CHROMALOX
*Advanced Thermal Technologies*

# DirectConnect™ MEDIUM VOLTAGE HEATING SYSTEMS

## REDUCE OPERATING AND INSTALLATION COSTS FOR LARGE HEATING DEMANDS IN HEAVY INDUSTRY

***Advanced thermal technology from the trusted industrial process heating experts.***

- Reduces or eliminates need for a dedicated step-down transformer
- Suitable for large heating demands in heavy industry
- Supplies exactly what is needed for the process
- Reduces amperage draw for same heat output
- Minimal maintenance, fast turnaround, minimal lost production
- Overall heating efficiency approaching 99%
- Offers precise temperature control to within 1°F
- Zero on-site emissions with electric heating
- Flameless heating offers clean operation
- Safe and reliable design backed by 100-year heating experience
- Significant installation, operation, and maintenance cost savings
- Significant savings in life cycle costs

## *Save with DirectConnect™ Medium Voltage Heating Systems*

***Now, for the first time ever, the benefits of low-voltage electric heating systems can be leveraged for much larger heavy-industry process heating demands through Chromalox® DirectConnect™ medium voltage technology. Benefits include overall heating efficiency, zero emissions, precise temperature control, clean operation, reduced risk, and the ability to supply exactly what is demanded by the process. Moreover, Chromalox DirectConnect™ medium voltage heating systems offer significant installation, operation, and maintenance cost savings. This advanced thermal technology is based on 100 years of Chromalox electric heat and control experience.***

### Low Cost of Ownership

Chromalox DirectConnect™ medium voltage (up to 7,200 V) electric systems slash installation and life cycle costs while providing emissions-free operation for process heating. By selecting medium voltage for heating applications greater than 1,000 kW (3.4 MMBtu/hour), industrial users will benefit from:

- Drastically lower installation costs
- Clean operation (zero local carbon emissions)
- Increased safety (no open flames)
- Stable electricity prices
- Minimal maintenance
- Precise temperature control

DirectConnect™ medium voltage electric heating systems are suitable for large heating demands in heavy industries such as power generation, oil and gas, petrochemical, and chemical. Typical process heating equipment includes in-line circulation systems, heat transfer packages, and steam boilers. Applications include anything from temperature maintenance to gas superheating and vaporization of virtually any water, oil, or liquid composition.

### No Pollution – No Open Flames

Fossil fuels have been traditionally used for applications with a large heating demand due to the existing infrastructure supplying heavy industry. But fossil fuels have become associated with increasing government emissions regulations, complex instrumentation, significant maintenance costs, increasing safety demands, and negative environmental concerns. For industrial heating equipment replacements and expansions, medium voltage electric heat offers an attractive emissions-free, environmentally friendly, and safe alternative to fuel-fired systems.

Chromalox DirectConnect™ systems provide a safe and reliable design utilizing metal-sheathed electric heating elements and advanced power controls that operate at medium voltages. Patented Chromalox

## PROJECT COST BREAKDOWN – 2,400 KW (8.2 MMBTU/HOUR)

| 480 V CONSTRUCTION - 24 CIRCUITS | |
|---|---|
| **Product** | |
| 2,400 kW Heater | $214,550 |
| Power Control Panel | $126,525 |
| Startup Service | $8,600 |
| Product Subtotal | $349,675 |
| **Installation** | |
| Transformer | $101,500 |
| 150 ft Run to Panel | $94,025 |
| 300 ft Run to Heater | $188,050 |
| 240 Labor Hours | $20,400 |
| Install Subtotal | $403,975 |
| | **$753,650** |

**TABLE 1**

| 4,160 V CONSTRUCTION - 2 CIRCUITS | |
|---|---|
| **Product** | |
| 2,400 kW Heater | $305,370 |
| Power Control Panel | $173,950 |
| Startup Service | $8,600 |
| Product Subtotal | $487,920 |
| **Installation** | |
| Transformer | $25,325 |
| 150 ft Run to Panel | $4,570 |
| 300 ft Run to Heater | $9,140 |
| 20 Labor Hours | $1,700 |
| Install Subtotal | $40,735 |
| | **$528,655** |

**TABLE 2**

DirectConnect™ medium voltage electric heating systems embody all the advantages of electric process heat while offering significant cost savings over low-voltage, high-amperage designs.

### Project Savings

When planning a new electric heating project, design engineers must consider three integral system components: the heater, the power control, and the installation. The installation requires transformers, wiring, terminations, conduit runs, hangers, wire pulls, and inspections. For a typical 2,400 kW (8.2 MMBtu/hr), 24-circuit project operating at 480 V, Table 1 shows the project costs, including installation. As indicated, installation cost easily exceeds that of the equipment and startup service, significantly increasing project cost.

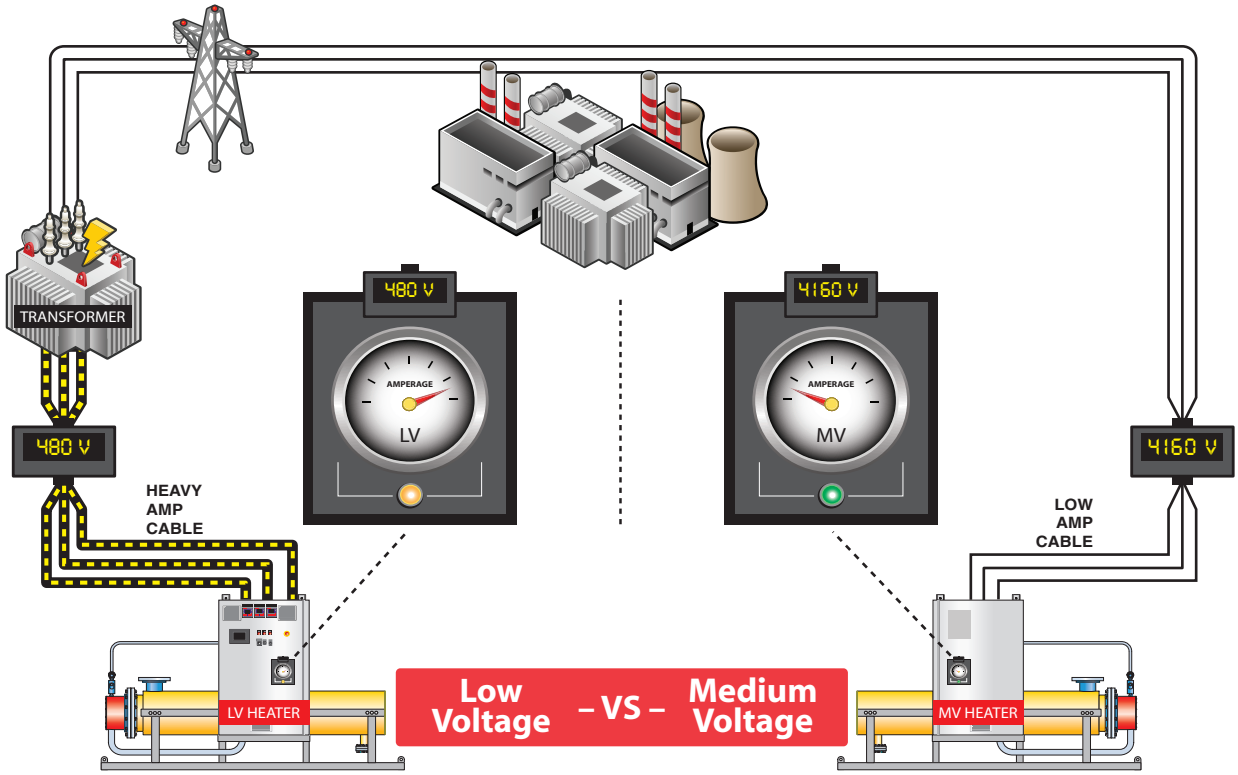
DirectConnect™ medium voltage technology operates process heating equipment directly from an existing distribution system up to 7,200 V. This reduces or eliminates the need for dedicated step-down transformers and complex wire runs. When operating multi-megawatt systems, this cost avoidance can be substantial. As shown in Table 2, project total cost savings are conservatively estimated to be $225,000.

### Reduced Amperage

Medium voltage technology for electric process heating drastically reduces the amperage draw for the same heat output. As the above tables show, operating process heating equipment at an industry standard 4,160 V reduces amperage by a factor of nine. Reduced amperage permits fewer wires with significantly smaller diameters compared to the 480 V source.

For example, converting from 480 V to 4,160 V for the same heating value decreases the number of circuits required from 24 to 2, greatly reducing wires, contactors, fusing, and installation labor. In this case, the installation costs are reduced by almost 90% compared to a 480 V system. Installation time would be reduced by an estimated 80%, allowing startup to occur in days rather than weeks.

# DIRECTCONNECT MEDIUM VOLTAGE HEATING COMPARED TO LOW VOLTAGE




## Fast Maintenance Turnaround

Electric heaters in heavy industry often operate in process-critical situations where downtime can cost hundreds of thousands of dollars or more each day. A system that incorporates replaceable medium voltage heating elements, like that designed by Chromalox, mitigates the risk of extended downtime. The end user can inventory a lower-cost set of DirectConnect™ spare elements rather than a costly spare bundle. Replaceable elements stored on-site enable quick replacement and return to service that can greatly reduce periods of downtime, decreasing the risk and cost of lost production.

## Operation and Maintenance Savings

Operating at medium voltages increases the efficiency of power distribution and consumption. A low-voltage system will operate at about 96% efficiency. Line losses come from heat generated by current transmission across wire, bussing, connections, and instrumentation (known as $I^2R$ losses). A multi-megawatt process heating system operating at 4,160 V and using the thyristor/SCR power control option maximizes efficiency to nearly 99%. That 3% improvement can translate into savings of hundreds of thousands of dollars over the equipment's lifetime. In the described example case, lifetime operating savings are estimated at more than $600,000, as shown in Table 3.

Routine inspections of electrical connections do help to ensure safety and maximize efficiency. Unlike heaters that are powered by fossil fuels, the major components of an electric process heater do not require daily maintenance and adjustments. The fact that medium voltage technology requires fewer wires and connections simplifies inspection time, further decreasing maintenance-associated costs.

Energy losses affecting efficiency are a function of amperage (the "I" in $I^2R$).

## ACCUMULATED SAVINGS

***Chromalox studies indicate that switching from 480 V to 4,160 V for a 2,400 kW (8.2 MMBtu/hr) electric heating system will produce savings that amount to more than $1 million over a 20-year span, or about $50,000 per year.***

| COST OF OWNERSHIP | 480 V | 4,160 V | SAVINGS |
|---|---|---|---|
| Installation | $753,650 | $528,655 | $224,995 |
| Operating | $873,940 | $240,800 | $633,140 |
| Maintenance | $61,200 | $10,200 | $51,000 |
| 10 yr Life Cycle Replacements | $163,655 | $69,500 | $94,155 |
| 20 Year Costs | $1,852,445 | $849,155 | $1,003,290 |
| Annualized Costs | $92,622 | $42,458 | $50,164 |

TABLE 3

## Patented Technology

As an industry leader in electric heating technology, Chromalox has submitted multiple patents worldwide for its advanced DirectConnect™ technology. These patents will add to the already long list of Chromalox patents obtained over the past century.

## Third-Party Certification

Chromalox is committed to providing the safest heating systems in the world. Our patented heaters and power control systems are tested and approved by independent, internationally recognized third-party laboratories like UL and ETL. This requires stringent testing. For example, every 7,200 V element must pass a minimum dielectric withstand test (hipot) of 18,200 V, and each panel carries a short circuit current rating of up to 50 kA.

Chromalox is the only third-party-certified manufacturer of medium voltage, metal-sheathed heating elements and medium voltage SCR control panels in the world.

## In-House Heater Production

Chromalox designs and manufactures all of the component parts in the heating systems that we sell. In-house manufacturing allows the most efficient, space-saving design possible. All welding, pressure-testing, and certification are performed in accordance with ASME, PED, and international standards. This provides our customers with consistent, long-lasting quality products that are tailored specifically to their unique applications, and optimized for reliable, cost-effective performance.

## In-House Control Panel Production

Chromalox also builds all of the associated power control panels that support the proprietary system. This in-house capability allows Chromalox to offer the ideal power and control logic package that best meets customer needs. Power control options, such as full contactor, full SCR, or contactor with SCR-trim load, provide an optimal balance between cost and performance. The control logic system safely manages all parameters and I/O functions gracefully. Critical control processes, such as soft starts and control around the setpoint, are efficiently managed.

DirectConnect™ Steam Superheater

DirectConnect™ Heat Transfer System

DirectConnect™ SCR Control Panel

DirectConnect™ Vaporizer

## Unmatched RedSage™ Engineering Capability

Over the past century, Chromalox has developed proprietary technologies and manufacturing systems that have created and supported the electric heating industry, while our engineers have designed electric heating solutions for countless industrial applications. Drawing upon this vast knowledge base, hundreds of thousands of designs on file, and industry-leading proprietary design software, Chromalox provides best-in-class products at the best value and in the shortest lead times. We call this knowledge base RedSage™. It brings together our institutional learning of nearly 100 years in a suite of process heating intelligence tools. RedSage™ provides design modeling and simulation for research and development, process and application design systems for estimating and quoting, product life cycle management, and product design systems to speed engineering-to-production hand-offs. Using our RedSage™ proprietary designs and tools during the design phase, Chromalox can quickly and nimbly address changing requirements.

## Site-Services Support through the Entire Product Life Cycle

Chromalox Service Solutions offer full support for Chromalox DirectConnect™ products to ensure optimal performance, directly extending product life. Service technicians are available any time, day or night, to assist with all process heating needs—from startup, training, and commissioning to scheduled maintenance visits and troubleshooting.

## The Chromalox Difference

Chromalox commitment to industrial heating innovation led to the development of DirectConnect™ products, made possible because of our wealth of experience and application knowledge. Chromalox is the world's leading advanced thermal technologies innovator since 1917. Founded by an engineering pioneer, Chromalox invented electric heating technology and created an entire industry. To put it simply, Chromalox has been doing it better and doing it longer than anyone else.

Our Heat Trace division delivers temperature management solutions for piping systems, valves, and tanks. Our Industrial Heaters and Systems division delivers process heating solutions for revenue generating industrial processes, and our Component Technologies division delivers component heating solutions for industrial equipment manufacturers. Chromalox partners with customers to provide the optimal electric heat and control solutions for their applications, solving even the most demanding and complex heating challenges. We meet high expectations with solutions designed to exceed specifications, limit risk, and operate within a defined budget. We do this while providing sustainable solutions that can be installed efficiently and require minimal design iterations. Drawing upon a century of experience, a global footprint, and the most comprehensive set of technologies in our industry, no thermal control project is too large or complex.

# CHROMALOX WORLDWIDE LOCATIONS


## Chromalox Headquarters

**103 Gamma Drive**
**Pittsburgh, PA 15238**
**USA**

**Phone: (412) 967-3800**
**Fax: (412) 967-5148**
**Toll-Free: 1-800-443-2640**

**email: sales@chromalox.com**
**www.chromalox.com**

| | | |
|---|---|---|
| **Canada** | Tel: 877-238-4754<br>Fax: 888-292-9607 | email: sales@chromalox.com<br>www.chromalox.com |
| **China** | Tel: +86 (0) 21-5866-8802<br>Fax: +86 (0) 21-5866-8803 | email: shanghai.office@chromalox.com<br>www.chromalox.cn |
| **France** | Tel: +33 (0) 3 23 74 39 39<br>Fax: +33 (0) 3 23 74 39 00 | email: ventes@chromalox.fr<br>www.chromalox.fr |
| **Germany** | Tel: +49 (0) 231-58 44 990-0<br>Fax: +49 (0) 231-58 44 990-9 | email: Kontakt@chromalox.com<br>www.chromalox.de |
| **Middle East** | Tel: +971 4 8879776<br>Fax: +971 4 8879793 | email: middle-eastsales@chromalox.com<br>www.chromalox.com |
| **India** | Tel: +91-11-25623134<br>Fax: +91-11-25623480 | email: indiasales@chromalox.com<br>www.chromalox.in |
| **Singapore** | Tel: +65 (0) 6339 1228<br>Fax: +65 (0) 6339 2648 | email: singaporesales@chromalox.com<br>www.chromalox.com |
| **Thailand** | Tel: +66 (0) 38 190916<br>Fax: +66 (0) 38 190919 | email: asiasales@chromalox.com<br>www.chromalox.com |
| **UK** | Tel: +44 (0) 20 8665 8900<br>Fax: +44 (0) 20 8689 0571 | email: uksales@chromalox.com<br>www.chromalox.co.uk |

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