosures and drilling platforms

XtremeDuty™ Platform Solutions

Solution	Example Application(s)
Unit Heater	• Installation on the exposed deck of an offshore drilling platform in oil & gas exploration
Heat Trace Cables and Connection Kits	• Maintain flow of hydrocarbons in a pipeline and certified for Class I, Division 2 and Zone 2 locations
Insertion Style Cartridge Heaters	• Used to maintain fluidized bed reactors at temperatures up to 1500°F
Cast Circulation Heaters	• Used for seal gas drying designed for pressures up to 7500psi
Control Panels	• Maintain precise temperatures in petrochemical refining and designed for Class I, Division 2 and Zone 2 locations

Selected XtremeDuty™ Products

XtremeDuty™ Heat Trace		• Self-regulating HT • Hazardous area HT • Mineral insulated HT • Instrument enclosures, panels and thermostats
XtremeDuty™ IH&S		• Custom process heaters • Immersion tank flange heaters • Circulation heaters
XtremeDuty™ Component Technologies		• Hazardous area enclosure heater • Drum heater • Maxizone heater • Explosion proof strip heaters

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High Temp Self-Regulating Heat Trace

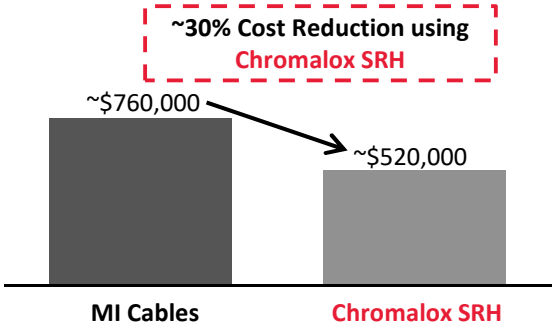
High Temp Self-Regulating Heat Trace is a break-through technology capable of operating at extreme temperatures

- New high temperature self-regulating polymer
  - Proprietary extrusion process enables higher temperature materials
  - Max continuous exposure temps up to 545°F
  - 480V self-regulating cable; up to 35W/ft
- Key advantages include:
  - Cables can be cut to length in the field for easier, less costly installation
  - Saves energy by reducing heat output when not needed
  - Lower installed cost than steam tracing leads to reduced maintenance expense and downtime
  - Greater flexibility than MI and Constant Wattage cables allows for easier installation
- Patented thermal box designs and connection accessories
- Primary end segment applications include power generation, chemical and oil & gas

Chromalox SRH Advantages Over Competing Technologies

	Chromalox SRH	Mineral Insulated Cables ("MI")	Power Limiting Constant Wattage	Traditional Self-Regulating
Address >500°F	• Yes	• Yes	• No	• No
Purchase Availability	• Stock	• Made-to-order • (4-6 week delivery)	• Stock	• Stock
Operating Metrics	• 480V • 35W/ft	• 600V • 50W/ft	• 480V • 20W/ft	• 277V • 20W/ft
Installation	• Flexible • Cut to length from spool	• Very stiff, heavy • Hard to install • Custom ordered	• Stiff • Electrical node • Hard to install	• Very flexible • Cut to length from spool
Efficiency	• Efficient	• Less efficient	• Somewhat efficient	• Efficient

Illustrative Cost Comparison



- In a typical high temperature application, **Chromalox SRH** can reduce costs by ~30%
  - No cold leads like MI Cables
  - Ease of installation
  - Reduced labor man-hours

Chromalox's break-through technology for High Temp Self-Regulating Heat Trace has an opportunity to displace competing technologies such as MI cables in the marketplace

IntelliTrace™ and Wireless Heat Trace Control

Proprietary control platform and software with intuitive Human Machine Interfaces ("HMI") simplify heat trace system installation and operation and provide end-to-end capabilities

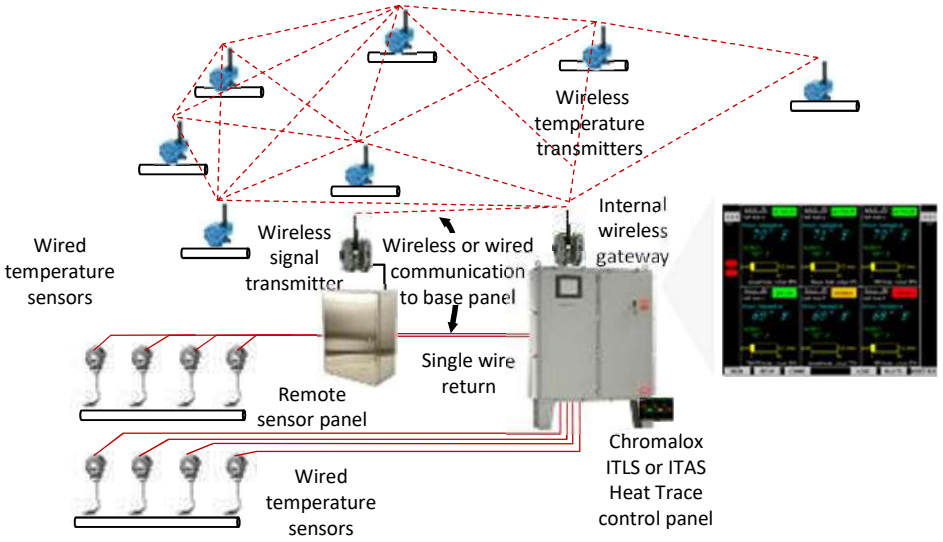
- Chromalox offers the full suite of integrated software and hardware products that maintains unique intellectual property protection
- Automation platform with remote monitoring and Industrial Internet of Things ("IIoT") capabilities
- Sensor and output mapping methodology reduces heat trace & control installation manpower and provides greater system flexibility
- Seamless wireless temperature transmitter integration
- Scalable supervisory control platform and software

Central Control Capability

- Remote monitoring and management of every parameter on each circuit across all multiple loop control panels

Based on 100ft Cable Circuit with 80ft Conduit Run

	Wired	Wireless	MI Cable	SRH Cable
Engineering Design	$200	$50	$250	$200
Material Cost	1,200	2,500	800	600
Installation Labor	2,750	250	2,600	1,300
Per Loop Installation Cost	$4,150	$2,800	$3,650	$2,100
Savings Per Circuit ($)		1,350		1,550
Savings Per Circuit (%)		*33%*		*42%*
100 Circuit System Savings		135,000		155,000
500 Circuit System Savings		675,000		775,000



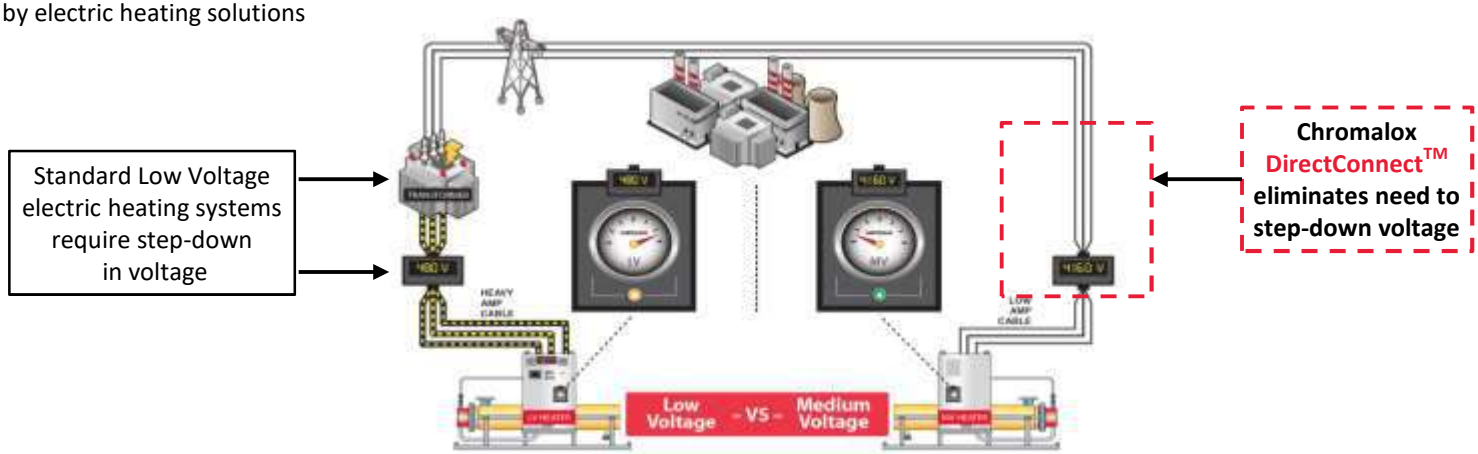
20 patents on various control methodologies and technologies

Chromalox **DirectConnect™** medium voltage electric heating systems are a new, disruptive technology that reduces installation and life-cycle costs while providing pollution-free operation for process heating

- Eliminates need for medium- to low-voltage conversion by connecting electric heating system directly to the medium voltage source
- Key advantages include:
  - Heater installation costs reduced by up to 90% and installation time reduced by 80%
  - Eliminates need to step-down voltage
  - Operating at medium voltages increases the efficiency of power distribution and consumption (~ 99% efficiency)
  - Drastically reduces the amount of cabling required
  - Yearly maintenance reduced to a few hours from a few days
  - Safer operation (no open flame)
  - Pollution free
- Tested and approved by third party laboratories like UL and ETL
- Created a product category of its own and no competitor has the same level of industry certification
- Opens applications in targeted end segments and applications previously unable to be served by electric heating solutions

Total DirectConnect™ Savings vs. Traditional Low Voltage Solutions

Cost of Ownership	Traditional 480 V	Direct Connect™ 4160 V	Savings ($)	*(%)*
Installation	$753,650	$528,655	$224,995	*30%*
Operating	$873,940	$240,800	$633,140	*72%*
Maintenance	$61,200	$10,200	$51,000	*83%*
Life Cycle Replacements	$163,655	$69,500	$94,155	*58%*
Total Life Cycle Costs	$1,852,445	$849,155	**$1,003,290**	***54%***



Customers save more than $1 million utilizing the DirectConnect™ electric heating system

DirectConnect™ Experience List

Type of Facility	Location	Product	Application	Voltage	Power Installed
NGL Processing & Export Terminal	USA	Circulation Heater / Panel	Propane Superheater	4160V	2.2 MW
NGL Processing & Export Terminal	USA	Circulation Heater / Panel	NGL Preheater	4160V	2.3 MW
Crude Refinery	USA	Circulation Heater / Panel	Light Cycle Oil Heating	4160V	2.4 MW
Power Plant	USA	Circulation Heater / Panel	Water Heater	4160V	2. MW
LPG Export Terminal	USA	Vaporizer	Ethane/Propane vaporization	4160V	1.65 MW
Deepwater Offshore Platform	GoM	(2) Circulation Heaters / Panels	Oil and Produced Gas Heater	4160V	2.6 MW
Combined Cycle Power Plant	MEX	(4) Circulation Heaters / Panels	Fuel Gas & Steam Heating	4160V	15.5 MW
NGL Processing & Export Terminal	USA	Circulation Heater / Panel	Butane Superheater	4160V	4.7 MW
Combined Cycle Power Plant	USA	Circulation Heater / Panel	Steam Superheating	4160V	1.1 MW
Natural Gas Conversion Power Plant	USA	Circulation Heater / Panel	Frazil Water Heating	4160V	3.17 MW
Offshore Production Platform	GoM	Circulation Heater / Panel	Water/Glycol Heating	4160V	1.32 MW
Chemical Processing Facility	USA	Circulation Heater / Panel	Hot Oil Heat Transfer System	4160V	2.03 MW
Chemical Processing Facility	Brazil	Circulation Heater / Panel	Liquid Ethane Heater	4160V	3.3 MW
Offshore Production Platform	GoM	Circulation Heater / Panel	Crude Oil Heater	4160V	.65 MW
Combined Cycle Power Plant	USA	Circulation Heater / Panel	Natural Gas Heater	4160V	3.23 MW
Gas Processing & Petrochem Plant	USA	Immersion Heater / Panel	Water Heater	4160V	1.8 MW
Combined Cycle Power Plant	USA	Circulation Heater / Panel	Water/Glycol Heating	4160V	5. MW
Mineral Processing Plant	Peru	Heat Transfer System	Water/Glycol Heating	4160V	1.8 MW
Power Plant	USA	Circulation Heater / Panel	Fuel Gas Heating	6900V	1.65 MW
Chemical Plant	USA	Circulation Heater / Panel	Hydrogen & Hydrocarbon Heating	4160V	.94 MW
Power Plant	USA	Circulation Heater / Panel	Sea water	4160V	7.33 MW
FPSO	UK	Circulation Heater / Panel	Fuel Gas Heating	6600V	.7 MW
NGL Processing & Export Terminal	USA	Immersion Heater	Butane, Propane, NGL	4160V	1.18 MW
Chemical Plant	USA	Vaporizer and Superheater	Carbon Dioxide vaporization	4160V	3.37 MW
Power Plant	USA	Circulation Heater / Panel	Natural Gas Heater	4160V	1.95 MW

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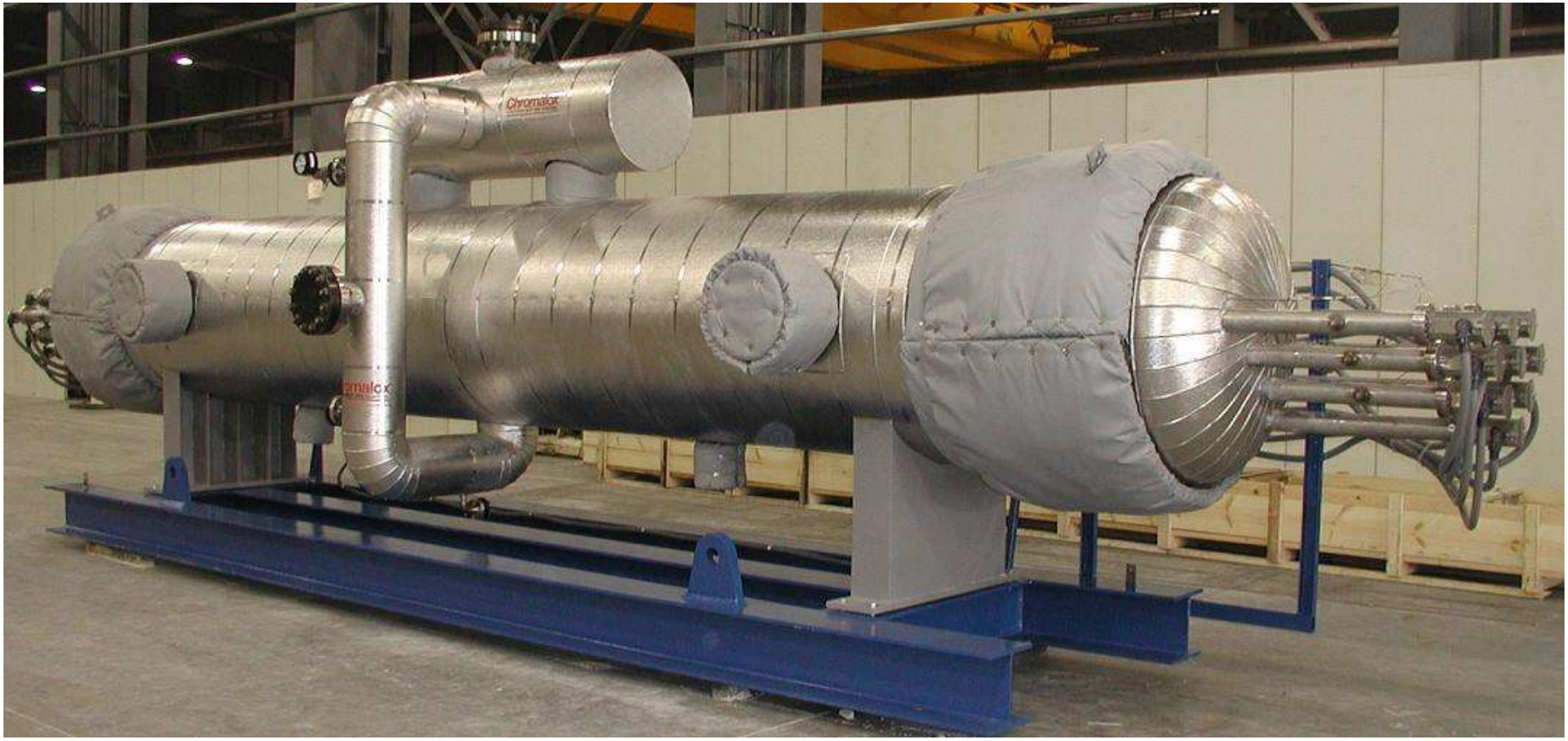
PROCESS SOLUTIONS APPLICATION PHOTOS

400 kW Process Vaporizer

400 kW Process Vaporizer



2 MW Auxiliary Steam Boiler

Natural Gas Pre-heater

- 5 MW, 480V 3Ph power
- Rated for Cl.1, Div. 1, Groups C & D area
- NEMA 7 enclosures
- Remote mounted SCR control panel

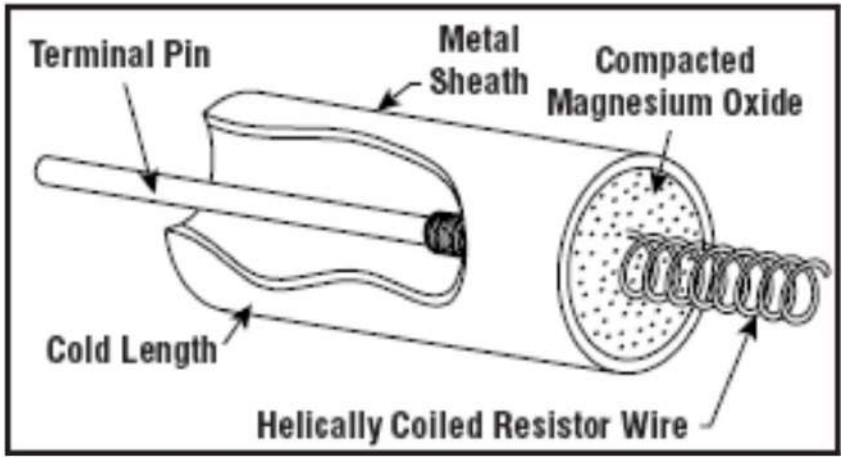
1 MW Hot Oil System with Pump Package

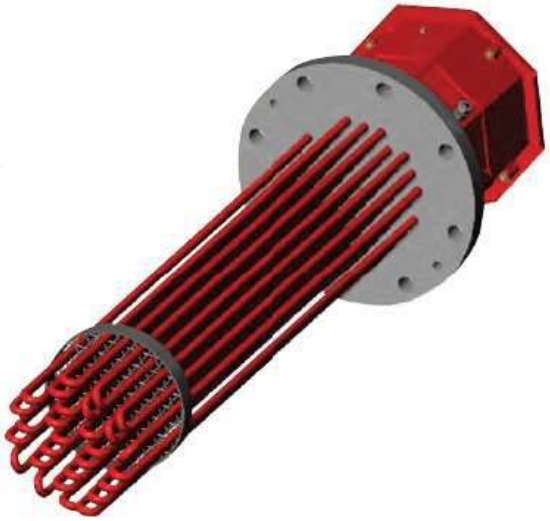
Steam Superheater with Remote Mounted SCR Panel

- 700 kW, 460V 3Ph
- Designed to superheat 14,000 lbs/hr
- (8) over temperature thermocouples, (1) for each circuit
- ASME rated 215 PSI @ 770° F
- Included remote mounted SCR panel

What is an electric heating element?

- Resistor (Ni Chrome Wire)
- Insulator (MgO)
- Container (Tubing)
- Cold Pin and Termination





Energy Conversion

$$kW = V.I$$

$$V = I.R$$

$$kW = V.I = {V^2}/{R} = m.C_p.\Delta T$$

$$kW = UA\Delta T$$

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Engineering and Development Tools

Design Tools

- Aspen Exchanger Design & Rating (EDR)
- AutoDesk Inventor
- Finglow
- PV Elite
- AutoCAD Electrical

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Heat Transfer Basic Formula

$$Hc = \alpha\lambda / D.\mathrm{Re}^{m}.\mathrm{Pr}^{0.34}$$

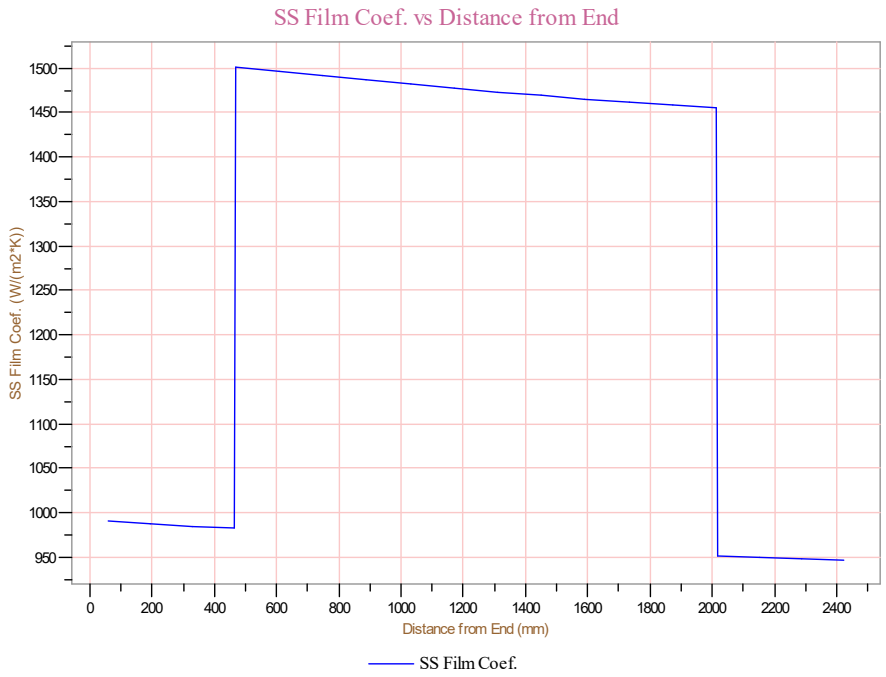
α = Constant for Bundle Layout

λ = Thermal Conductivity

D = Tube Diameter

Re^{m} = Reynolds Number

Pr = Prandtl Number



The MTASC software modifies the formula depending on the Heat Exchanger design and the Re value

Process Heater Design Datasheet

Operating Conditions	
1. **HEATED MEDIUM:**	
2. **TEMPERATURE IN:** °F **TEMPERATURE OUT:** °F	
3. **FLOW RATE:** SCFM or GPM or	
Lbs/Hr or ☐ Other *(Specify)*	
4. **OPERATING PRESSURE:** psig.	
5. **DESIGN TEMPERATURE:** °F Max. °F Min.	
6. **DESIGN PRESSURE:** psig.	
7. ☐ Indoor ☐ Outdoor	
8. **HAZARDOUS AREA ENVIRONMENT:**	
Class Div. Group	
9. **AMBIENT TEMPERATURE:** °F	
Heater Specifications *(Check All That Apply)*	
1. **RATING:**	
Volts Phase Kilowatts	
2. **NUMBER OF ELECTRICAL CIRCUITS:** ☐ Standard	
☐ Other: No. of Circuits kW/Circuit	
3. **NOMINAL FLANGE & VESSEL SIZE/NO. HEATING ELEMENTS:**	
☐ 3"/3 ☐ 6"/12 ☐ 8"/18	
☐ 10"/27 ☐ 12"/36 ☐ 14"/45	
☐ 16"/72 ☐ 18"/108 ☐ Other *(Specify)*	

4. **FLANGE AND VESSEL MATERIAL:**	
☐ Carbon Steel	☐ Carbon Steel-Galvanized
☐ 304 Stainless Steel	☐ Other *(Specify)*
5. **FLANGE RATING:** ☐ Class 150 ☐ Class 300 ☐ Other *(Specify)*	
6. **HEATING ELEMENT WATT DENSITY:** ☐ 6.5 W/In² ☐ 15 W/In²	
☐ 23 W/In² ☐ 45 W/In² ☐ Other *(Specify)*	
7. **HEATING ELEMENT SHEATH MATERIAL:**	
☐ Steel ☐ Copper ☐ 304 Stainless Steel	
☐ 316 Stainless Steel	☐ INCOLOY®
☐ Other *(Specify)*	
8. **TERMINAL SEALS:**	☐ Yes ☐ No
☐ Silicone Resin (450°F)	☐ Silicone Fluid (500°F)
☐ RTV (450°F)	☐ Epoxy (250°F)
☐ Hermetic (Maximum 1000°F Sheath Temperature)	
☐ Other *(Specify)*	
9. **TERMINAL ENCLOSURE:**	☐ General Purpose
☐ Moisture Resistant	☐ Explosion Resistant
10. **TERMINAL ENCLOSURE STANDOFFS:**	☐ Yes ☐ No
☐ 4" ☐ 6"	☐ Other *(Specify)*
11. **BODY FLANGE GASKET:**	
☐ Standard ☐ Spiral Wound	☐ Other *(Specify)*

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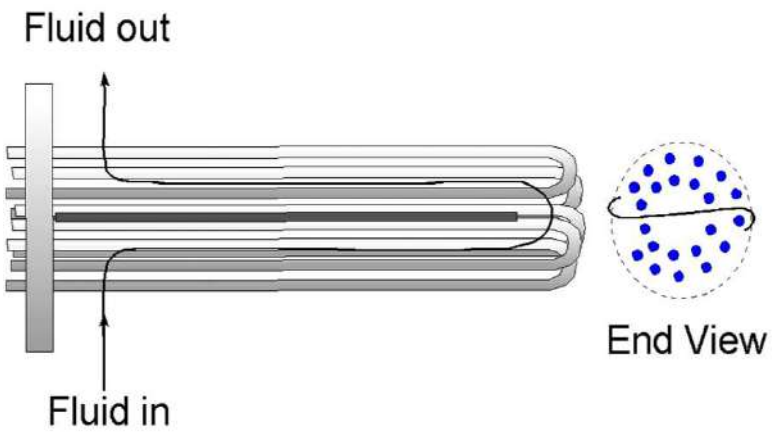
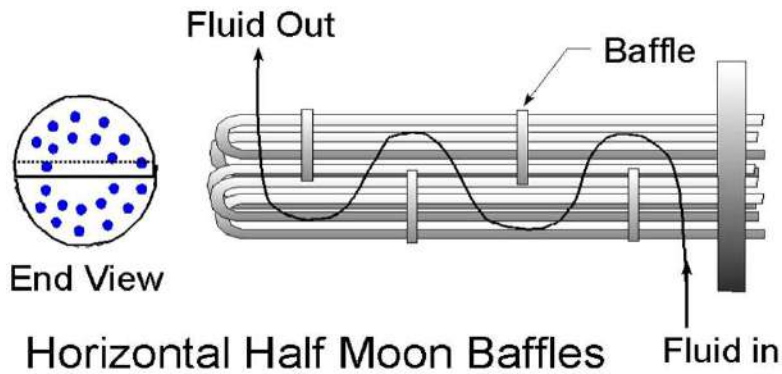
Maximize flow conditions

- Increase turbulence
- Reduce sheath/shell temperatures
- Reduce watt density (heat flux) W/inch2



Longitudinal Baffle



Horizontal Half Moon Baffles

Traditional Cross Flow Baffle

- High turbulence hence higher pressure drop
- Best heat transfer coefficient

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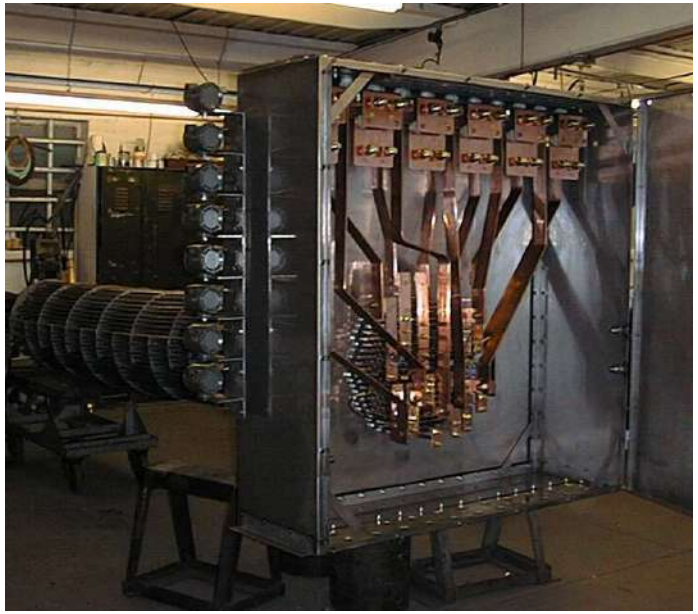
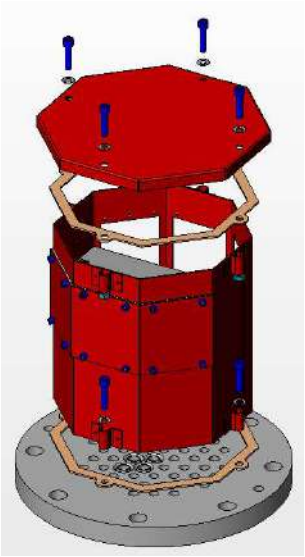
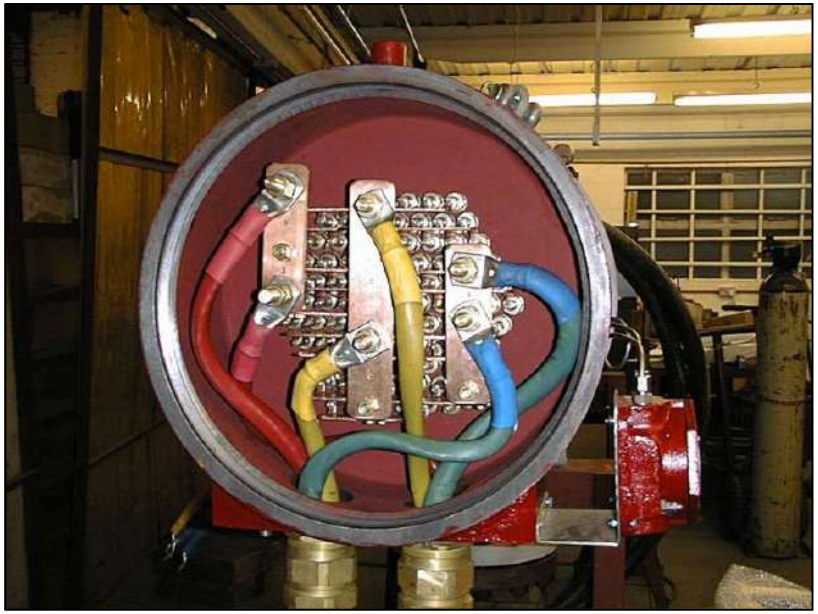
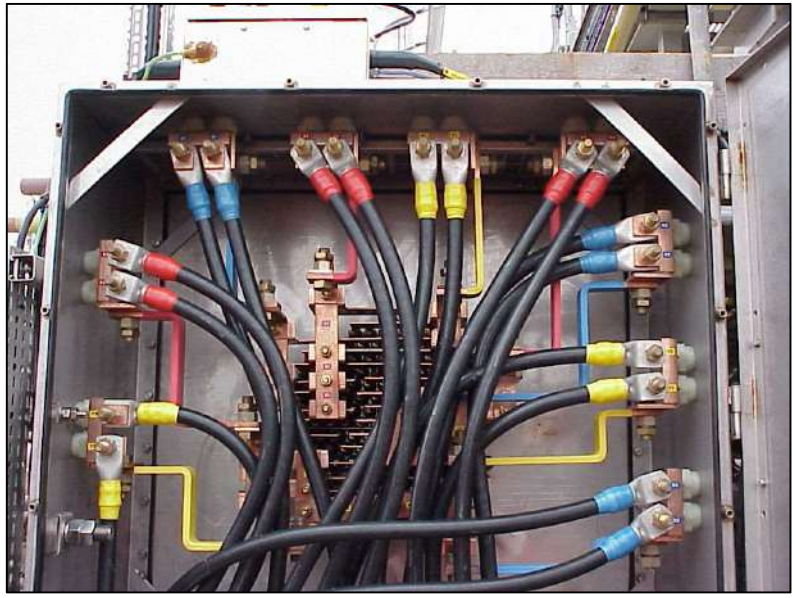
Terminal House Configurations



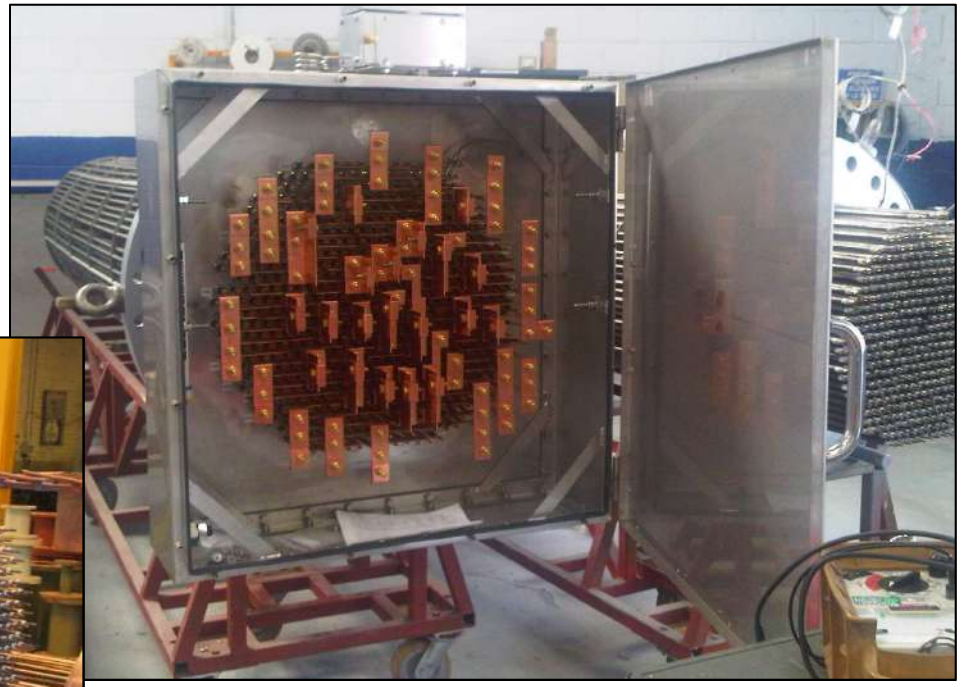


Terminal House Configurations



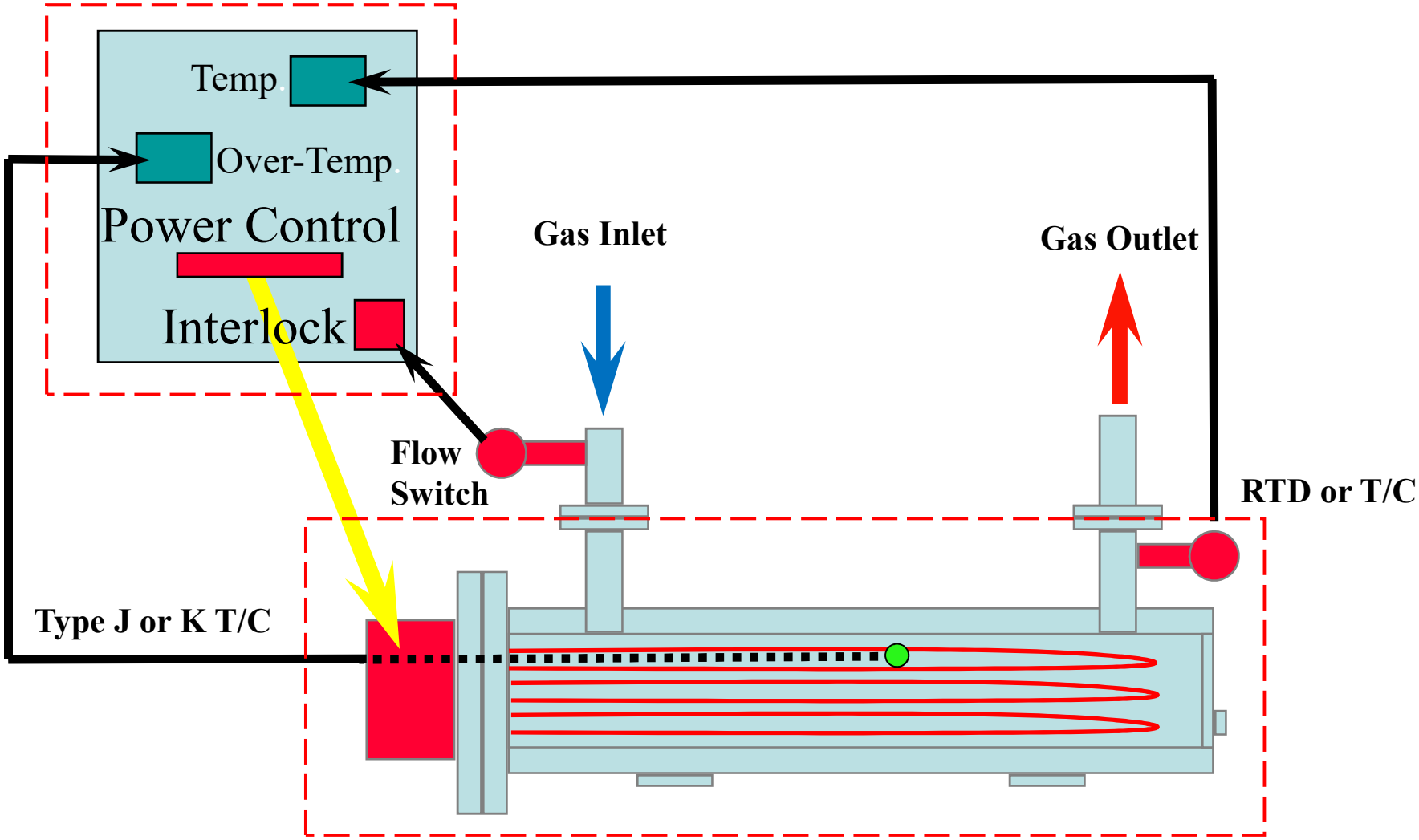


Terminal House Configurations

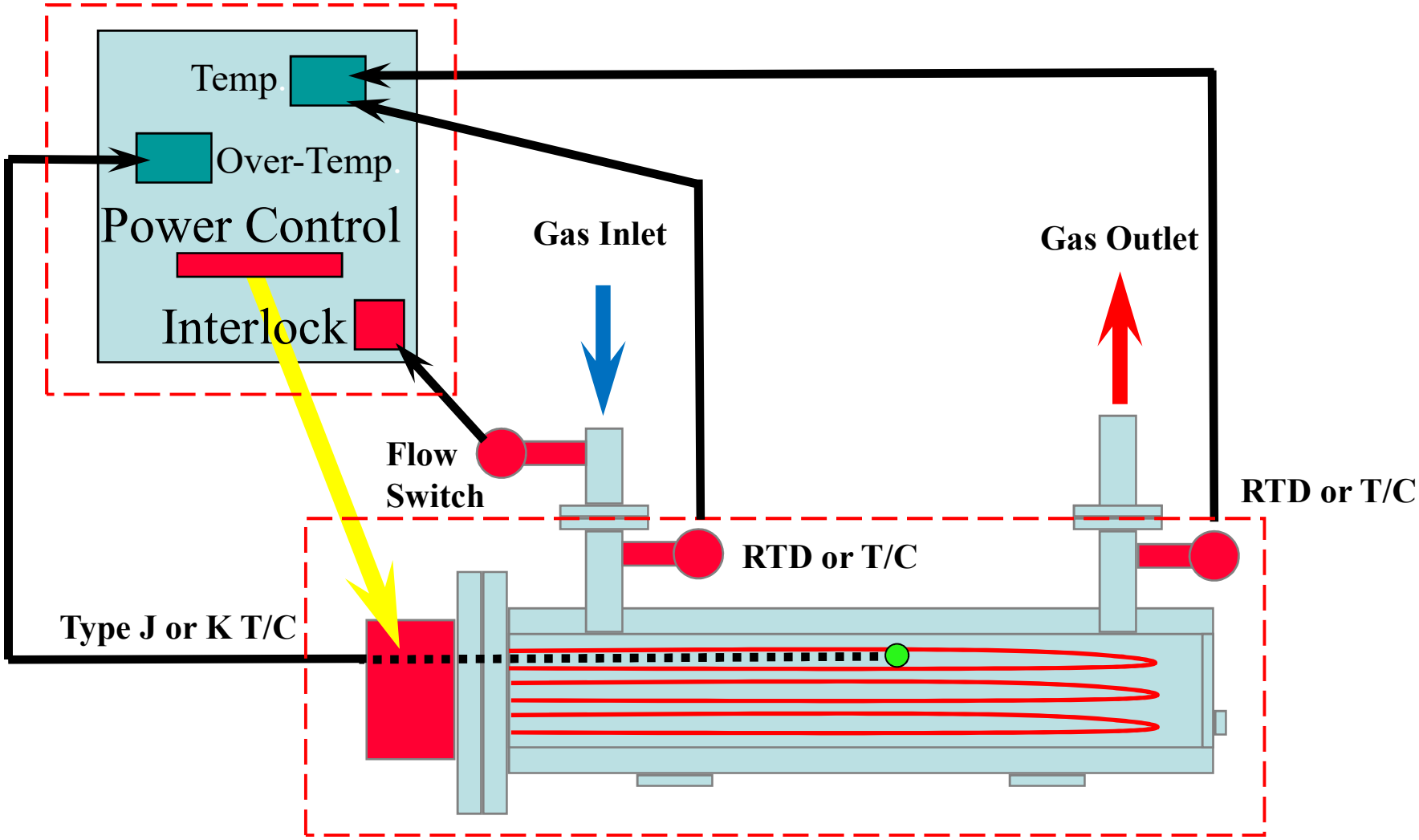


TERMINAL HOUSE CONFIGURATIONS

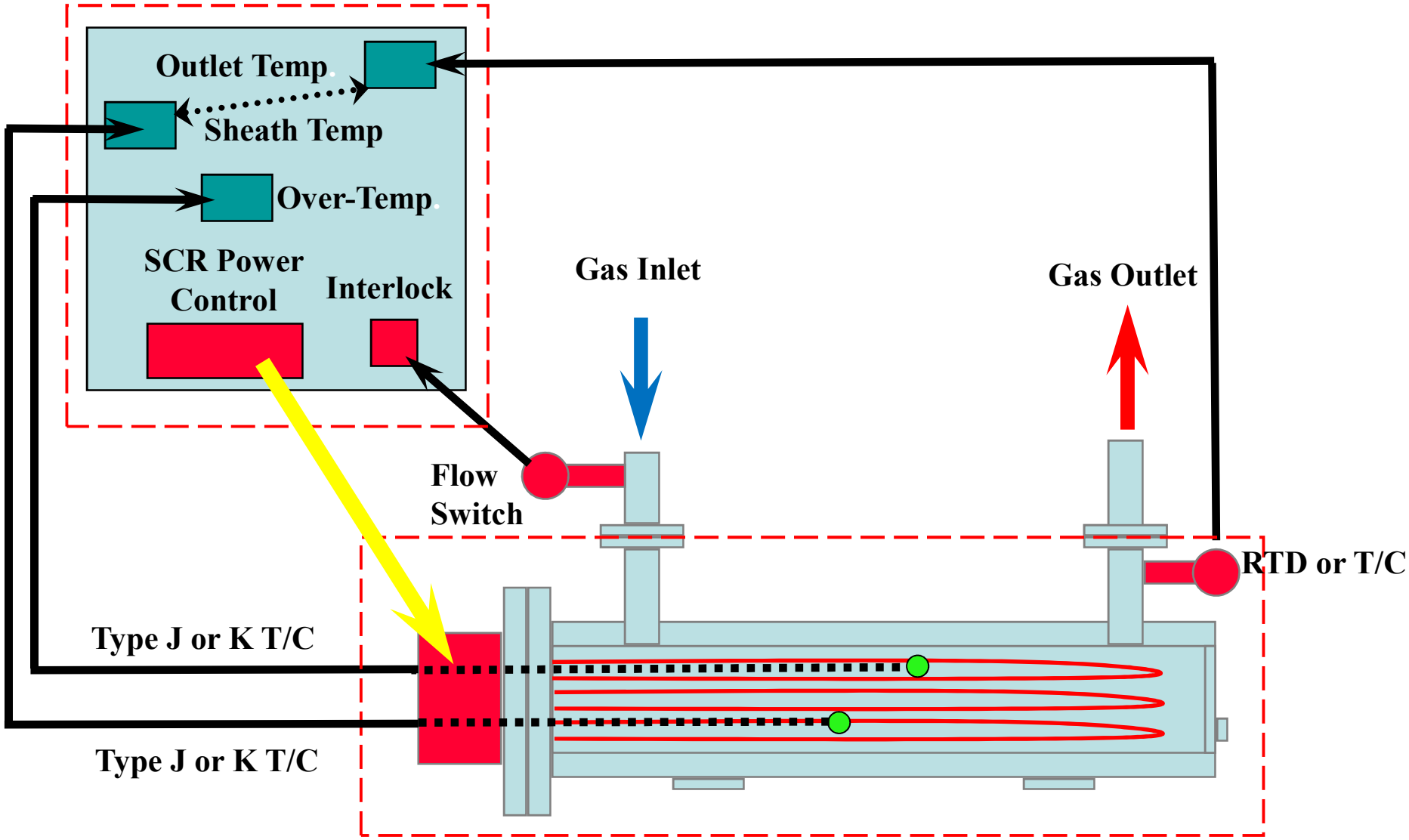
STANDARD CONTROL SCHEME FOR A PROCESS HEATER



DIFFERENTIAL CONTROL SCHEME FOR A PROCESS HEATER

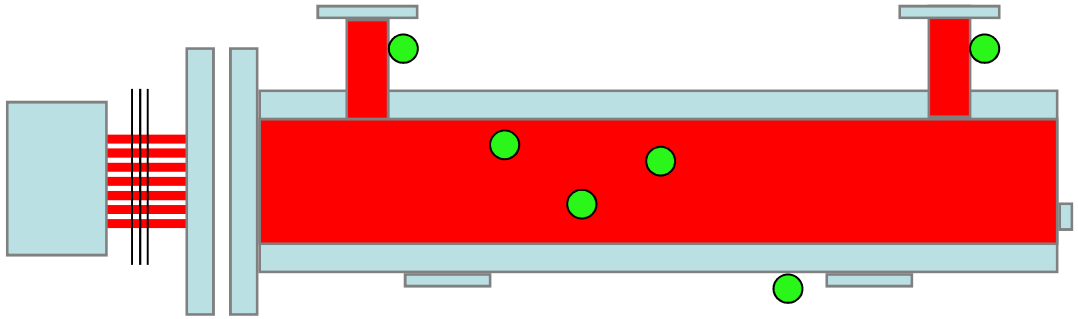


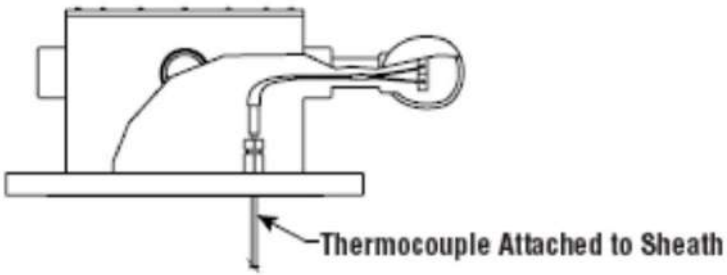
CASCADE CONTROL SCHEME FOR A PROCESS HEATER



Temperature Sensor Locations

- Outlet/Inlet
- Shell
- Heater Elements
- Heater Elements (multi)
- Terminal Box Standoffs
- Terminal Box Heater
- Heat Shields





Overheat Protection Thermocouple

CHROMALOX

Advanced Thermal Technologies

THANK YOU FOR ATTENDING!

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Advantages of EX 'd'

- Cost – The casting are a lower cost than fabricated boxes
- Weather Protection – The boxes maintain IP66 with rough handling and large cable bending moments
- Maintenance - Low Maintenance annual maintenance is recommended but essential after 2 years
- Protection Devices - Additional thermocouples or RTD's are not required for elements arranged on close centres
- Ambient Temp Range – Minus (-) 50° C to Plus (+) 60° C
- Certification - ATEX IEC Ex
  CENELEC CSA
  GOST R

Disadvantages of EX'd'

- Glandplates – The gland plate is an integral part of the casting limiting conductor bending and removal
- Volume – The box volume is restricted to contain any explosion this makes terminating large and or numerous cables difficult
- Single Core Cables – Cannot be used due to eddy currents being set up in magnetic material
- Weight – Cast iron enclosures are heavy and care is essential when handling
- Cast Iron Boxes – Unless maintained the enclosure and the entries will rust

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Advantages of EX'e'

- Weight – The enclosures are lighter being fabricated from 316L stainless steel sheet metal
- Glandplates – The enclosures have 2 removable gland plates in Stainless Steel or Brass
- Size & Volume – The largest enclosure is 1500mm x 1500mm and 2600kW
- Box Material – Stainless Steel 316L natural finish
- Ambient Temp Range – Minus (-) 50° C to Plus (+) 55° C
- Cables – Gland plate material is non-magnetic can use single core cables, Less restriction on cable

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Disadvantages of EX'e'

- Cost – The fabricated enclosure and copper busbar system make this design more costly
- Glandplates – Cables must have the bending moment removed to prevent box distortion and loss of weatherproof (IP66) seal
- Protection Devices – Close centre elements must have flange and terminal box devices and shutdown circuits
- Stand Off Distances – The larger enclosures need long up to 650mm for T1 applications
- Certification – Not available in CSA

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