# CEMS Umbilical Overview

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# CEMS Umbilical Overview

## ❖ Topics

- Company background
- Purpose
- Types of Umbilicals
- Design Process
- Configurations
- Arrival Inspections
- Preinstall / Storage instructions
- Install Instructions
- Best Practices
- Finishing and Power up
- Permeation, Burn-in, and Flushing
- Maintenance
- Questions

# CEMS Umbilical Overview

## ❖ Company overview


Instrument Supports

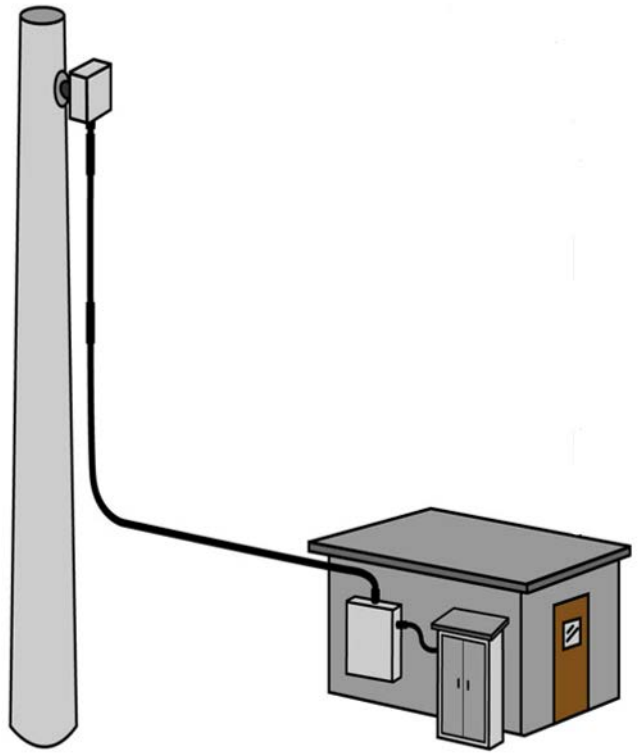
For over 50 years, O'Brien has been supplying the petrochemical, refining, pulp & paper, and power industries with quality products based on the application of our heat transfer expertise. Our recommendations and products reflect our knowledge of industry practices, regulations, and code requirements so you are assured of a complete solution for your specific application.

Product offering

- Tubing Bundle
  - TracePak and StackPak
  - Single and multi-jacketed tubing
  - Insulated tubing, PIT
  - Steam traced tubing
- Enclosures
  - ViPak, FlexPak, HeatPak, and Sunshades
- Instrument stands
  - SaddlePak

# CEMS Umbilical Overview

## ❖ Purpose



Purpose:

- Eliminate specification problems between components
- Single source responsibility for design, installation details and operation
- Properly sized and configured sample probe and sample transfer line
- Maintain consistent temperature profile in the heated sample line
- Reduce sample dew point with minimum loss to water soluble compounds
- Provide a properly conditioned sample at a stable dew point delivered to your analyzer from one source.

# CEMS Umbilical Overview

## ❖ Types of umbilicals

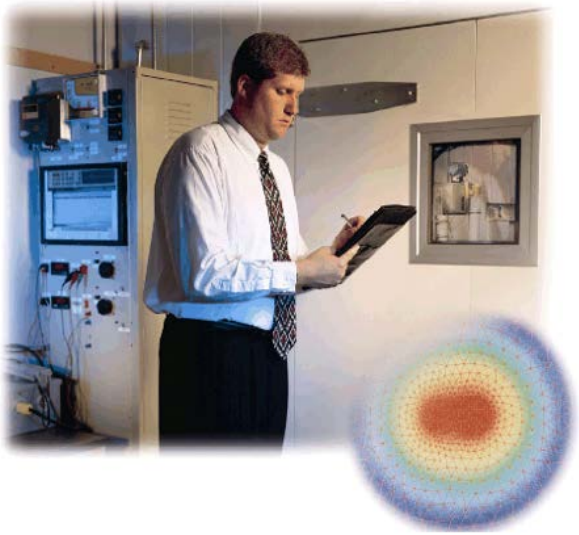
Below are the basic types of CEMS umbilicals with some typical configurations:

- Straight Extractive
  - Natural gas (simple or combined cycle)
  - 250F or greater maintain temperature
  - 1 heated tube / 2 unheated tubes (blowback/cal)
  - Messenger wires (heater/relays/solenoid valves/thermocouples)
- Dilution
  - Coal fired
  - Freeze protection only
  - 1 heated tube / 5 unheated tubes (blowback/cal/vacuum/air/fast loop)
  - Messenger wires (heater/relays/solenoid valves/thermocouples)
- Mercury CEMS
  - Coal fired
  - Originally 320F, then 250F, now as low as 120F maintain
  - 2-3 heated tubes / 3+ unheated tubes (blowback/cal/vacuum/etc)
  - Messenger wires (heater/relays/solenoid valves/thermocouples)

→ Most CEMS applications only require General Purpose electrical codes (not Div 2, etc)

# CEMS Umbilical Overview

## ❖ Design Process



O'Brien TracePak/StackPak design starts with input from the Customer:

- Ambient temperatures (high/low)
- Maintain temperature
- Maximum inlet temperature
- Operating voltage and circuit breaker sizing
- Heated process tubes (qty, size, metallugy, approval specs)
- Unheated calibration/misc tubes (qty, size, metallurgy, specs)
- Area approval requirements (Div 2, Zone 1, general, etc)
- Temperature control/monitoring equipment and method
- Run length(s)
- End preparation
- Jacket material and color
- Special printing on outer jacket

# CEMS Umbilical Overview

## ❖ Design Process

Tube size(s) and metallurgy is ultimately up to the customer to determine

Standard CEMS offerings:
- PFA Teflon
- 316/316L Stainless Steel

Other tubing available:
- FEP/PTFE
- Alloy 625
- Alloy 825
- Alloy 400
- Alloy C22/C276
- Copper
- Duplex/Super Duplex 2205/2507

Processes available on 316/316L:
- Chemical Passivation
- Passivation/SilcoNert
- ElectroPolishing
- EP/SilcoNert

# CEMS Umbilical Overview

## ❖ Design Process

O'Brien recommendations

Don't overinflate your maintain temperature requirement:

Higher maintains

Draw more current/power consumption
Larger/more expensive bundles
Require larger breakers
Shorter circuit lengths
Use more expensive tracers
Shorter life of tracer

Higher maintain/current draw/watt density

If using Teflon tubing for heated/process tubes:

Use the heaviest wall possible
Use the lowest maintain possible
All Teflon is porous, higher temperatures make the tubing more porous.
This may lead to more permeation/off-gassing issues

# CEMS Umbilical Overview

## ❖ Design Process

Electric Heat Trace

Tracer selection is based on the following criteria:

- Maintain temperature
- Exposure temperature
- Operating voltage
- Circuit length
- Cut-to-length requirements
- Electrical approvals

Common types of electric tracers:

- Self-Regulating
- Power-limiting
- Constant Power Density
- Series Resistance (M.I.)

# CEMS Umbilical Overview

## ❖ Design Process

<u>Self-Regulating Tracer</u>
Power output changes at the tracer heats up

Pros

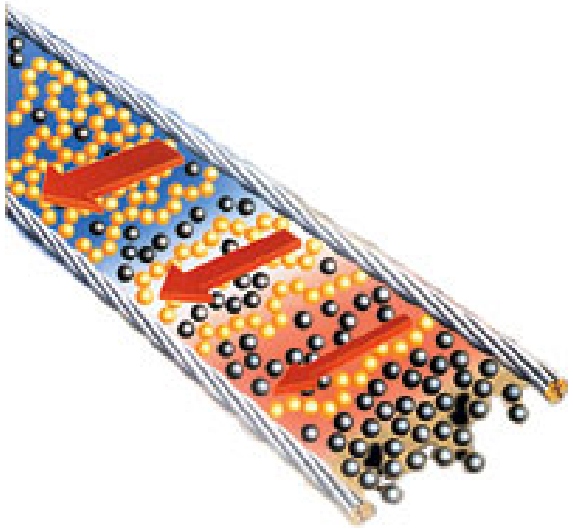
- Maintain temperatures up to 250F/121C
- Cut to length
- Some designs do not require temperature control
- Class 1, Div 2 approved (Div 1 option)
- Robust construction

Cons

- Inrush current on startup
- At higher maintains, output may not be enough

O'Brien examples:

- Raychem BTV, XTV, and HTV



# CEMS Umbilical Overview

## ❖ Design Process

How does self-regulating heat trace work?

Raychem self-regulating heating cables automatically adjust their power output to compensate for temperature changes.

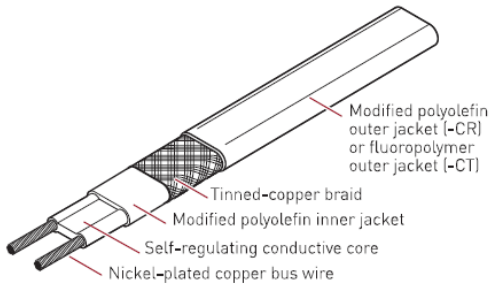
The outer jacket, braid and inner jacket provide mechanical, chemical and electrical protection... but the magic happens in the conductive core. The conductive core is extruded over the two, parallel conductors in our BTV and QTVR products or in the case of our XTV and KTV fiber heating cables is wrapped around the conductors.

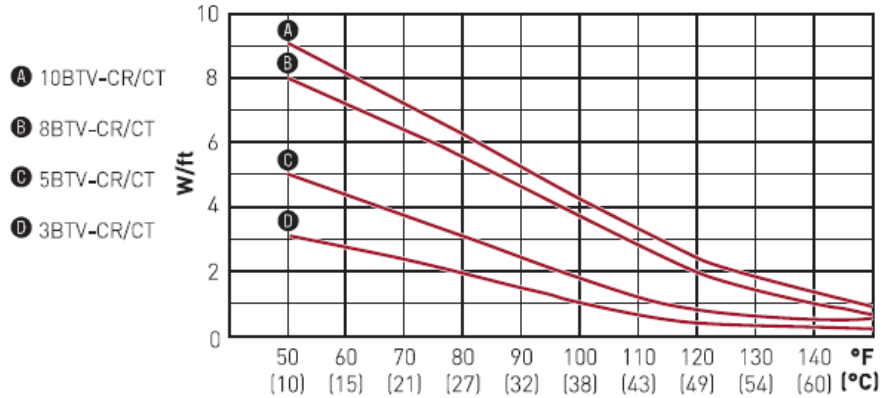
As the ambient temperature drops, the core contracts microscopically and the number of electrical paths through the core increases. More heat is produced. Conversely, as the ambient temperature rises, the core expands and has fewer electrical paths. Less heat is produced. A self-regulating heating cable adjusts its power output along its entire length. That's what makes it a safe and reliable solution for many applications.


# CEMS Umbilical Overview

## ❖ Design Process

**Raychem** BTV




| | |
|---|---|
| Maximum maintain or continuous exposure temperature (power on) | 150°F (65°C) |
| Maximum intermittent exposure temperature, 1000 hours (power on) | 185°F (85°C) |
| Minimum installation temperature | –40°F (–40°C) |

| | Adjustment factors | |
|---|---|---|
| | Power output | Circuit length |
| **208 V** | | |
| 3BTV2-CR/CT | 0.82 | 0.96 |
| 5BTV2-CR/CT | 0.85 | 0.94 |
| 8BTV2-CR/CT | 0.89 | 0.92 |
| 10BTV2-CR/CT | 0.89 | 0.92 |
| **277 V** | | |
| 3BTV2-CR/CT | 1.13 | 1.08 |
| 5BTV2-CR/CT | 1.12 | 1.09 |
| 8BTV2-CR/CT | 1.08 | 1.11 |
| 10BTV2-CR/CT | 1.08 | 1.11 |

**MAXIMUM CIRCUIT LENGTHS BASED ON CIRCUIT BREAKER SIZES**

| | Ambient temperature at start-up | | Maximum circuit length (in feet) per circuit breaker | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 120 V | | | | 240 V | | | |
| | | | 15 A | 20 A | 30 A | 40 A | 15 A | 20 A | 30 A | 40 A |
| **3BTV-CR/CT** | 50°F | (10°C) | 330 | 330 | 330 | 330 | 660 | 660 | 660 | 660 |
| | 0°F | (–18°C) | 200 | 265 | 330 | 330 | 395 | 530 | 660 | 660 |
| | –20°F | (–29°C) | 175 | 235 | 330 | 330 | 350 | 465 | 660 | 660 |
| | –40°F | (–40°C) | 155 | 205 | 310 | 330 | 310 | 410 | 620 | 660 |
| **5BTV-CR/CT** | 50°F | (10°C) | 230 | 270 | 270 | 270 | 460 | 540 | 540 | 540 |
| | 0°F | (–18°C) | 140 | 190 | 270 | 270 | 285 | 380 | 540 | 540 |
| | –20°F | (–29°C) | 125 | 165 | 250 | 270 | 250 | 330 | 500 | 540 |
| | –40°F | (–40°C) | 110 | 145 | 220 | 270 | 220 | 295 | 440 | 540 |
| **8BTV-CR/CT** | 50°F | (10°C) | 150 | 200 | 210 | 210 | 300 | 400 | 420 | 420 |
| | 0°F | (–18°C) | 100 | 130 | 200 | 210 | 200 | 265 | 400 | 420 |
| | –20°F | (–29°C) | 85 | 115 | 175 | 210 | 175 | 235 | 350 | 420 |
| | –40°F | (–40°C) | 80 | 105 | 155 | 210 | 155 | 210 | 315 | 420 |
| **10BTV-CR/CT** | 50°F | (10°C) | 120 | 160 | 180 | 180 | 240 | 315 | 360 | 360 |
| | 0°F | (–18°C) | 80 | 110 | 160 | 180 | 160 | 215 | 325 | 360 |
| | –20°F | (–29°C) | 70 | 95 | 140 | 180 | 145 | 190 | 285 | 360 |
| | –40°F | (–40°C) | 65 | 85 | 125 | 170 | 125 | 170 | 255 | 340 |

**IECEx** IECEx BAS 06.0043X
Ex e IIC T6 Gb
Ex tD A21 IP66 T80°C

[1] BTV-CR is not CSA Certified for Division 1
[2] BTV-CT only

**Hazardous Locations**

FM APPROVED — Class I, Div. 2, Groups A, B, C, D
Class II, Div. 2, Groups F, G
Class III

SP -W — Class I, Div. 1[1] & 2, Groups A, B, C, D
Class II, Div. 1[1] & 2, Groups E, F, G
Class III

BTV heating cables also have many other approvals, including Baseefa, PTB, DNV, and ABS.

**Zone Approvals**

FM APPROVED — CLI, ZN1, AEx e II T6

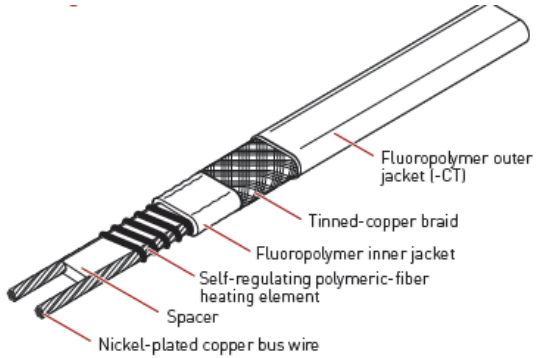
SP -W — Ex e II T6[2]

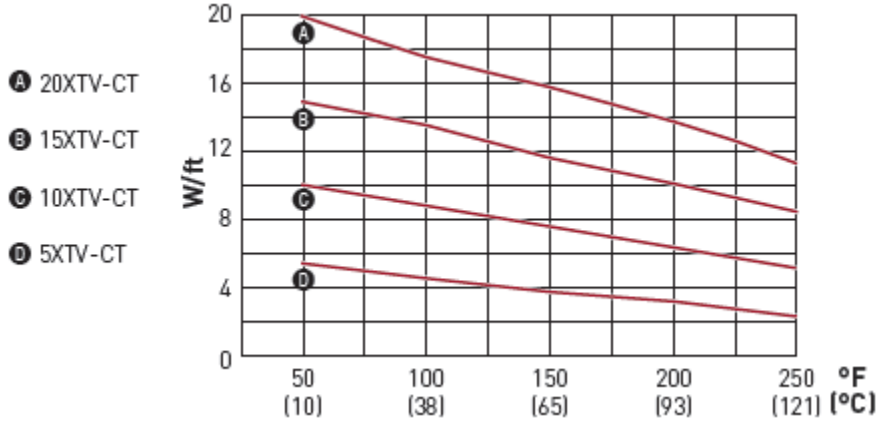
IEx — 09-IEx-0004X
Ex e IIC T6 Gb

# CEMS Umbilical Overview

## ❖ Design Process

**Raychem** XTV




| | |
|---|---|
| XTV1 | 100–130 Vac |
| XTV2 | 200–277 Vac |

| | |
|---|---|
| Maximum maintain or continuous exposure temperature (power on) | 250°F (121°C) |
| Maximum intermittent exposure temperature, 1000 hours (power on or off) | 482°F (250°C) |
| Minimum installation temperature | –40°F (–40°C) |

| | Adjustment factors | |
|---|---|---|
| | Power output | Circuit length |
| **208 V** | | |
| 5XTV2 | 0.87 | 0.99 |
| 10XTV2 | 0.88 | 0.99 |
| 15XTV2 | 0.88 | 0.98 |
| 20XTV2 | 0.86 | 1.00 |
| **277 V** | | |
| 5XTV2 | 1.07 | 1.08 |
| 10XTV2 | 1.08 | 1.06 |
| 15XTV2 | 1.08 | 1.06 |
| 20XTV2 | 1.07 | 1.08 |

| | Ambient temperature at start-up | | Maximum circuit length (in feet) per circuit breaker | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 120 V | | | | | 240 V | | | | |
| | | | 15 A | 20 A | 30 A | 40 A | 50 A | 15 A | 20 A | 30 A | 40 A | 50 A |
| **5XTV-CT** | 50°F | (10°C) | 180 | 240 | 360 | 385 | 385 | 360 | 480 | 720 | 765 | 765 |
| | 0°F | (–18°C) | 160 | 210 | 320 | 385 | 385 | 315 | 420 | 625 | 765 | 765 |
| | –20°F | (–29°C) | 150 | 200 | 305 | 385 | 385 | 295 | 395 | 595 | 765 | 765 |
| | –40°F | (–40°C) | 145 | 195 | 290 | 385 | 385 | 285 | 380 | 570 | 760 | 765 |
| **10XTV-CT** | 50°F | (10°C) | 110 | 145 | 220 | 270 | 270 | 220 | 295 | 440 | 540 | 540 |
| | 0°F | (–18°C) | 95 | 130 | 195 | 260 | 270 | 195 | 260 | 385 | 515 | 540 |
| | –20°F | (–29°C) | 95 | 125 | 190 | 250 | 270 | 185 | 245 | 370 | 495 | 540 |
| | –40°F | (–40°C) | 90 | 120 | 180 | 240 | 270 | 175 | 235 | 355 | 470 | 540 |
| **15XTV-CT** | 50°F | (10°C) | 75 | 100 | 150 | 200 | 220 | 150 | 200 | 300 | 400 | 445 |
| | 0°F | (–18°C) | 65 | 90 | 135 | 180 | 220 | 130 | 175 | 265 | 355 | 440 |
| | –20°F | (–29°C) | 65 | 85 | 130 | 170 | 215 | 125 | 165 | 250 | 335 | 420 |
| | –40°F | (–40°C) | 60 | 80 | 125 | 165 | 205 | 120 | 160 | 240 | 320 | 405 |
| **20XTV-CT** | 50°F | (10°C) | 60 | 80 | 120 | 160 | 190 | 115 | 150 | 230 | 305 | 380 |
| | 0°F | (–18°C) | 50 | 70 | 105 | 140 | 180 | 100 | 135 | 205 | 275 | 345 |
| | –20°F | (–29°C) | 50 | 65 | 100 | 135 | 170 | 100 | 130 | 200 | 265 | 330 |
| | –40°F | (–40°C) | 50 | 65 | 100 | 130 | 165 | 95 | 125 | 190 | 255 | 320 |

**IECEx**
IECEx BAS 06.0044X
Ex e IIC T* Gb
Ex tD A21 IP66 T**°C

(1) Applications must be reviewed by the manufacturer.
(2) For maximum surface temperature, see heating cable, design documentation or schedule

**Hazardous Locations**

Class I, Div. 2, Groups A, B, C, D
Class II[1], Div. 2, Groups F, G
Class III[1]

Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

XTV heating cables also have many other approvals, including Baseefa, PTB, DNV, and ABS.

**Zone Approvals**

CLI, ZN1, AEx e II T3 (T2)

Ex e II T3 (T2)

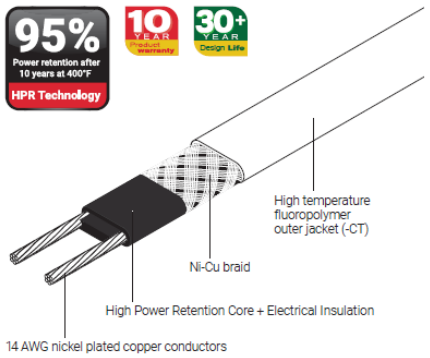
09-IEx-0005X
Ex e IIC T* Gb

# CEMS Umbilical Overview

## ❖ Design Process

nVent RAYCHEM

HTV




| | |
|---|---|
| HTV1 | 100–130 Vac |
| HTV2 | 200–277 Vac |

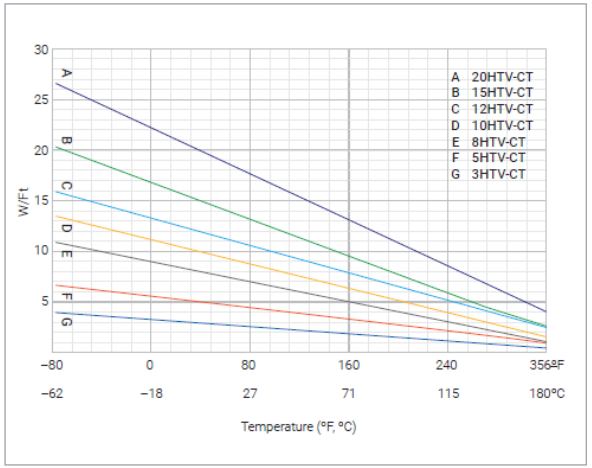
| | |
|---|---|
| Maximum maintain or continuous operating temperature (power on) | 400°F (205°C) |
| Maximum intermittent exposure temperature (power on/off) | 500°F (260°C) for 2000 hours cumulative. Longer durations allowed between 500°F (260°C) and 400°F (205°C) |
| Minimum installation temperature | –76°F(–60°C) |

For HTV Cable

Class I Division 1 (Zone 1*), Groups A, B, C, D Class I Zone 1 Group IIC Class II/III Division 1 (Zone 21*) Groups E, F, G Zone 21 IIIC
Class I Division 2 (Zone 2*), Groups A, B, C, D Class I Zone 2 Group IIC Class II/III Division 2 (Zone 22*) Groups F, G Zone 22 IIIB
-WS for Canada * Per CE Code Table 18

IECEx PTB 21.0007X
Ex 60079-30-1 IIC T3...T2 Gb
Ex 60079-30-1 IIIC T3...T2 Db
System's hazardous area location rating and ambient temperature range depend on the connection kits used (see schedule).

| | Adjustment factors | |
|---|---|---|
| | Power Output | Circuit Length |
| **208V** | | |
| 3HTV2-CT | 0.85 | 0.94 |
| 5HTV2-CT | 0.87 | 0.93 |
| 8HTV2-CT | 0.88 | 0.93 |
| 10HTV2-CT | 0.88 | 0.93 |
| 12HTV2-CT | 0.88 | 0.93 |
| 15HTV2-CT | 0.91 | 0.92 |
| 20HTV2-CT | 0.92 | 0.92 |
| **277** | | |
| 3HTV2-CT | 1.10 | 1.10 |
| 5HTV2-CT | 1.08 | 1.11 |
| 8HTV2-CT | 1.06 | 1.12 |
| 10HTV2-CT | 1.08 | 1.10 |
| 12HTV2-CT | 1.08 | 1.11 |
| 15HTV2-CT | 1.05 | 1.09 |
| 20HTV2-CT | 1.04 | 1.10 |




| | Ambient temperature at start-up | | Maximum circuit length (in feet) per circuit breaker | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 120 V | | | | | 240 V | | | | |
| | °F | °C | 15 A | 20 A | 30 A | 40 A | 50 A | 15 A | 20 A | 30 A | 40 A | 50 A |
| 3HTV-CT | 50 | 10 | 241 | 322 | 482 | 485 | 485 | 482 | 643 | 964 | 978 | 978 |
| | 0 | –18 | 213 | 284 | 426 | 485 | 485 | 415 | 554 | 831 | 978 | 978 |
| | –20 | –29 | 203 | 271 | 407 | 485 | 485 | 395 | 527 | 791 | 978 | 978 |
| | –40 | –40 | 195 | 260 | 390 | 485 | 485 | 378 | 504 | 756 | 978 | 978 |
| 5HTV-CT | 50 | 10 | 180 | 240 | 360 | 372 | 372 | 360 | 480 | 720 | 751 | 751 |
| | 0 | –18 | 157 | 209 | 314 | 372 | 372 | 314 | 418 | 627 | 751 | 751 |
| | –20 | –29 | 151 | 201 | 302 | 372 | 372 | 299 | 398 | 598 | 751 | 751 |
| | –40 | –40 | 145 | 194 | 291 | 372 | 372 | 285 | 380 | 571 | 751 | 751 |
| 8HTV-CT | 50 | 10 | 131 | 174 | 261 | 289 | 289 | 261 | 348 | 523 | 581 | 581 |
| | 0 | –18 | 113 | 151 | 227 | 289 | 289 | 229 | 305 | 457 | 581 | 581 |
| | –20 | –29 | 108 | 144 | 216 | 288 | 289 | 218 | 291 | 437 | 581 | 581 |
| | –40 | –40 | 103 | 138 | 207 | 276 | 289 | 209 | 278 | 418 | 557 | 581 |
| 10HTV-CT | 50 | 10 | 111 | 148 | 221 | 254 | 254 | 221 | 296 | 443 | 508 | 508 |
| | 0 | –18 | 97 | 130 | 195 | 254 | 254 | 196 | 261 | 392 | 508 | 508 |
| | –20 | –29 | 93 | 124 | 185 | 247 | 254 | 187 | 249 | 374 | 498 | 508 |
| | –40 | –40 | 89 | 118 | 177 | 236 | 254 | 178 | 238 | 357 | 476 | 508 |
| 12HTV-CT | 50 | 10 | 96 | 128 | 192 | 226 | 226 | 192 | 256 | 384 | 462 | 462 |
| | 0 | –18 | 85 | 114 | 171 | 226 | 226 | 167 | 223 | 335 | 446 | 462 |
| | –20 | –29 | 81 | 109 | 163 | 217 | 226 | 160 | 213 | 319 | 426 | 462 |
| | –40 | –40 | 78 | 104 | 156 | 207 | 226 | 153 | 204 | 305 | 407 | 462 |
| 15HTV-CT | 50 | 10 | 75 | 101 | 151 | 201 | 201 | 151 | 202 | 302 | 400 | 400 |
| | 0 | –18 | 67 | 89 | 133 | 177 | 201 | 132 | 176 | 264 | 352 | 400 |
| | –20 | –29 | 63 | 84 | 127 | 169 | 201 | 126 | 168 | 252 | 336 | 397 |
| | –40 | –40 | 60 | 80 | 121 | 161 | 193 | 120 | 160 | 240 | 320 | 381 |
| 20HTV-CT | 50 | 10 | 60 | 80 | 120 | 160 | 169 | 115 | 154 | 230 | 307 | 330 |
| | 0 | –18 | 53 | 71 | 106 | 141 | 155 | 101 | 135 | 203 | 271 | 294 |
| | –20 | –29 | 51 | 68 | 101 | 135 | 149 | 97 | 129 | 194 | 259 | 283 |
| | –40 | –40 | 49 | 65 | 97 | 130 | 144 | 93 | 124 | 186 | 248 | 273 |

# CEMS Umbilical Overview

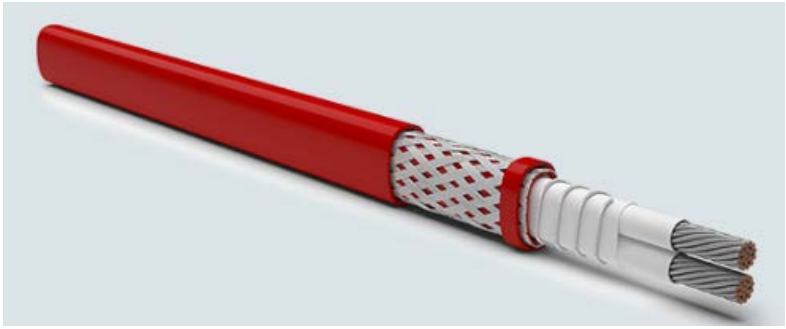
## ❖ Design Process

Power-Limiting Tracer
Power output changes at the tracer heats up

Pros
- Maintain temperatures up to 455F/230C
- Cut to length but zones must be respected
- Class 1 Div 2 approved

Cons
- Zones can be damaged
- Inrush current on startup but less than BTV and XTV
- At higher maintains, output may not be enough
- Expensive

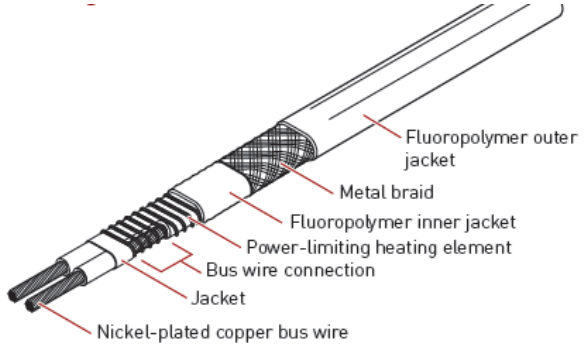
O'Brien examples:
- Raychem VPL



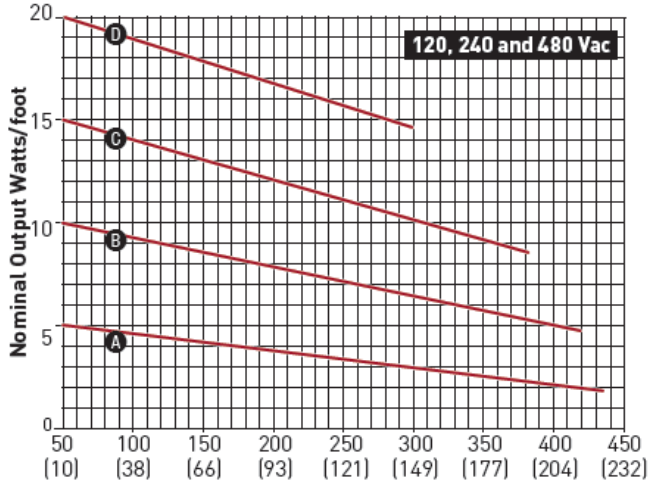
# CEMS Umbilical Overview

## ❖ Design Process

**Raychem** VPL




| | Adjustment factors | |
|---|---|---|
| | Power output | Circuit length |
| **208 V** | | |
| 5VPL2-CT | 0.77 | 0.89 |
| 10VPL2-CT | 0.78 | 0.90 |
| 15VPL2-CT | 0.79 | 0.91 |
| 20VPL2-CT | 0.80 | 0.92 |
| **277 V** | | |
| 5VPL2-CT | 1.30 | 1.13 |
| 10VPL2-CT | 1.28 | 1.11 |
| 15VPL2-CT | 1.26 | 1.09 |
| 20VPL2-CT | Not allowed | |




| | |
|---|---|
| Maximum exposure temperature (power off) | 500°F (260°C) |
| Minimum installation temperature | –40°F (–40°C) |

**Maximum continuous maintain (power on) temperature table**

| Cable | 120 V | 208 V | 230 V | 240 V | 277 V |
|---|---|---|---|---|---|
| 5VPL1-CT | 445°F (230°C) | – | – | – | – |
| 10VPL1-CT | 400°F (205°C) | – | – | – | – |
| 15VPL1-CT | 335°F (170°C) | – | – | – | – |
| 20VPL1-CT | 300°F (150°C) | – | – | – | – |
| 5VPL2-CT | – | 455°F (235°C) | 445°F (230°C) | 445°F (230°C) | 435°F (225°C) |
| 10VPL2-CT | – | 425°F (220°C) | 410°F (210°C) | 400°F (205°C) | 390°F (200°C) |
| 15VPL2-CT | – | 410°F (210°C) | 375°F (190°C) | 335°F (170°C) | 240°F (115°C) |
| 20 VPL2-CT | – | 300°F (150°C) | 300°F (150°C) | 300°F (150°C) | – |
| 5VPL4-CT | – | – | – | – | – |
| 10VPL4-CT | – | – | – | – | – |
| 15VPL4-CT | – | – | – | – | – |
| 20VPL4-CT | – | – | | | |

| | Ambient temperature at start-up | Maximum circuit length (in feet) per circuit breaker | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 120 V | | | | | 240 V | | | | | 480 V | | | | |
| | | 15 A | 20 A | 30 A | 40 A | 50 A | 15 A | 20 A | 30 A | 40 A | 50 A | 15 A | 20 A | 30 A | 40 A | 50 A |
| **5VPL-CT** | 50°F (10°C) | 260 | 350 | 370 | 370 | 370 | 525 | 685 | 740 | 740 | 740 | 1050 | 1370 | 1480 | 1480 | 1480 |
| | 0°F (–18°C) | 240 | 325 | 370 | 370 | 370 | 485 | 645 | 740 | 740 | 740 | 970 | 1290 | 1480 | 1480 | 1480 |
| | –20°F (–29°C) | 235 | 315 | 370 | 370 | 370 | 470 | 625 | 740 | 740 | 740 | 940 | 1250 | 1480 | 1480 | 1480 |
| | –40°F (–40°C) | 225 | 305 | 370 | 370 | 370 | 455 | 610 | 740 | 740 | 740 | 910 | 1220 | 1480 | 1480 | 1480 |
| **10VPL-CT** | 50°F (10°C) | 130 | 175 | 260 | 260 | 260 | 260 | 350 | 525 | 525 | 525 | 520 | 700 | 1050 | 1050 | 1050 |
| | 0°F (–18°C) | 120 | 165 | 245 | 260 | 260 | 245 | 325 | 490 | 525 | 525 | 490 | 650 | 980 | 1050 | 1050 |
| | –20°F (–29°C) | 120 | 160 | 240 | 260 | 260 | 235 | 315 | 475 | 525 | 525 | 470 | 630 | 950 | 1050 | 1050 |
| | –40°F (–40°C) | 115 | 155 | 230 | 260 | 260 | 230 | 310 | 465 | 525 | 525 | 460 | 620 | 930 | 1050 | 1050 |
| **15VPL-CT** | 50°F (10°C) | 85 | 115 | 175 | 215 | 215 | 175 | 230 | 350 | 430 | 430 | 350 | 460 | 700 | 860 | 860 |
| | 0°F (–18°C) | 80 | 110 | 165 | 215 | 215 | 165 | 220 | 325 | 430 | 430 | 330 | 440 | 650 | 860 | 860 |
| | –20°F (–29°C) | 80 | 105 | 160 | 215 | 215 | 160 | 215 | 320 | 425 | 430 | 320 | 430 | 640 | 850 | 860 |
| | –40°F (–40°C) | 75 | 100 | 155 | 210 | 215 | 155 | 210 | 310 | 415 | 430 | 310 | 420 | 620 | 830 | 860 |
| **20VPL-CT** | 50°F (10°C) | 65 | 85 | 130 | 175 | 185 | 130 | 175 | 260 | 350 | 370 | 260 | 350 | 520 | 700 | 740 |
| | 0°F (–18°C) | 60 | 85 | 125 | 165 | 185 | 125 | 165 | 250 | 330 | 370 | 250 | 330 | 500 | 660 | 740 |
| | –20°F (–29°C) | 60 | 80 | 120 | 160 | 185 | 120 | 160 | 245 | 325 | 370 | 240 | 320 | 490 | 650 | 740 |
| | –40°F (–40°C) | 60 | 80 | 120 | 160 | 185 | 115 | 155 | 240 | 320 | 370 | 230 | 310 | 480 | 640 | 740 |

**Hazardous Locations**

**IECEx**
IECEx BAS 06.0048X
Ex e IIC T* Gb
Ex tD A21 IP66 T***°C

(1) For maximum surface temperature, see heating cable, design documentation or

Class I, Div. 2, Groups B, C, D
Class II, Div. 2, Groups F, G
Class III
T-class by design

09-IEx-0007X
Ex e IIC T* Gb

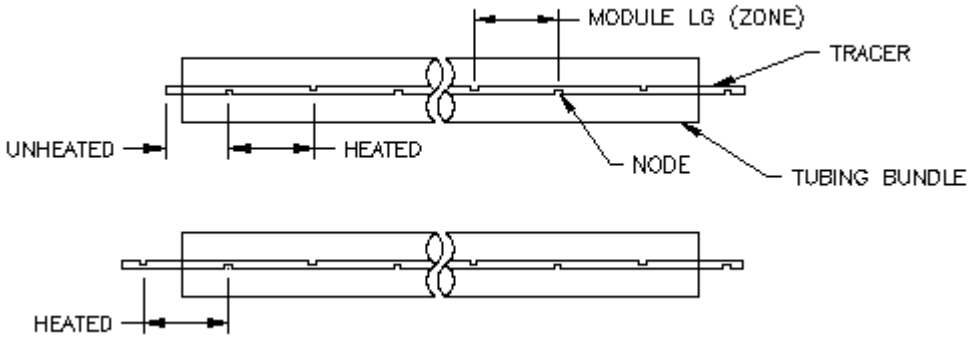
-W
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Ex e II T*
*T-class by design

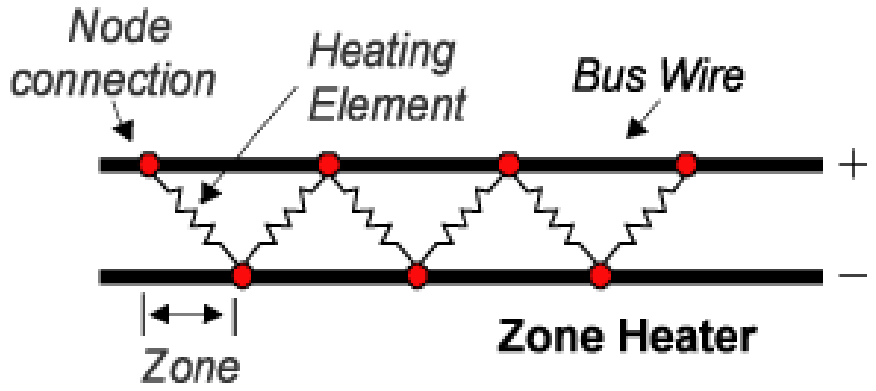
# CEMS Umbilical Overview

## ❖ Design Process

VPL zone diagram

| Voltage | 5 W/ft | 10 W/ft | 15 W/ft | 20 W/ft |
|---|---|---|---|---|
| 120 V | 25 in.(JV5) | 18 in.(JV10) | 13 in.(JV15) | 13 in.(JV20) |
| 240 V | 49 in.(JN5) | 36 in.(JN10) | 25 in.(JN15) | 21 in.(JN20) |



# CEMS Umbilical Overview

## ❖ Design Process

Constant Power Density (CPD) Tracer
Specific output tracer under all conditions

Pros

- Maintain temperatures up to 400F/204C
- Cut to length but zones must be respected
- Continuous output allows for high maintain temperatures

Cons

- Zones can be damaged
- More care must be taken during installation
- Cannot be used in Class 1 Div 2 areas
- General Purpose area

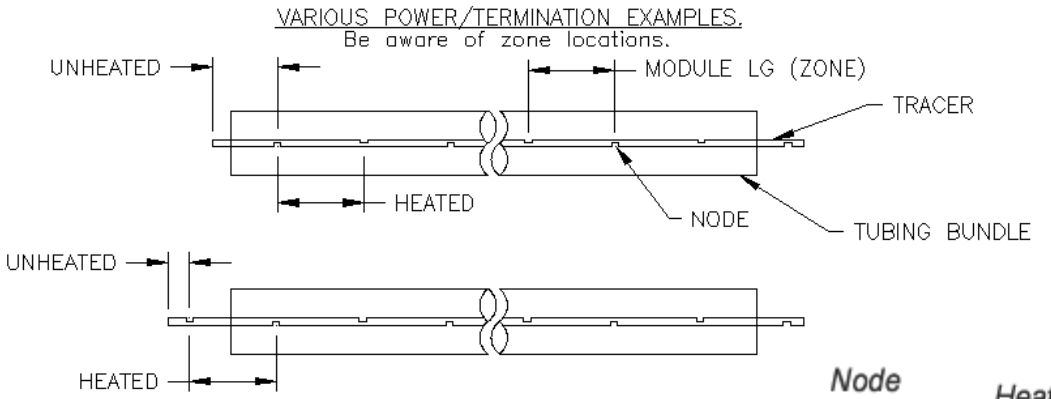

O'Brien examples:

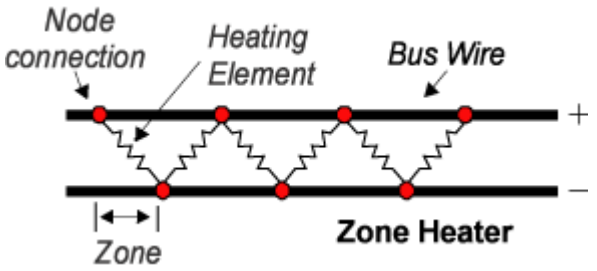
- O'Brien T-series (T18, TY18, TN18)

# CEMS Umbilical Overview

## ❖ Design Process

| O'Brien Designator | Voltage | Zone length | Jacket color | Resistance/zone | Resistance/inch |
|---|---|---|---|---|---|
| TN18 | 240 | 30" | Blue | 1280.00 | 42.667 |
| TY18 | 208 | 24" | White | 1201.78 | 50.074 |
| T18 | 120 | 24" | Orange | 400.00 | 16.667 |
| Z18 | 440 | 48" | Clear | 2688.889 | 56.0185 |



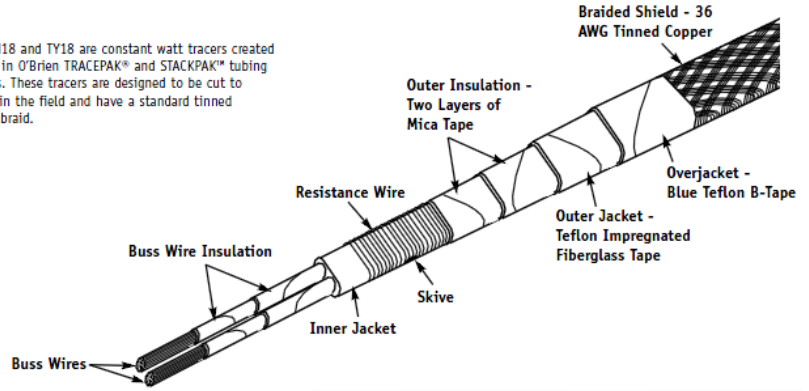




Process Accuracy Through Heat Transfer Expertise

O'BRIEN analytical

### Constant Wattage Heating Cable for Non-Hazardous Areas

T18, TN18 and TY18 are constant watt tracers created for use in O'Brien TRACEPAK® and STACKPAK™ tubing bundles. These tracers are designed to be cut to length in the field and have a standard tinned copper braid.




| | T18 | TY18 | TN18 |
|---|---|---|---|
| Size | 0.22" x 0.30" 5.5mm z 7.6mm | 0.22" x 0.30" 5.5mm z 7.6mm | 0.22" x 0.30" 5.5mm z 7.6mm |
| Specification | | | |
| Nominal Power Output | 18 w/ft 59 w/m | | |
| Voltage | 120V | 208V | 240V |
| Area Classification | General Purpose | | |
| Maximum Circuit Length | 160ft 48.8m | 277ft 84.4m | 320ft 97.5m |
| Maximum Exposure Temperature (Power Off) | 450°F 232°C | | |
| Maximum Maintain Temperature | 400°F 204°C | | |
| Minimum Installation Temperature | -40°F -40°C | | |
| Minimum Bending Radius | 1" 25.4mm | | |
| Inner Jacket Color | Orange | White | Blue |
| Heater Zone Length | 24" 610mm | 24" 610mm | 30" 762mm |

# CEMS Umbilical Overview

## ❖ Design Process

Series Resistance Tracer
Specific resistance under all conditions

Pros
- Maintain temperatures up to 1022F/550C
- Pre-terminated ends
- Class 1, Div 1 approved

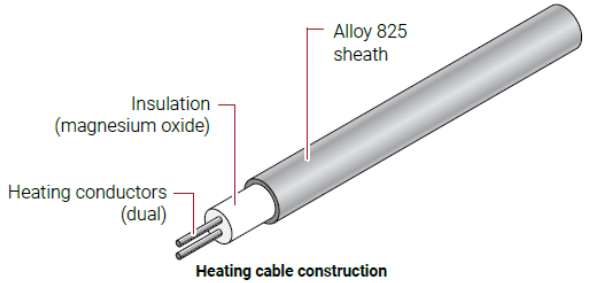
Cons
- Output based on resistance wire
- Cannot be cut to length, order specific length
- Long lead times
- Expensive

O’Brien examples:
- Raychem/Pyrotenax MI-Alloy 825

# CEMS Umbilical Overview

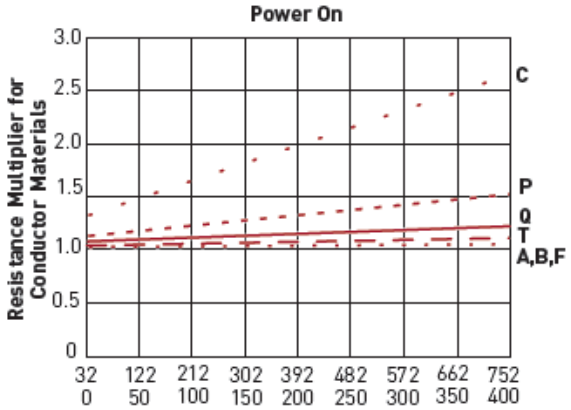
## ❖ Design Process

MI HEATING CABLE



Heating cable construction


| Heating cable reference | Nominal cable resistance at 20°C Ω/ft | Ω/m | Approximate cable diameter in | mm | Maximum unjointed cable length ft | m | Nominal weight lb/1000 ft | kg/1000 m |
|---|---|---|---|---|---|---|---|---|
| 62SF1110 | 11.0 | 36.1 | 0.205 | 5.2 | 718 | 219 | 80.0 | 119.1 |
| 62SF2900 | 9.00 | 29.5 | 0.215 | 5.5 | 820 | 250 | 80.2 | 119.4 |
| 62SF2600 | 6.00 | 19.7 | 0.215 | 5.5 | 820 | 250 | 80.6 | 119.9 |
| 62SA2414 | 4.14 | 13.6 | 0.228 | 5.8 | 665 | 203 | 88.9 | 132.3 |
| 62SF2200 | 2.00 | 6.56 | 0.248 | 6.3 | 580 | 177 | 106.7 | 158.8 |
| 62ST2115 | 1.15 | 3.77 | 0.224 | 5.7 | 665 | 203 | 89.5 | 133.2 |
| 62SB3700 | 0.700 | 2.30 | 0.268 | 6.8 | 535 | 163 | 125.6 | 186.9 |
| 62SQ3505 | 0.505 | 1.66 | 0.224 | 5.7 | 640 | 195 | 85.5 | 127.2 |
| 62SQ3286 | 0.286 | 0.938 | 0.236 | 6.0 | 628 | 191 | 95.1 | 141.5 |
| 62SQ3200 | 0.200 | 0.656 | 0.248 | 6.3 | 615 | 187 | 106.0 | 157.7 |
| 62SQ3150 | 0.150 | 0.492 | 0.248 | 6.3 | 630 | 192 | 107.0 | 159.2 |
| 62SQ3100 | 0.100 | 0.328 | 0.265 | 6.7 | 520 | 158 | 127.3 | 189.4 |
| 62SP4775 | 0.0775 | 0.254 | 0.252 | 6.4 | 540 | 165 | 111.6 | 166.1 |
| 62SP4561 | 0.0561 | 0.184 | 0.264 | 6.7 | 480 | 146 | 123.5 | 183.8 |
| 62SP4402 | 0.0402 | 0.132 | 0.280 | 7.1 | 443 | 135 | 138.7 | 206.4 |
| 62SP4281 | 0.0281 | 0.0922 | 0.295 | 7.5 | 390 | 119 | 158.7 | 236.2 |
| 62SC4200 | 0.0200 | 0.0656 | 0.295 | 7.5 | 460 | 140 | 146.1 | 217.4 |
| 62SC4130 | 0.0130 | 0.0427 | 0.311 | 7.9 | 370 | 113 | 169.4 | 252.1 |
| 62SC5818 | 0.00818 | 0.0268 | 0.343 | 8.7 | 345 | 105 | 199.7 | 297.2 |
| 62SC5516 | 0.00516 | 0.0169 | 0.364 | 9.2 | 270 | 82 | 246.8 | 367.3 |
| 62SC5324 | 0.00324 | 0.0106 | 0.402 | 10.2 | 228 | 69 | 314.5 | 468.0 |
| 62SC5204 | 0.00204 | 0.00669 | 0.496 | 12.6 | 151 | 46 | 474.8 | 706.6 |
| 62SC5128 | 0.00128 | 0.00420 | 0.543 | 13.8 | 125 | 38 | 562.5 | 837.1 |




**Nonhazardous and Hazardous Locations**

FM APPROVED
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

C SP US
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

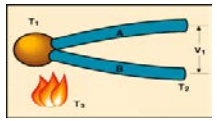
Zone 2

09-IEx-0010X
BR-Ex e II T1

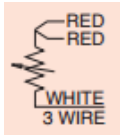
# CEMS Umbilical Overview

## ❖ Design Process

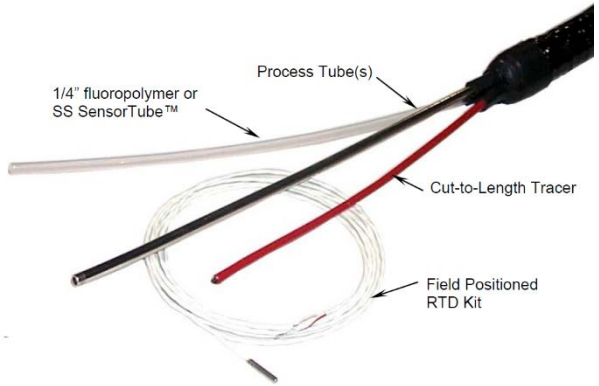
Temperature Sensors
- Type J/K thermocouples
  - Factory install
  - Field install
  - SensorTube



RTD 3-wire PT100
- Factory install
- Field install
- SensorTube



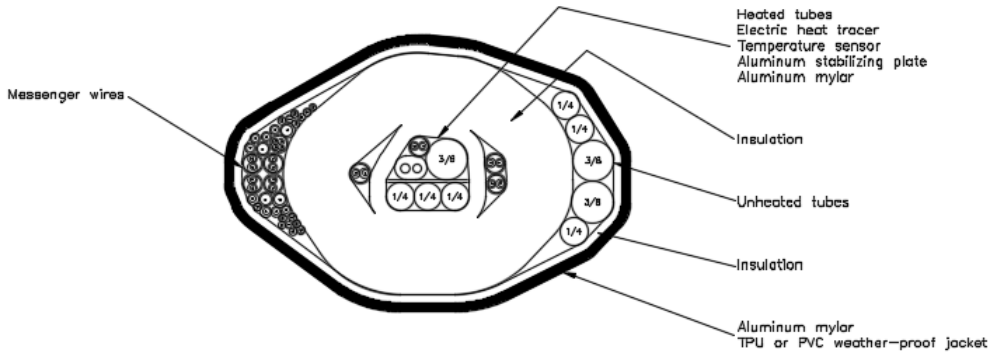

SensorTube
1/4" and 3/8"




# CEMS Umbilical Overview

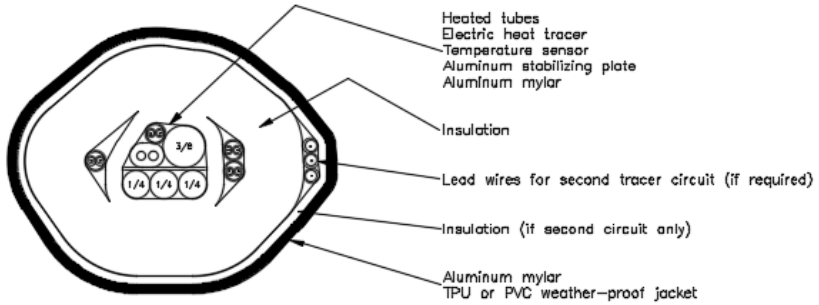
## ❖ Configurations

All-in-One

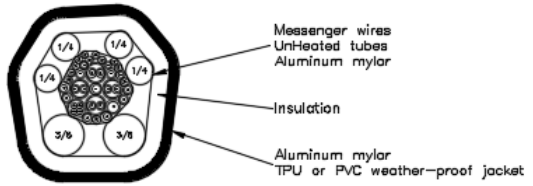



Two bundle

Heated




Unheated

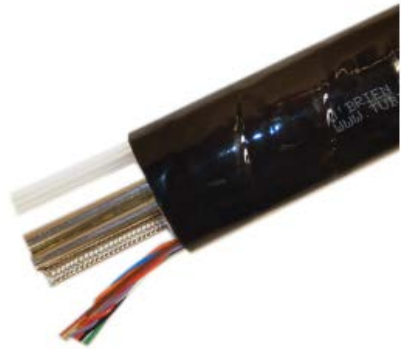


# CEMS Umbilical Overview

## ❖ Configurations

All-in-One approach

- Heated and unheated material in the same tubing bundle
- Pros:
  - One bundle to install
  - Lower initial cost
- Cons:
  - Larger, heavier bundle can be more difficult to install
  - If tracer fails, entire bundle must be replaced



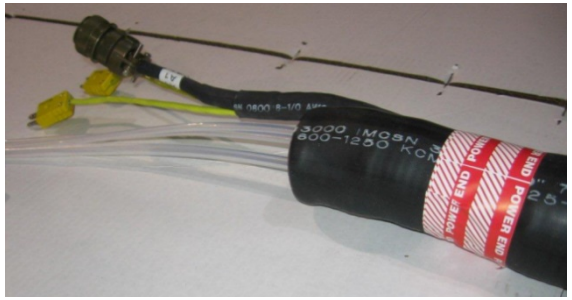
Two bundle approach

- One bundle has all heated tubes, second bundle has unheated
- Pros:
  - If tracer fails, only replacing the heated line
  - Two smaller bundles to install, instead of one larger
- Cons:
  - More expensive to purchase
  - More expensive to install

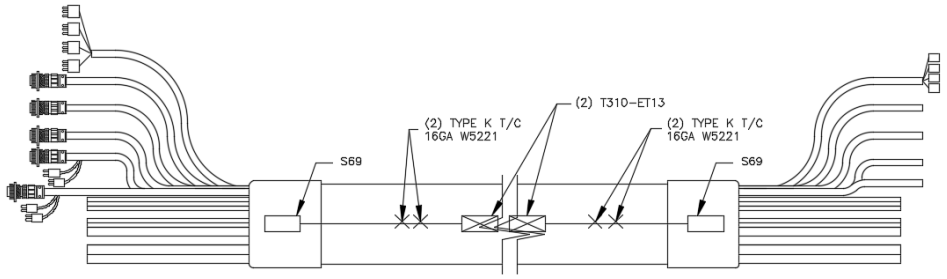
In some applications, only a two bundle is available

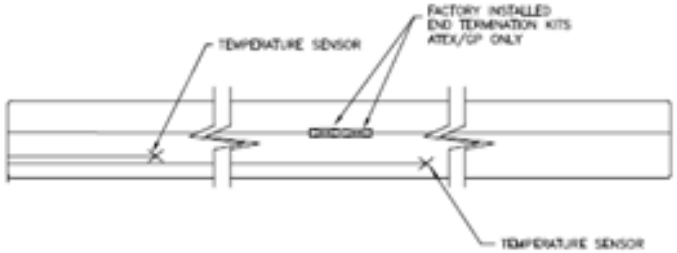
# CEMS Umbilical Overview

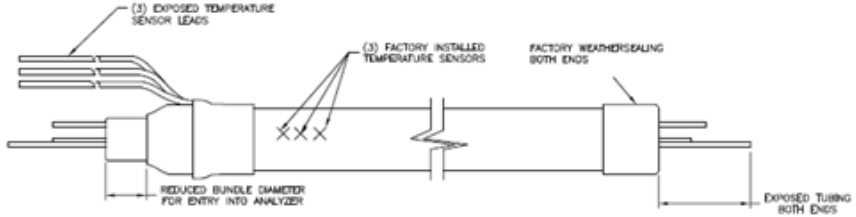
## ❖ Configurations

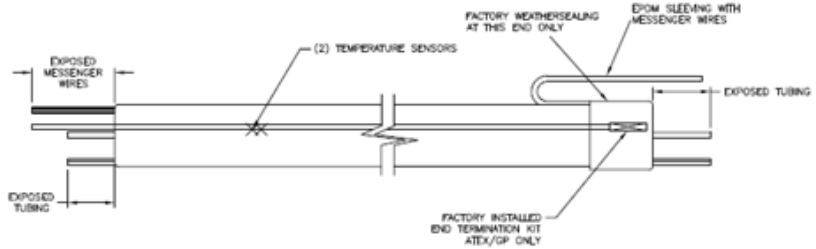


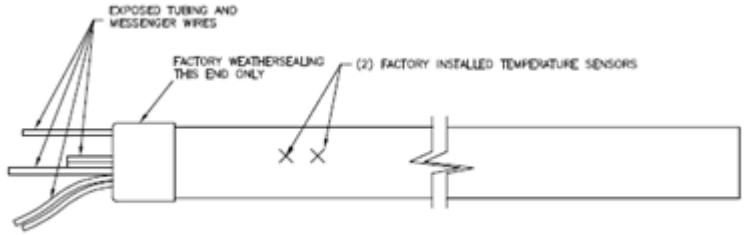
### End Preparation Options



# CEMS Umbilical Overview

## ❖ Configurations

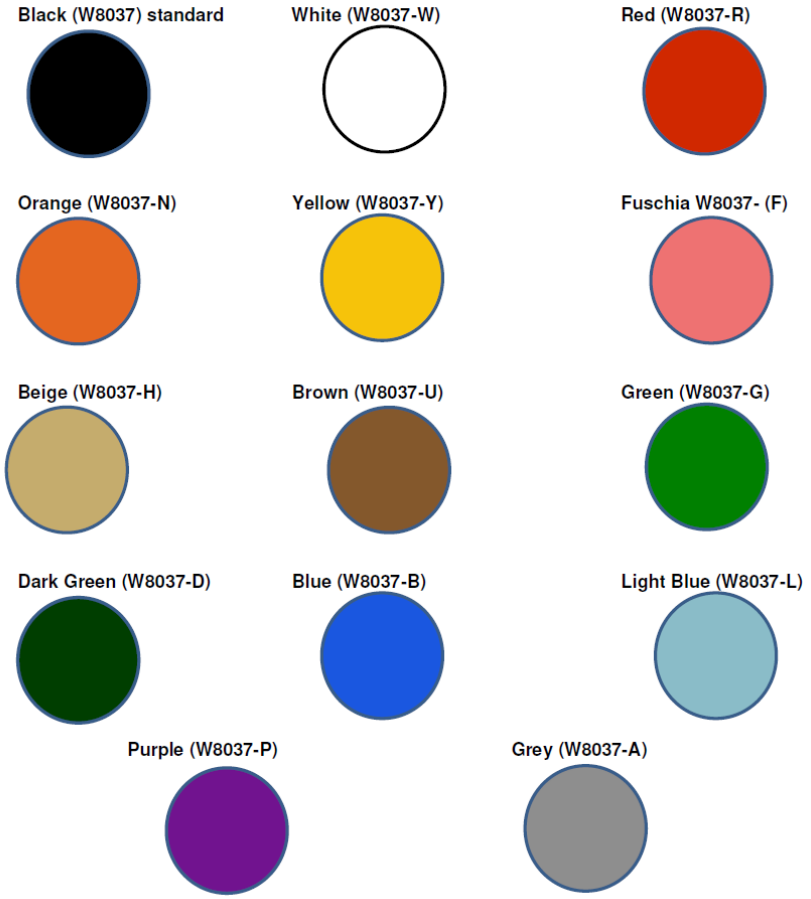
### Jacket Materials

**SV47** is a proprietary thermoplastic formulation that exceeds the requirements of 105C PVC and outperforms other PVC jacket materials in UV resistance as well as providing low temperature flexibility. SV47 is the standard jacket on TRACEPAK® tubing bundles and S-Line® preinsulated tubing.

**TPU** is a thermoplastic polyurethane jacket that offers excellent abrasion resistance and extreme cold temperature workability. TPU also contains no chlorides so it should be selected for applications where chloride stress cracking is a problem.

| | Standard 105C PVC | **O'Brien SV47** | **O'Brien TPU** |
|---|---|---|---|
| Abrasion Resistance | G | G | E |
| Tensile Strength PSI | 18-1900 | 2200 | 3800 |
| Elongation % | 250 | 350 | 700 |
| Hardness, Shore A | 85-90 | 80 | 80 |
| Minimum Service Temperature | None Stated | -30°F/-35°C* | -67°F/-58°C |
| Minimum Installation Temperature | 15°F/-9°C* | -10°F/-23°C* | -40°F/-40°C |
| UL94 Flame | V2 | V2 | V0 to V2 |
| Halogenated (Chlorides) | YES | YES | NO |
| Maximum Temperature | 220°F/105°C | 220°F/105°C | 250°F/120°C |
| Water Absorption % | 0.1% | 0.1% | 1.2-1.4% |
| Aromatic Hydrocarbons | F | F | G |
| Weathering | G | G | E |
| UV Resistance | F | G | E |

E = Excellent G = Good F = Fair P = Poor



# CEMS Umbilical Overview

## ❖ Arrival Inspections

Visual check (umbilical and spool) for damage/cuts/rips
Resistance check of tracer
Megger test tracer
Continuity check of all messenger wires
Temperature sensor(s) reading
Print on jacket verification against PO/SO
Confirm correct product and quantity

Umbilical ends must be protected from moisture ingress at all times
Moisture is the enemy of the thermal insulation

If you have any questions, please contact O'Brien Engineering

# CEMS Umbilical Overview

## ❖ Arrival Inspections

Resistance check
- Buss-buss wire resistance measurement
  - Self reg/Pwr limiting tracer
    - Both tracer ends within 0.2 ohm of each other
  - CPD tracer
    - Using Ohm's Law, resistance +/-10% of nominal

Megger test
- 1000vdc
- Buss wires to tracer ground braid
- 20mOhm or greater resistance
- Record values for future comparison

# CEMS Umbilical Overview

## ❖ PreInstall / Storage Instructions

Store indoors if possible
Store off of the ground
Keep ends weather sealed
Keep away from traffic to reduce chance of damage

Umbilical ends must be protected from moisture ingress at all times
Moisture is the enemy of the thermal insulation

# CEMS Umbilical Overview

## ❖ Installation Instructions

Plan the installation with the appropriate number of qualified personnel
Use Kellum style grips to pull vertical sections
Post personnel at all bends/turns to avoid damage
Do not twist the sample line
Use wide bands or clamps to hold in final position
Horizontal runs require a maximum of 6ft spacing between supports
Vertical runs require a maximum of 15ft spacing between supports
Use a downward slope from the probe to the analyzer
Supports need to be rigidly held
Do not over-clamp or deform the sample line
Fully support all bends
Do not exceed the minimum bend radius (8” or 12” depending on design)
Avoid running near external heat sources
Keep a minimum of ½” air gap between lines
Do not run in an enclosed tray, air must be allowed to circulate
Once installed and clamped, complete a visual inspection to look for damaged jacket, unsupported areas, or tight bends
Protect from moisture ingress/seal ends

# CEMS Umbilical Overview

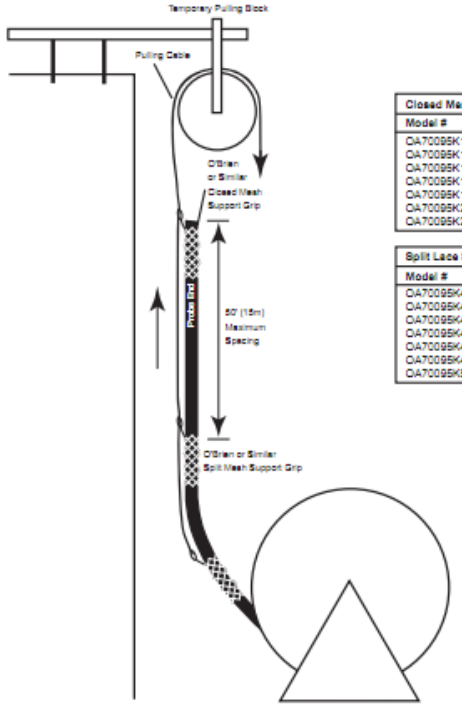
## ❖ Installation Instructions

### Vertical Runs

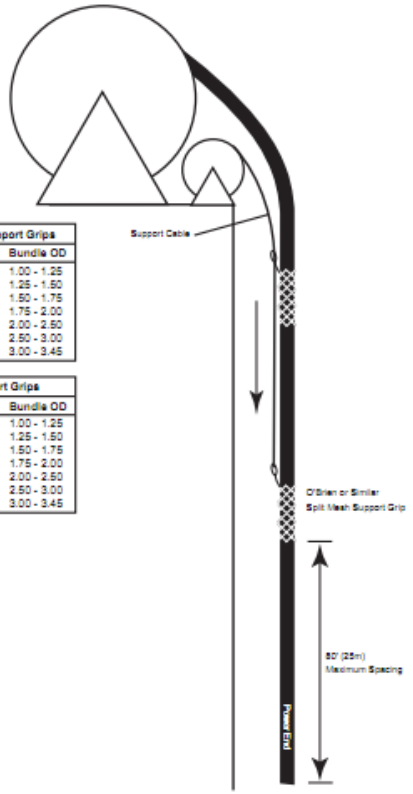
- Two methods are used, one pulls the probe or process end of the bundle into place and the other lifts the product spool to the highest point and lowers the instrument or analyzer end.

If the bundle has factory finished ends or factory installed temperature sensors the probe and power ends will be labeled on the bundle.

### Pulling Bundle Into Place




### Lowering Bundle from Top Down




| Closed Mesh Support Grips | |
|---|---|
| Model # | Bundle OD |
| OA70095K15 | 1.00 - 1.25 |
| OA70095K16 | 1.25 - 1.50 |
| OA70095K17 | 1.50 - 1.75 |
| OA70095K18 | 1.75 - 2.00 |
| OA70095K19 | 2.00 - 2.50 |
| OA70095K21 | 2.50 - 3.00 |
| OA70095K21 | 3.00 - 3.45 |

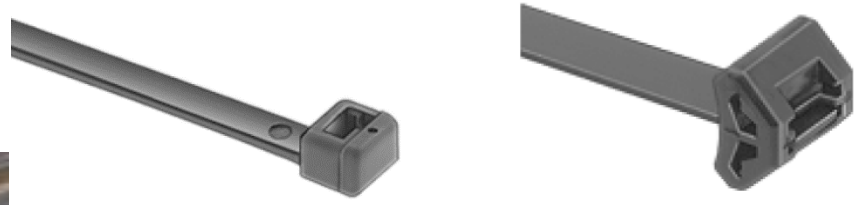
| Split Lace Support Grips | |
|---|---|
| Model # | Bundle OD |
| OA70095K44 | 1.00 - 1.25 |
| OA70095K45 | 1.25 - 1.50 |
| OA70095K46 | 1.50 - 1.75 |
| OA70095K47 | 1.75 - 2.00 |
| OA70095K48 | 2.00 - 2.50 |
| OA70095K49 | 2.50 - 3.00 |
| OA70095K51 | 3.00 - 3.45 |


Can provide spool with probe end or power end off first. (Probe end first is standard)

# CEMS Umbilical Overview

## ❖ Installation Instructions

Recommended primary support method
½“ minimum width cable ties
Outdoor rated
Black acetal or UV resistant black nylon

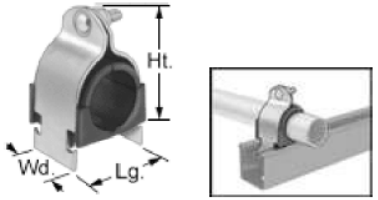


Kellems Grip for pulling into place all vertical runs
50ft maximum spacing
Once installed may be used as secondary support


Double Eye, Split Mesh, Lace Closing

Recommended primary support method
Strut clamps with plastic insert
Galvanized or stainless steel

Vibration-Damping Strut-Mount Clamps




<u>Support requirements</u>
15ft minimum spacing on vertical runs
6ft minimum spacing on horizontal runs
Permanent clamping on rigid support structure/non-moving

# CEMS Umbilical Overview

## ❖ Installation Instructions

Confirm correct ends
Position close to stack base
Use a pipe and stand to allow the spool to be uncoiled
Use Kellum grips to pull vertical sections

# CEMS Umbilical Overview

## ❖ Installation Instructions

Continue pulling up stack until reaching probe. Account for extra for tracer termination, tube connections and wire hookups.

# CEMS Umbilical Overview

## ❖ Installation Instructions

Pull remaining umbilical off of spool. Feed into shelter. Account for extra at shelter end for tracer power connection, tube connections, and wire hookups.

# CEMS Umbilical Overview

## ❖ Installation Instructions

Attach final permanent support
Leave Kellum grips in place and anchor
Make probe connections
Weather seal

# CEMS Umbilical Overview

## ❖ Installation Instructions

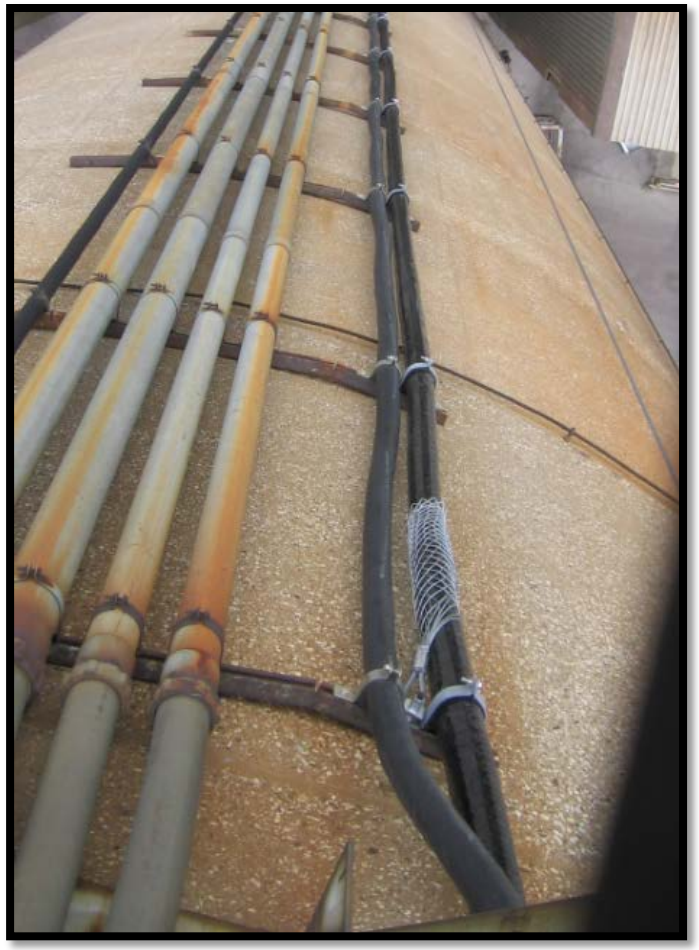
Make final routing connections
Make connections at shelter end
Conduct final electrical checks
Weather seal


# CEMS Umbilical Overview

## ❖ Best Practices

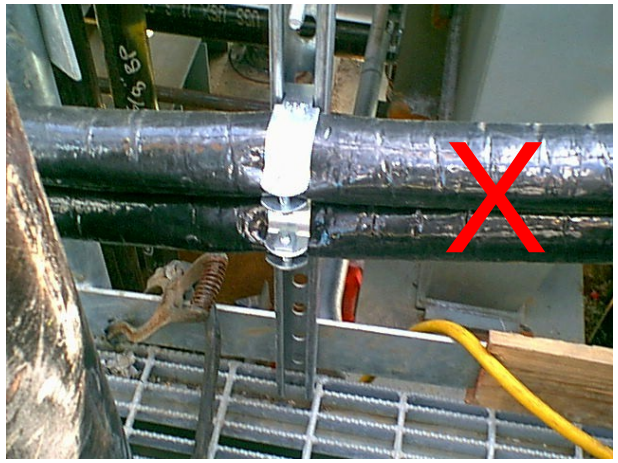
Bad : Possible Damage to entire construction: Jacket, Insulation, Heater Cable

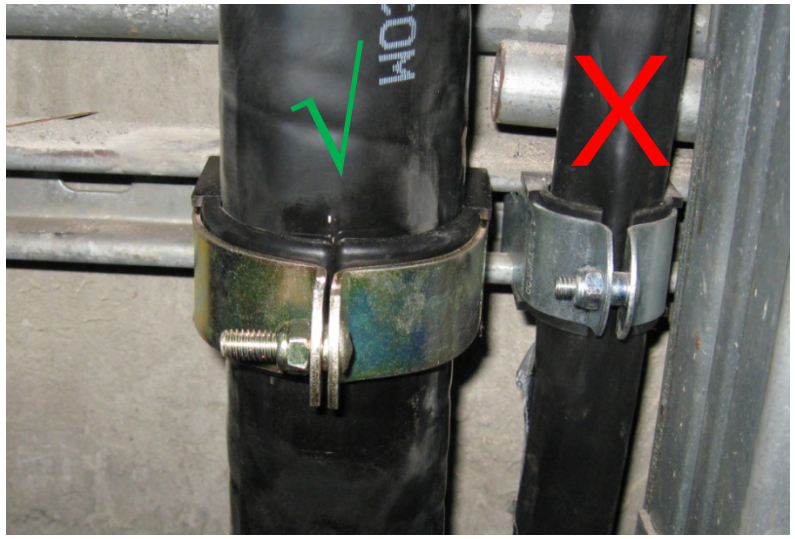

Good: Use Kellums grip or Closed Mesh Support Grip, proper rigging, and supports to protect bundle/umbilical

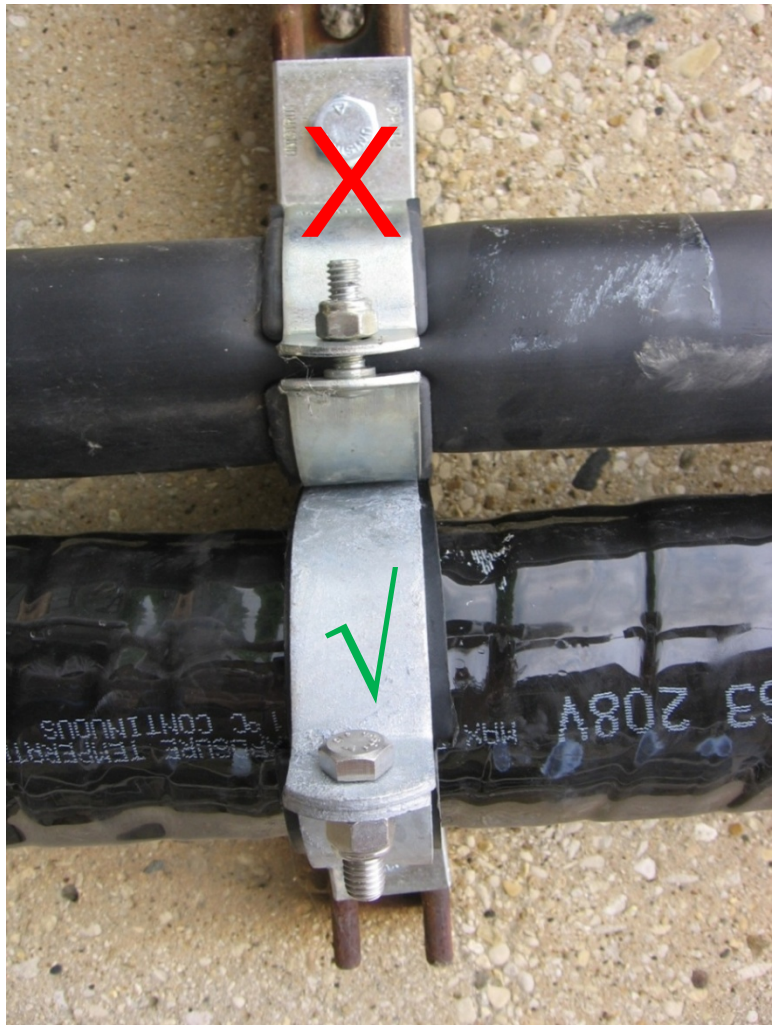


# CEMS Umbilical Overview

- Best Practices



# CEMS Umbilical Overview

- Best Practices

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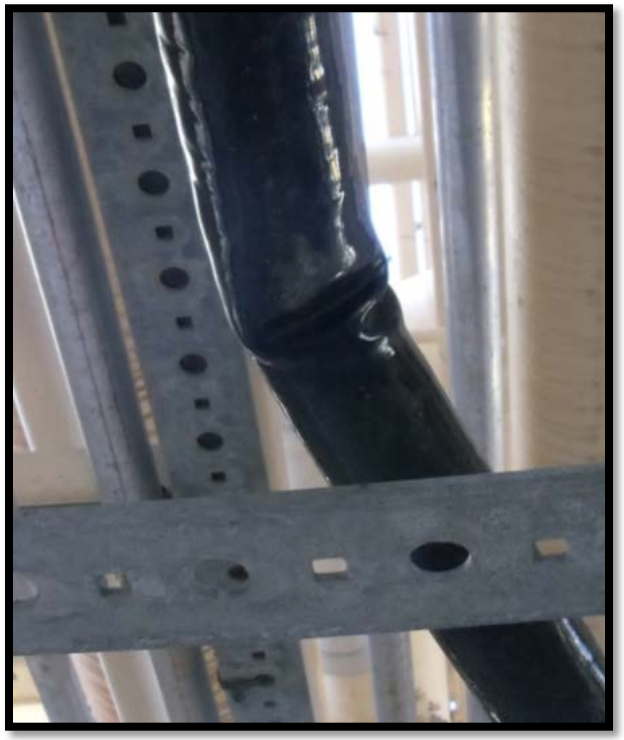

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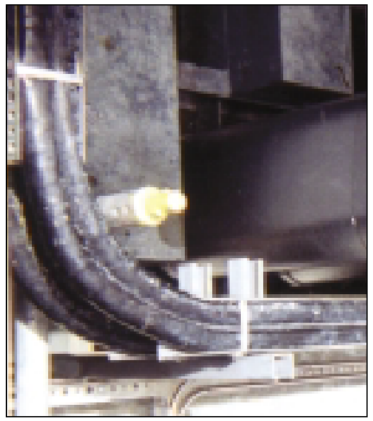
# CEMS Umbilical Overview

## ❖ Best Practices

**Wrong Way:**

✗ Leaving several inches of tubing exposed at the end of a tubing bundle leaves the entire system open to freezing. Stainless steel tubing can lose more than 100°F (38°C) per inch if not insulated and traced.



✗ When supporting tubing bundle in a cable tray, care should be taken to keep bundles from touching each other. Supports and hangers must have a large surface area and be designed so they can not be overtightened to crush the tubing bundle.

✗ Unsealed bundle ends, splices and terminations allow moisture to be absorbed by the insulation. Wet insulation degrades the bundle two ways: by reducing the insulating properties and secondly by releasing water soluble chlorides which may contribute to chloride stress corrosion of stainless steel process tubes.

✗ When using MI heater cable or other heaters that cannot be cut to length accurate measurements of the sample line length are critical. Sample bundle must be installed so that there is a continuous slope toward the sample system.

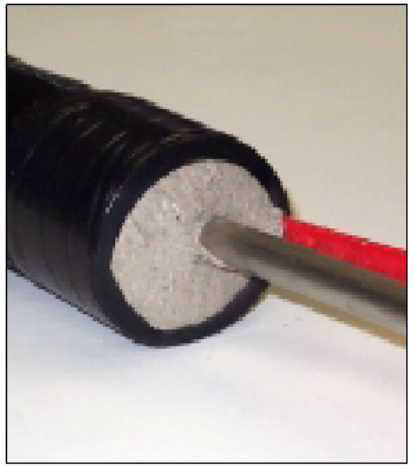
# CEMS Umbilical Overview

## ❖ Best Practices

**Right Way:**

✓ Bringing the insulated tubing bundle in to the cabinet through a weatherproof entry seal to maintain the integrity of insulation and heating in tubing bundles.

✓ O'Brien's TRACEPAK® has a unique design which allows for an 8" (203mm) bending radius.



✓ Weatherproof seals must be installed at each end of the tubing bundle. Select the end seal kit designed for the maximum exposure temperature.

✓ Use a cut-to-length heater whenever possible. This improves the chances of having a successful installation. The actual length is determined during installation and cut from long continuous reels to minimize scrap.

# CEMS Umbilical Overview

## ❖ Best Practices

## Troubleshooting

While the most common cause of trouble/failure is water/moisture related, below is a list of basic troubleshooting checks to make in no particular order.

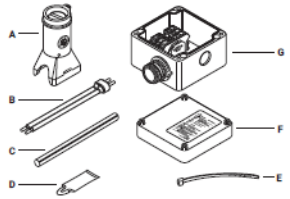
1) Moisture/water ingress
   Conduct a visual inspection along the length of the tubing bundle looking for cuts//tears/deformations in the outer jacket. Also look for repairs or field installed temperature sensors. Look at the ends and confirm they are weather sealed. The tubing bundle should feel firm to the touch.
2) Confirm model of tubing bundle. Check original design.
3) Confirm both correct voltage and circuit breaker sizing including checking the proper function.
4) Confirm circuit length doesn't exceed limits.
5) Confirm maintain temperature doesn't exceed limits or design.
6) Confirm proper operation of temperature controller.
7) Check resistance and conduct Megger test on heat trace.
8) Confirm functioning temperature sensor.
9) Check for proper installation and support. Look for hard bends, unsupported areas, and near heat sources.
10) Confirm no electrical anomalies or events have occurred (electrical spikes, severe storms, etc).
11) Check for proper wiring.
12) Check for approved and properly installed tracer kits.
13) Confirm electrical connection of any plugs/receptacles installed.
14) If using GFCI, check for trip level.
15) Conduct flow and pressure test on heated tubes.
16) Confirm one-time installation.
17) Have customer send pictures of installation including overall layout, power connection and end termination areas.
18) Gather information on what led up to the failure/event.

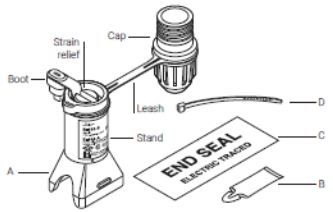
# CEMS Umbilical Overview

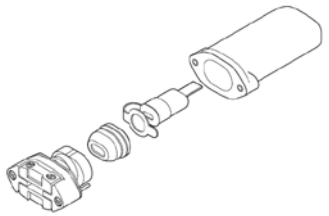
## ❖ Best Practices

## Accessories

Tracer connection kits

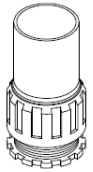


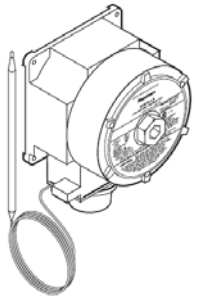



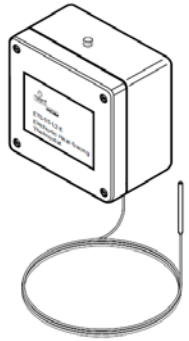
Bundle end seals

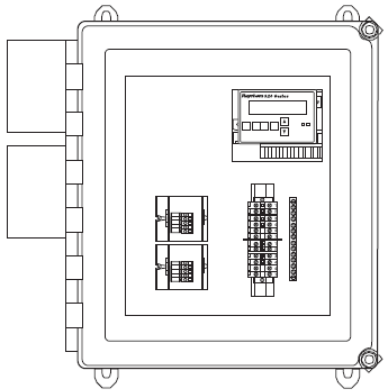

Entry seals



Temperature controllers







# CEMS Umbilical Overview

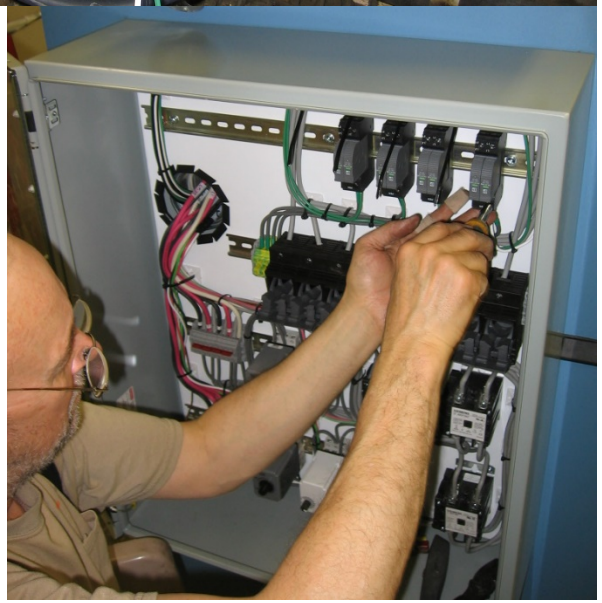
## ❖ Finishing and Power up

Make final checks at each end of the umbilical
- Resistance check and Megger test tracer
- Make and confirm proper tracer connections
- Confirm temp sensor(s) functionality
- Confirm tube and wire connections
- Confirm weather sealing
- Confirm temp controller operation and settings

Follow routing of the entire length, look for
- Proper support
- No bend radius exceeded
- No cuts/tears/rips in outer jacket

Power up umbilical and monitor until reaching setpoint and proper cycling

Investigate any irregularities

# CEMS Umbilical Overview

## ❖ Permeation, Burn -in, and Flushing

As stated earlier, if using Teflon tubing CO migration/permeation may occur. The following steps can reduce or eliminate this issue.

Burn-in
Power umbilical at the highest safe temperature allowed. This should accelerate the CO migration process. Pull sample from fresh air (filtered) instead of the stack if possible. This process may take 1 week or more. Depending on the application, some permeation may continue but the level usually flatlines.

Flushing
There are many tube flushing processes used by customers. The only process that O'Brien promotes is a D.I. water flush followed by a Nitrogen gas drying.

# CEMS Umbilical Overview

## ❖ Permeation, Burn -in, and Flushing

Below is a typical cleaning/ flushing procedure. This is not specifically endorsed by O'Brien Ametek.

1. Disconnect heating power from the umbilical line.
2. Allow the line to cool to ambient temperature.
3. Disconnect the Sample and Calibration Gas lines from the probe and analyzer.
4. Flow cleaning agent down each line, collecting the residue in a container for proper disposal as required by your protocol.
   A. Recommended Order
      I. Distilled or D.I. water
      II. Vinegar or 5-10% Nitric Acid solution
      III. Distilled or D.I. water (if step II is utilized)

      Note: Flow D.I. water (preferred) or distilled water until a complete rinse is achieved. Typically, 2x the rinse agent to the cleaning agent.
5. Blow dry for a minimum of 30 minutes or until no water droplets are present.

# CEMS Umbilical Overview

## ❖ Permeation, Burn -in, and Flushing

Continued

6. Reconnect the line to the probe only.
7. Repower the umbilical line and allow to heat to temperature.
8. Reconnect sample line to analyzer/shelter end.
9. Allow system to stabilize.
10. Calibrate the system and validate the systems stabilization.
11. Return the system to service.

Note: The system may show some drift for as much as 3 days of operation before returning to total normal operation.

# CEMS Umbilical Overview

## ❖ Maintenance

Suggested maintenance

Weekly
Visual checks
- Temperature controller proper operation and alarm status

Monthly
Visual checks
- Temperature controller proper operation and alarm status
- Routing of umbilical and checks for damage/ weather sealing

Annually
- Temperature controller proper operation and alarm status
- Tracer Megger test
- Tracer resistance check
- Temperature sensor check

# CEMS Umbilical Overview

- Questions