

## Table of Contents

<b>Heat Loss Calculations &amp; Heater Selection .....</b>	<b>I-5-35</b>
<b>Determining Heat Energy Requirements .....</b>	<b>I-6-9</b>
Basic Heat Energy Equations .....	I-7
General Information .....	I-6
Total Energy Requirements .....	I-7
Typical Steps in Heat Loss Calculations .....	I-8
<b>Heat Loss Calculations &amp; Examples</b>	
Air & Gas Heating - Atmospheric Pressure .....	I-16
- Cryogenic Applications .....	I-20
- Oven Heating .....	I-20
- Pressure Drop for Process Air Heaters .....	I-20
- Pressurized with Circulation Heaters .....	I-22
- Strip and Finstrip® Heater Selection .....	I-17
Determining Maximum Sheath & Chamber Temperatures .....	I-22
Comfort Heating .....	I-12
Heat Exchangers - Heating & Cooling .....	I-27
Liquid Heating - General Applications .....	I-8
Oil Heating with Circulation Heaters .....	I-9
Pipe & Tank Tracing .....	I-11
Soft Metal Heating .....	I-9
Solids Heating - Platens, Dies & Molds .....	I-26
Steam Heating .....	I-23-25
Water Heating with Circulation Heaters .....	I-9
<b>Heat Transfer Fundamentals .....</b>	<b>I-5</b>
<b>Heater Selection Guidelines .....</b>	<b>I-13</b>
Air Heating Applications .....	I-16-22
Clamp-On Heating Applications .....	I-13
Liquid Heating Applications .....	I-14
Oil Heating Applications .....	I-15
<b>Radiant Infrared Heating .....</b>	<b>I-28-35</b>
Infrared Comfort Heating - Indoor & Outdoor .....	I-35
Infrared Source Evaluations .....	I-29
Infrared Theory .....	I-28
Process Heating Applications .....	I-30-34
Curing & Baking Applications .....	I-33
Drying Applications .....	I-32
Product Heating Applications .....	I-32
View Factors for Flat Panels .....	I-34
Radiant Oven Example .....	I-34
<b>Thermodynamic Properties - Terminology &amp; Constants .....</b>	<b>I-5</b>
<b>Watt Density Determination .....</b>	<b>I-13</b>
<b>Technical Information .....</b>	<b>I-36-39</b>
Electrical Fundamentals & Ohm's Law .....	I-36
Field Wiring - Size & Selection .....	I-39
Three Phase Wiring & Calculations .....	I-36-37
Wiring Diagrams & Methods .....	I-37
Wiring Practices for Electric Heaters .....	I-38

## Table of Contents *(cont'd.)*

<b>Reference Data</b> .....	<b>I-40-58</b>
<b>Corrosion Guidelines for Sheath Materials in Various Heated Media</b> .....	<b>I-48-54</b>
Types of Corrosion .....	I-48
Sheath Selection Process .....	I-48
Tables of Common Heated Media .....	I-49-54
<b>Engineering Constants &amp; Conversions</b> .....	<b>I-46-47</b>
<b>Hazardous Locations &amp; Chromalox Electric Heaters</b> .....	<b>I-56</b>
<b>Hazardous Locations &amp; Electric Heating Applications</b> .....	<b>I-57-58</b>
Classification & Groups .....	I-57
Division Locations .....	I-57
Temperature Ratings for Class I & II .....	I-58
<b>NEMA Electrical Enclosures &amp; Chromalox Equivalents</b> .....	<b>I-55</b>
<b>Physical &amp; Thermodynamic Properties of Materials</b> .....	<b>I-41-45</b>
Air - Dry .....	I-42
Air - Moist .....	I-42
Common Gases at Cryogenic Temperatures .....	I-43
Common Gases .....	I-43
Common Liquids .....	I-41
Metals - Liquid .....	I-44
Metals - Solid .....	I-44
Non-Metallic Solids .....	I-45
<b>Pipe Specifications</b> .....	<b>I-40</b>
<b>Pressure Conversions</b> .....	<b>I-46</b>
<b>Pressure-Temperature Ratings for Standard Catalog Heaters</b> .....	<b>I-40</b>
<b>Temperature Conversions</b> .....	<b>I-46</b>

### Graphs

Graph - GADHTB	ADH and ADHT Terminal Box Temperatures .....	I-21
- G100S	Strip Heater (Chrome Sheath) Air Heating .....	I-18
- G105S	Strip Heater Air Heating – Selection of Watt Density .....	I-17
- G106S	Finstrip® Heater Air Heating – Selection of Watt Density .....	I-17
- G107S	Finstrip® (Iron Sheath) Air Heating .....	I-18
- G108S	Finstrip® (Chrome Sheath) Air Heating .....	I-18
- G112S3	Air Heating – CAB and Finstrip® Pressure Drop Curves .....	I-21
- G114S	Heat Losses from Water Surfaces .....	I-10
- G122S	Surface Temperatures of Oil Immersion Blade Heaters .....	I-15
- G125S	Heat Losses from Uninsulated Surfaces .....	I-10
- G126S	Heat Losses from Insulated Surfaces .....	I-10
- G127S	Heat Losses from Oil & Paraffin Surfaces .....	I-10
- G128S	Heat Losses from Molten Metal Surfaces .....	I-10
- G130S	Clamp-On Strip Heaters .....	I-14
- G132S	Strip Heater (Iron Sheath) Air Heating .....	I-18
- G136S	Tubular Heater Air Heating .....	I-18
- G151-1	Fintube® & Tubular Air Heating (1 Fps) .....	I-19
- G152-1	Fintube® & Tubular Air Heating (4 Fps) .....	I-19
- G153-1	Fintube® & Tubular Air Heating (9 Fps) .....	I-19
- G154-1	Fintube® & Tubular Air Heating (16 Fps) .....	I-19
- G155-1	Fintube® & Tubular Air Heating (25 Fps) .....	I-19
- G156-1	Fintube® & Tubular Air Heating (36 Fps) .....	I-19
- G175S	Clamp-On Tubular Heaters .....	I-13
- G176S	Air Heating .....	I-16
- G189S1	Air Heating – Fintube® Pressure Drop Curves .....	I-21

## Table of Contents *(cont'd.)*

- G201	Cartridge - Suggested Watt Density Limits for Optimum Life .....	I-26
- G227-2	Air Heating - TDH Pressure Drop Curves .....	I-21
- G227ADH	Air Heating - ADH Pressure Drop Curves .....	I-21
- G235A	Cartridge - Maximum Watt Density vs. Platen Temperature .....	I-26
- G236	Circulation - Heat Required for Oil Heating .....	I-9
- G237	Circulation - Sheath Temperature vs. Mass Velocity .....	I-22

### Tables & Charts

<b>Air Heating</b>	- Booster Humidification Table .....	I-23
<b>Boilers</b>	- Feed Water Temperature vs. kW required per Lb/Steam .....	I-25
<b>Circulation Heaters</b>	- Free Internal Cross Sectional Area .....	I-22
	- Temperature Rise vs. Water Flow .....	I-9
<b>Clamp-On Heaters</b>	- Strip Heater Nomograph .....	I-14
<b>Comfort Heating</b>	- Comfort Heating Chart .....	I-12
<b>Heat Exchangers</b>	- Steam Pressure Factor .....	I-27
<b>Immersion Heating</b>	- Oil Heating Watt Density Guide .....	I-15
	- Suggested Allowable Watt Densities for Liquids .....	I-14
	- Typical Viscosities of Oils .....	I-15
	- Viscosity Conversion Chart .....	I-15
<b>Infrared Heating</b>	- Absorption Bands of Plastics .....	I-30
	- Approximate Emissivities of Various Surfaces .....	I-28
	- Characteristics of Infrared Sources .....	I-29
	- Estimating Infrared kW Requirements for Drying .....	I-32
	- Estimating Time/Temperature .....	I-30
	- Estimating Total kW for Product Heating .....	I-32
	- Estimating Watt Density Requirements for Curing or Baking .....	I-33
	- Intensity vs. Spacing - Point & Line Infrared Sources .....	I-33
	- Pattern Areas for Radiant Infrared Comfort Heating .....	I-35
	- Percent Increment Radiant Energy Output .....	I-29
	- Radiation Intensities .....	I-30
	- Spectral Distribution of Black Bodies .....	I-28
	- Time/Temperature Relationships .....	I-30
	- View Factor for Two Parallel Sources .....	I-34
<b>Pipe Tracing</b>	- Heat Losses from Metal Pipe Surfaces .....	I-11
	- Thermal Conductivity of Pipe Insulation .....	I-11
<b>Steam Heating</b>	- Saturated Steam Thermodynamic Properties .....	I-25
	- Superheating Steam Nomograph .....	I-24
<b>Tank Tracing</b>	- Heat Losses from Insulated Metal Tanks .....	I-11

**Note —** The facts and recommendations made in this publication are based on data assembled from various sources, our own research and the research of others. Although every attempt has been made to ensure accuracy, neither Chromalox nor the contributors to this publication assume responsibility for any inaccuracies or omissions in the data presented.

In addition, Chromalox and its representatives cannot anticipate all conditions under which the information contained herein, our products or our products in combination with products of other manufacturers may be used. Neither Chromalox nor its representatives accept responsibility for the results obtained by the application of the information contained herein or the safety or suitability of our products, either alone or in combination with other products. Users are advised to make their own tests and evaluations of the suitability and safety of each such product or product combination for their specific purposes.