



# **DESIGN GUIDE FOR FROST HEAVE PREVENTION**









# CHROMALOX OFFERS EASY-TO-INSTALL, ENERGY-EFFICIENT PRODUCTS FOR THE BUILDING AND CONSTRUCTION MARKET.

With thousands of products in stock and ready to ship, we can provide the perfect solution for your application. Our applications engineering team stands ready to help design a system that meets your specification, code approval, cost and installation schedule needs.

Our Frost Heave Prevention system is listed and approved to the latest IEEE 515.1 standard for installation of heating cable in conduit. Chromalox offers a variety of integrated technologies to meet all freezer frost heave prevention needs. Our Intellitrac line of controls provide monitoring and communication of the system to your building management system and provide years of trouble free, protection for your frost heave prevention system.

At Chromalox, our focus is on solving customer's problems quickly and economically, minimize energy use and maximize the useful life of the heating cable system.

## TABLE OF CONTENTS

### Introduction - Safety - Approvals

Page 4

### System Overview

Page 5

### System Components

Page 6

### Frost Heave Applications

Page 7

### Typical Applications

Page 7

### Frost Heave Install Guide

Page 8

### Design Step 1:

#### Project Information

Page 10

### Design Step 2:

#### Heat Trace Selection Tables

Page 10

### Design Step 3:

#### Determining Conduit Spacing and Heat Trace Load

Page 11

### Design Step 4:

#### Determining Heating Cable Layout and Length

Page 12

### Design Step 5:

#### Connection Kits

Page 15



## INTRODUCTION

Chromalox's Frost Heave Prevention Design Guide will assist the user with the proper selection of Chromalox heating cables, connection kits, controls and communication equipment. This design guide covers heating cables with a voltage range of 120-480V and for non-hazardous areas only. It does not assist with the design of the actual freezer itself. The user should consult a licensed professional for guidance on the design of the freezer. In addition to this design guide, the user should reference Chromalox's individual data sheets & installation instructions for further information on the products selected. All data sheets and installation instructions can be found on our website: [www.chromalox.com](http://www.chromalox.com).

## SAFETY

Chromalox recognizes that electrical safety is an important aspect of every project and we recommend that all of our installation instructions and warnings are followed during the design, installation & service of our heating cable systems. All final electrical connections should be performed by a licensed electrical contractor only. Chromalox installation instructions require power be disconnected to all heating cable systems & controls before installing or servicing the heating cable system. Failure to do so could result in personal injury or property damage. To minimize the danger of a fire from sustained electrical arcing if the heating cable system is damaged or if it has been improperly installed and to comply with agency certifications and National Electric Codes, Chromalox recommends ground fault equipment protection be installed on every heating cable circuit.

## APPROVAL

Chromalox frost heave prevention system is cCSAus listed for use in nonhazardous locations. Our frost heave prevention system has been tested to the requirements of the following standards:

- ▼ IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Industrial Applications, IEEE 515
- ▼ IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications, IEEE 515.1
- ▼ National Electrical Code, ANSI/NFPA 70
- ▼ CSA C22.2 No.130-16 Requirements for electrical resistance trace heating and heating device sets.



# CHROMALOX'S FROST HEAVE PREVENTION SYSTEM OVERVIEW

## DESCRIPTION

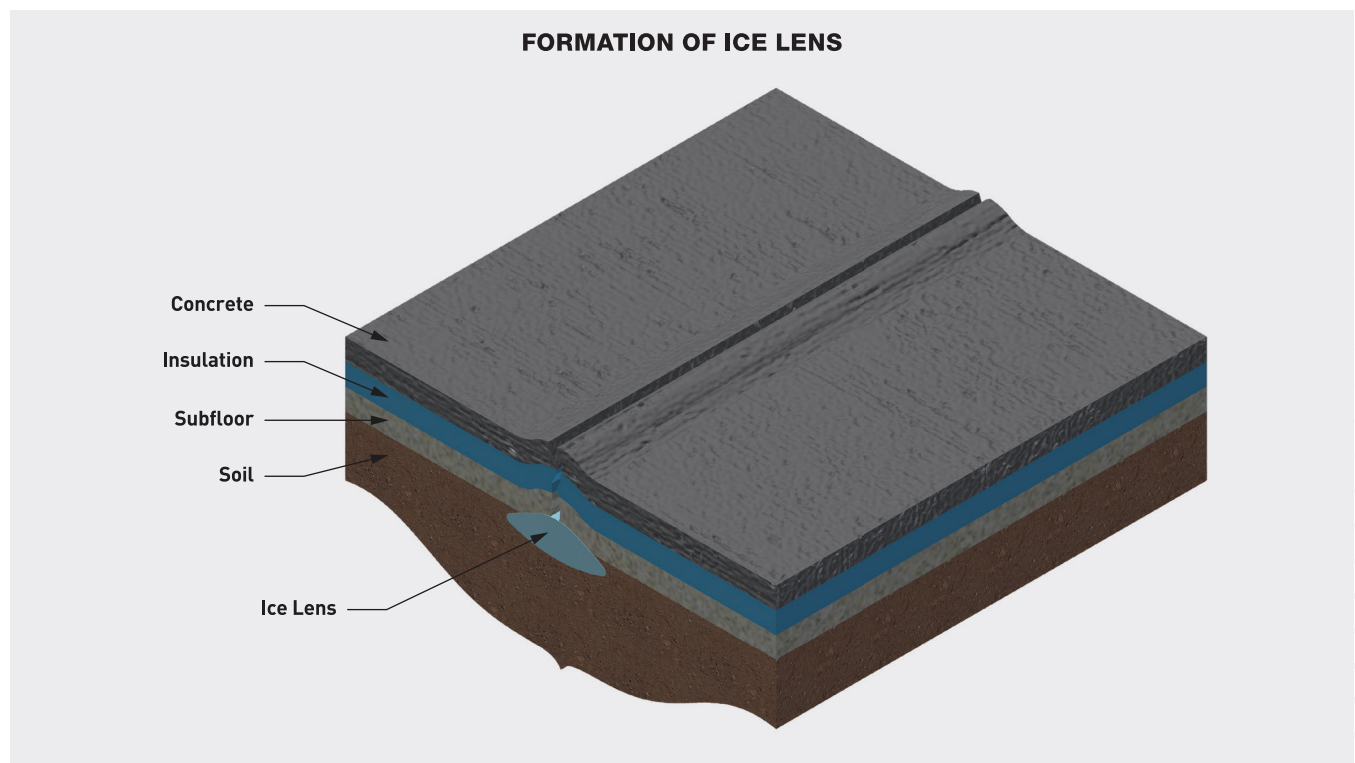
Subfreezing temperatures inside cold rooms, freezers, and ice arenas cause heat to be lost from the soil under the floor, even when it is well insulated. As the soil freezes, capillary action draws water into the frozen areas where the water forms a concentrated ice mass, known as an Ice Lens. As the Ice Lens grows, it heaves the freezer floor and columns, causing damage. Chromalox frost heave protection systems are designed to prevent an Ice Lens by keeping the soil underneath warm. The Chromalox frost heave prevention system is comprised of the following:

- ▽ Heating Cable (CPR, CZH, or CMI)
- ▽ EL Series Connection Accessories
- ▽ CTC or CIP Controls
- ▽ RTD Temperature Sensors

## CONTROLLERS & TEMPERATURE SENSORS

**If it is desired to control each circuit** in the frost heave protection system with individual controllers the IntelliTrace CTC series controller fits the application perfectly. The CTC is a compact single point commercial heating cable controller. It provides monitoring of 1 or 2 heating cable circuits for commercial heating cable applications. The CTC can be set up to monitor high and low temperature, high and low current, ground-fault, and sensor failure. The CTC also offers a wide range of communication protocols.

**If it is desired to control multiple circuits** in the frost heave protection system with a single controller the IntelliTrace CIP advanced heat trace control system fits the application perfectly. The CIP is a multi point electronic control and monitoring system for use in many commercial applications. It provides monitoring of 2 to 72 heating cable circuits for commercial heating cable applications. The CIP can be set up to monitor high and low temperature, high and low current, ground-fault, and sensor failure. The CIP also offers a wide range of communication protocols.





# SYSTEM COMPONENTS

## HEATING CABLE

### CPR SELF REGULATING CABLE

Chromalox's CPR Cable is designed to keep soil underneath cold rooms from freezing. Our CPR cable is constructed of a self-regulating polymer core that automatically & efficiently adjust its heat output to changes in soil temperature along the length of the conduit. Chromalox's CPR cable can be cut-to length to easily be pulled through conduit to protect soil from freezing temperatures. Chromalox's CPR Heating Cable is available in four watt densities - 3, 5, 8 & 10 watts/ft and is approved for installation inside of conduit. Chromalox's CPR Heating Cable is available for 120V or 208-277V and features 16 gauge copper bus wires to permit maximize circuit lengths. Our CPR Heating Cable is available with either a modified polyolefin or fluoropolymer jacket to protect the cables from abrasion and abuse.



### CZH CONSTANT WATTAGE CABLE

Chromalox CZH constant-wattage heating cable is a proven, reliable solution for frost heave prevention. CZH cable features a parallel heating core that produces uniform thermal output — over its entire length. It is flexible at most ambient temperatures and can be easily pulled through conduit. It is rugged, easy to monitor and maintain temperature, and has zero inrush at start-up. With a fluoropolymer electrical insulation over jacketing, CZH cable has out-standing electrical and thermal properties, and is well suited for frost heave prevention. An extensive range of wattages and voltages is available immediately from Chromalox stock.



### CMI HDPE JACKETED COPPER MI CABLE

Chromalox CMI cables are copper-sheathed, mineral insulated heating cables that are covered with an extruded high-density polyethylene (HDPE) jacket and are supplied as complete factory-assembled cables ready to connect to a junction box. The series-type technology, inherent to all mineral insulated heating cables, provides a reliable and consistent heat source that is ideal for frost heave prevention



## EL SERIES CONNECTION KITS

The EL Series connection kits and accessories, are designed to cover pipe and tank freeze protection and process maintenance in ordinary area and commercial applications. The kits are for use with Self Regulating cables. The connection kits and accessories are third party approved for ordinary areas and are designed for fast, easy installation and safe, reliable operation.







**WAREHOUSE FREEZER**



**BLAST FREEZER**

## TYPICAL APPLICATIONS



**COLD ROOMS**

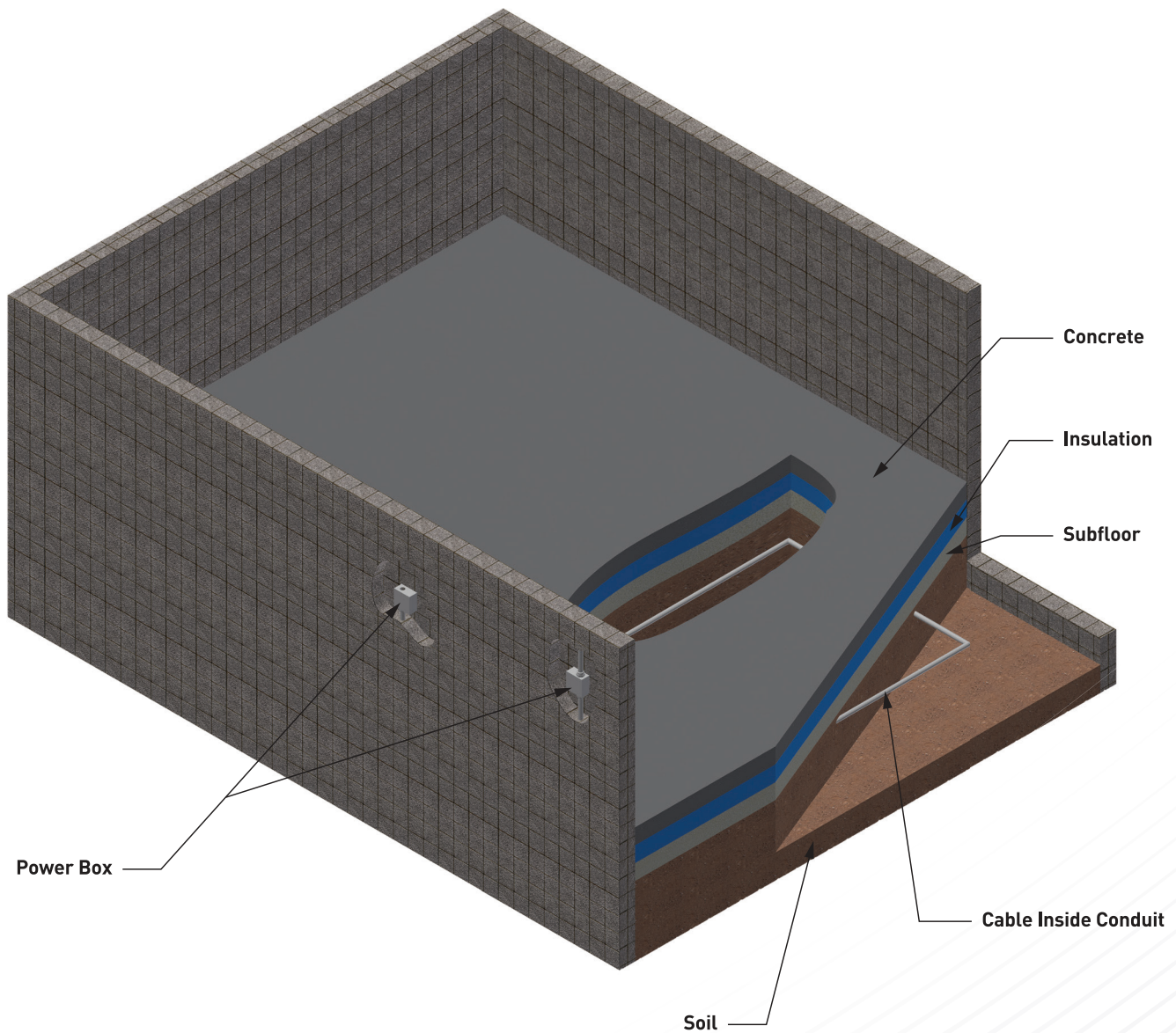


**ICE ARENAS**



## INSTALLATION GUIDE

*Install Guide is a specification tool only. Always refer to proper installation instructions when installing heat trace cable.*





## CONTROL SYSTEMS

### IntelliTrace



- ▽ Up to 72 Loops at 40 A/circuit
- ▽ Full monitoring, powerful sensor mapping, Modbus RS485 or Ethernet communications & supervisory control
- ▽ Extremely intuitive programming via large touch screen HMI, ordinary or hazardous (Division 2) areas

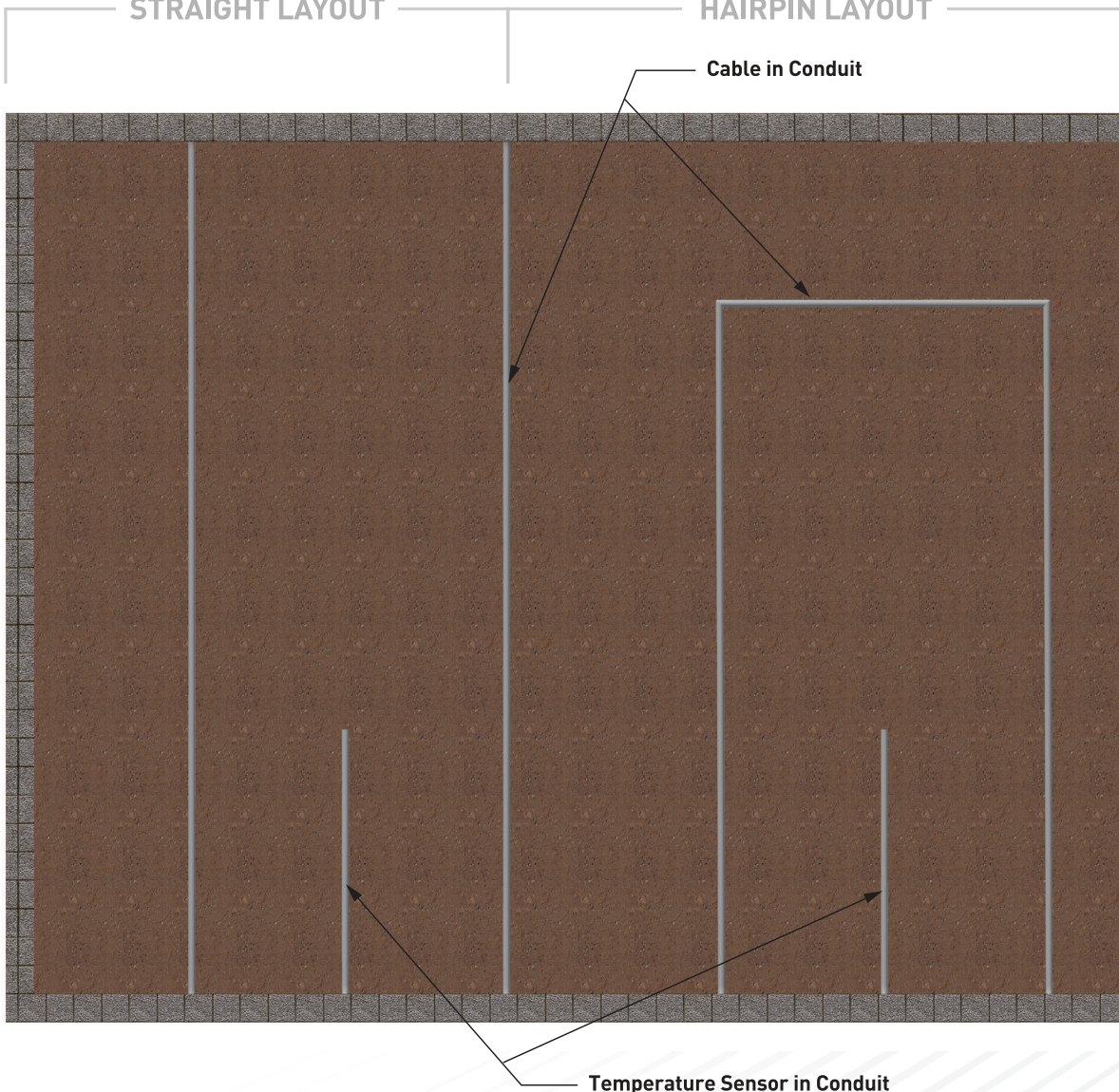


### CTC CONTROLLER

- ▽ 1 or 2 circuits, 40 A/circuit, SSR control
- ▽ Full monitoring, RS485 or Ethernet communications, up to 2 RTD inputs/circuit, soft start, alarms
- ▽ Bright display & easy to program, only 8x10x8 in./ 203x254x203mm, Division 2 hazardous area

## STRAIGHT LAYOUT

## HAIRPIN LAYOUT



Temperature Sensor in Conduit



# DESIGN STEP 1: PROJECT INFORMATION

**PROJECT DATA** *The first step in designing your frost heave prevention solution is to gather necessary project information which will enable you to select the system best suited for your application. The following information is needed to complete the system design.*

DESCRIPTION	VALUE	EXAMPLE
<b>Project Information</b>		
Name		Chromalox
Location		Nashville, TN
Area Classification		Non-Hazardous
Freezer or Ice Arena		
Length of Side A		40
Length of Side B		80
Operating Temperature		-20
<b>Insulation</b>		
Type		EPS
R-Value		40
<b>Electrical Information</b>		
Voltage		277V
Circuit Breaker Size		40A
Panel Location		Electrical Room
BMS Interface (Y/N)		Not Required
BMS Protocol		N/A

# DESIGN STEP 2: HEAT TRACE SELECTION TABLES

## HEAT TRACE SELECTION TABLE

*Select cable based on conduit type, installation method, and voltage supply.*

CABLE TYPE	CONDUIT TYPE	W/FT OUTPUT (IN CONDUIT)	VOLTAGE	INSTALLATION METHOD	LAYOUT TYPE
Self Regulating	Metal, Plastic	8(4)	120-277V	In Conduit	Straight or Hairpin
Constant Wattage	Meatal, Plastic	8	120-480V	In Conduit	Straight or Hairpin
Mineral Insulated	Metal	8	120-480V	In Conduit or Direct Bury	Straight

# DESIGN STEP 3: CONDUIT SPACING AND HEAT TRACE LOAD

## DETERMING TOTAL CONDUIT SPACING

1. Step 3 will determine the conduit spacing, and freezer loads for the Self-Regulating, Constant Wattage or MI heating cables . Use the freezer operating temperature and the floor insulation R-value to select the correct spacing shown in the table below. Using Table 4 and 5, calculate the total cable length required by combining the pipe length with the additional lengths needed for all of the other components.
2. If your calculated R-value or freezer operating temperature does not match the values in the table, use the values that give the closer spacing.
3. Within each cell in the table below there are two numbers: conduit spacing and freezer load. Freezer load is the additional cooling load imposed on the cooling system by the freezer frost heave prevention heating cable. It is the heat transferred through the insulation into the freezer, expressed in  $W/ft^2$  ( $W/m^2$ ) of floor area.

FREEZER OPERATING TEMPERATURE	CONDUIT SPACING AND FREEZER LOAD		FLOOR INSULATION R-VALUE (FT <sup>2</sup> ·°F·HR/BTU)			
			R-10	R-20	R-30	R-40
30°F (–1°C)	Conduit spacing	in (cm)	96 (244)	96 (244)	96 (244)	96 (244)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	0.7 (8)	0.4 (4)	0.3 (3)	0.2 (2)
20°F (–7°C)	Conduit spacing	in (cm)	81 (206)	96 (244)	96 (244)	96 (244)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	0.8 (9)	0.5 (5)	0.3 (3)	0.3 (3)
10°F (–12°C)	Conduit spacing	in (cm)	63 (160)	96 (244)	96 (244)	96 (244)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	1.0 (11)	0.6 (6)	0.4 (4)	0.3 (3)
0°F (–18°C)	Conduit spacing	in (cm)	51 (130)	84 (213)	96 (244)	96 (244)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	1.2 (13)	0.8 (9)	0.5 (5)	0.4 (4)
–10°F (–23°C)	Conduit spacing	in (cm)	42 (107)	72 (183)	96 (244)	96 (244)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	1.5 (16)	0.8 (9)	0.6 (6)	0.5 (5)
–20°F (–29°C)	Conduit spacing	in (cm)	36 (91)	63 (160)	87 (221)	96 (244)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	1.8 (19)	1.0 (11)	0.6 (6)	0.5 (5)
–30°F (–34°C)	Conduit spacing	in (cm)	33 (84)	57 (145)	78 (198)	93 (236)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	2.0 (22)	1.1 (12)	0.8 (9)	0.6 (6)
–40°F (–40°C)	Conduit spacing	in (cm)	30 (76)	51 (130)	69 (175)	84 (213)
	Freezer load	W/ft <sup>2</sup> (W/m <sup>2</sup> )	2.3 (25)	1.2 (13)	0.8 (9)	0.7 (8)



## DESIGN STEP 4: HEATING CABLE LAYOUT AND LENGTH

### DETERMING NUMBER OF CIRCUITS/CIRCUIT PROTECTION

1. To determine the number of conduit runs and heating cable length for your freezer or ice arena, refer to Install guide in the previous pages.
2. Define Side “**A**” as the side that is parallel to the conduit runs. Side “A” cannot be greater than the maximum circuit length for Self-regulating heating cable in table below.
3. Define Side “**B**” as the side that is perpendicular to the conduit runs.
4. Two basic types of heating cable layouts are used (refer to installation section of guide).
  - ▼ **A** The hairpin layout is used both in smaller freezers where it results in material and labor savings over the straight run layout, and in other freezers where only one wall of the freezer is accessible for mounting junction boxes.
  - ▼ **B** The straight run layout is used when the freezer dimension exceeds one-half the maximum heating cable circuit length (insufficient heating cable allowed for a run down and back).
5. Calculate the number of conduit runs as follows: (Side B(ft) x 12)/conduit spacing (from step 3) or (Side B(m) x 100)/conduit spacing (from step 3)
6. Round number of conduit runs to next highest whole number.
7. Determine heating cable length needed by taking Side A x number of conduit runs.
8. Take length needed + end allowances (from table below) + connection kit allowances (from tables on next page) to get your total heating cable length required.



## DESIGN STEP 4: HEATING CABLE LAYOUT AND LENGTH

ADDITIONAL CABLE LENGTH FOR FROST HEAVE PREVENTION			
Heating cable allowance	Description	Hairpin layout	Straight run layout
End allowances	From end of conduit to junction box	8 ft per hairpin conduit	8 ft per straight run conduit
Connection kit allowances	Required to assemble the connection kit	4 ft per kit	4 ft per kit

MAXIMUM SELF-REGULATING HEAT TRACE CIRCUIT LENGTH						
Cable Rating	40°F Start-Up (Ft.)			0°F Start-Up(Ft.)		
	20A	30A	40A	20A	30A	40A
CPR 8-1 CT	180	215	NR	145	215	NR
CPR 8-2 CT	330	420	NR	265	395	420
<b>NR = Not Required.</b> Maximum circuit length has been reached in a smaller breaker size. Note - Thermal magnetic circuit breakers are recommended since magnetic circuit breakers could "nuisance trip" at low temperature.						

MAXIMUM CONSTANT WATTAGE HEAT TRACE CIRCUIT LENGTH						
Cable Type/ Voltage	40°F Start-Up (Ft.)			0°F Start-Up(Ft.)		
	10A	20A	30A	10A	20A	30A
CZH 8-1CT	140	290	NR	140	290	NR
CZH 8-2CT	300	600	NR	300	600	420
<b>NR = Not Required.</b> Maximum circuit length has been reached in a smaller breaker size.						



## DESIGN STEP 4: HEATING CABLE LAYOUT AND LENGTH

### FOR SELF-REGULATING AND CONSTANT WATTAGE CABLES:

*After determining the approximate total length of heating cable, the number of circuits, and the junction box location, do a trial layout. In making the trial layout, follow these recommendations:*

- ▽ *Start and end each circuit in a junction box.*
- ▽ *Do not design more than one run of heating cable per conduit.*
- ▽ *Arrange the conduit so it uniformly covers the area to be heated.*
- ▽ *Maintain the design conduit spacing within 4 in (10 cm).*
- ▽ *Do not extend the heating cable beyond the room or area in which it originates.*
- ▽ *Do not cross expansion or other subfloor joints.*
- ▽ *Do not route the conduit closer than 4 in (10 cm) to the edge of the subfloor, drains, anchors, or other material in the concrete.*
- ▽ *Do not exceed the maximum circuit length allowed on a branch circuit breaker as given in table from design step 4*
- ▽ *The maximum length of heating cable that can be pulled through conduit is 500 feet (150 m). The maximum total degree of conduit turn is 360 degrees.*
- ▽ *When the combined lengths of two or more circuit runs are less than the maximum circuit length allowed, these runs can be combined in parallel on one circuit breaker.*

### FOR MINERAL INSULATED CABLES:

- ▽ *The conduits must be laid out in straight runs as shown in Installation section of this design guide*
- ▽ *Where cable lengths exceed 50 ft (15.2 m), the conduit must be accessible from both ends to allow long runs of cable to be pulled into the conduit.*
- ▽ *If it is necessary to stub-up the ends of the conduit, use a minimum 12 in (30 cm) radius in conduit bends*
- ▽ *Arrange the conduits so that they uniformly cover the area to be heated.*
- ▽ *Maintain the design conduit spacing within 4 in (10 cm).*
- ▽ *Do not cross expansion or other subfloor joints.*
- ▽ *Do not route the conduit closer than 4 in (10 cm) to the edge of the subfloor, drains, anchors, or other material in the concrete.*



# DESIGN STEP 5: CONNECTION KITS

## DETERMINE QUANTITY OF CONNECTION KITS & ACCESSORIES

1. *For Self-Regulating or Constant wattage heating cable systems, determine the number of junction boxes, power connections, end seals and splice kits required.*
  - ▼ *Hairpin and straight layouts have one junction box per conduit end as shown in the installation section of this manual.*
2. *For MI systems, determine the number of junction boxes required.*
  - ▼ *Straight run layout has one junction box per conduit run per the installation section of this manual.*
3. **Select Junction Box**
  - ▼ *For Self Regulating, Constant Wattage, and MI cable, use a UL Listed and/or CSA Certified junction box that is suitable for the location. Use a box with minimum internal volume of 16 cubic inches if the box is metallic and 19 cubic inches if the box is not metallic. Metal junction boxes are recommended for MI cable.*



**SCAN THE QR CODE TO EXPLORE OUR WORLDWIDE  
LOCATIONS AND FIND YOUR LOCAL SPECIALIST:**

[www.chromalox.com](http://www.chromalox.com) | [sales@chromalox.com](mailto:sales@chromalox.com)

