CEMS Umbilical Overview

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O'Brien Ametek

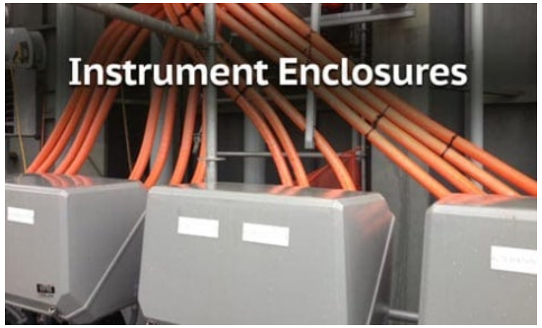
CEMS Umbilical Overview

❖ 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

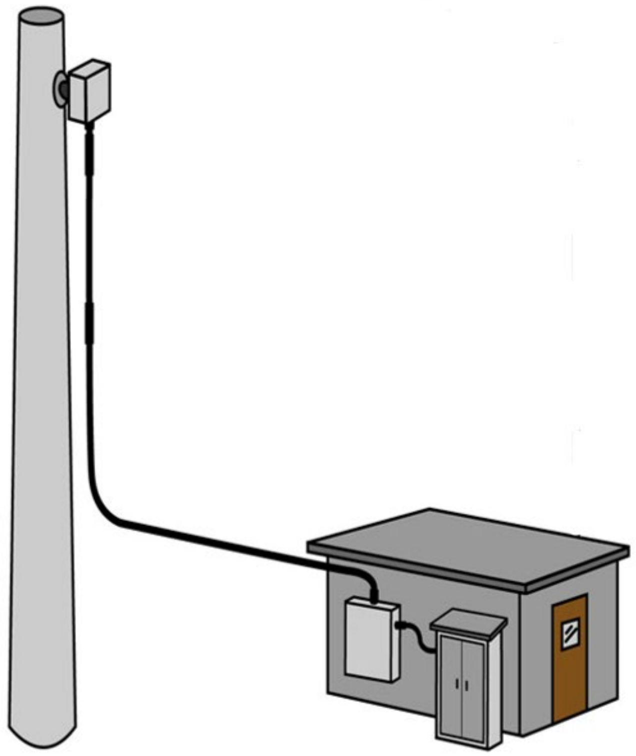
For over 50 years, O'Brien has been supplying the petrochemical, refining, pulp & paper, and power industries with quality products based on the application of our heat transfer expertise. Our recommendations and products reflect our knowledge of industry practices, regulations, and code requirements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

Product offering

- Tubing Bundle
  - TracePak and StackPak
  - Jacketed tubing
  - Insulated 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

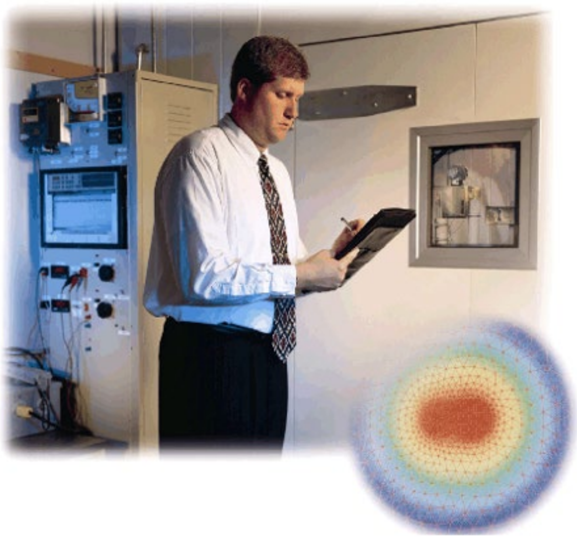
❖ Types of umbilicals

Below are the basic types 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)

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:

- 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
      - Require larger breakers
      - Shorter circuit lengths
      - Use more expensive tracers
      - Shorter life of tracer
  - 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

Self-Regulating Tracer

Power output changes at the tracer heats up

Pros

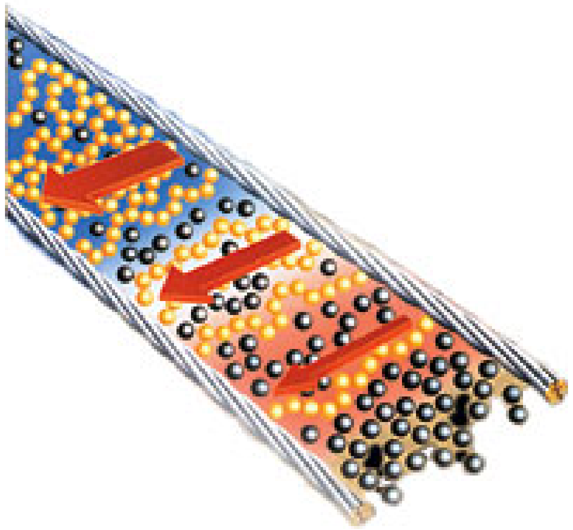
- Maintain temperatures up to 250F/121C
- Cut to length
- Some designs do not require temperature control
- Class 1, Div 2 approved (Div 1 option)
- Robust construction

Cons

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

O'Brien examples:

- Raychem BTV and XTV



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.

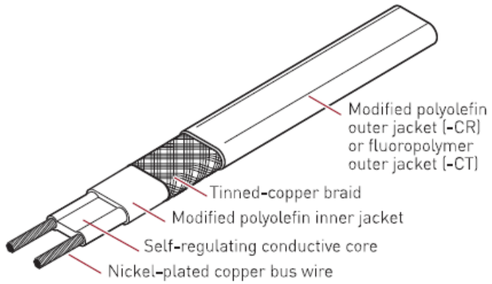
The outer jacket, braid and inner jacket provide mechanical, chemical and electrical protection... but the magic happens in the conductive core. The conductive core is extruded over the two, parallel conductors in our BTV and QTVR products or in the case of our XTV and KTV fiber heating cables is wrapped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

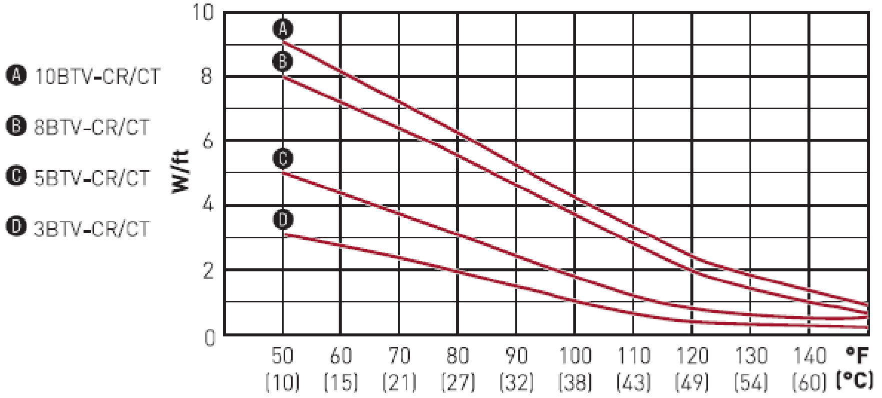
As the ambient temperature drops, the core contracts microscopically and the number of electrical paths through the core increases. More heat is produced. Conversely, as the ambient temperature rises, the core expands and has fewer electrical paths. Less heat is produced. A self-regulating heating cable 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

CSA -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

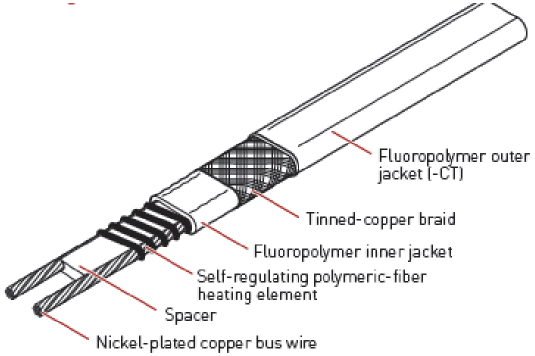
CSA -W
Ex e II T6[2]

IEx
09-IEx-0004X
Ex e IIC T6 Gb

CEMS Umbilical Overview

❖ Design Process

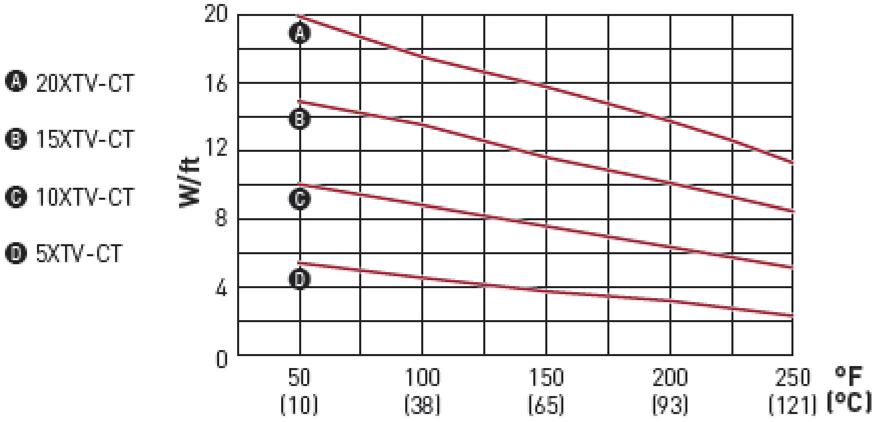
Raychem XTV



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

Hazardous Locations

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

CSA: 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

FM: CLI, ZN1, AEx e II T3 (T2)

CSA: Ex e II T3 (T2)

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

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

CEMS Umbilical Overview

❖ Design Process

<u>Power-Limiting Tracer</u>

Power output changes at the tracer heats up

Pros

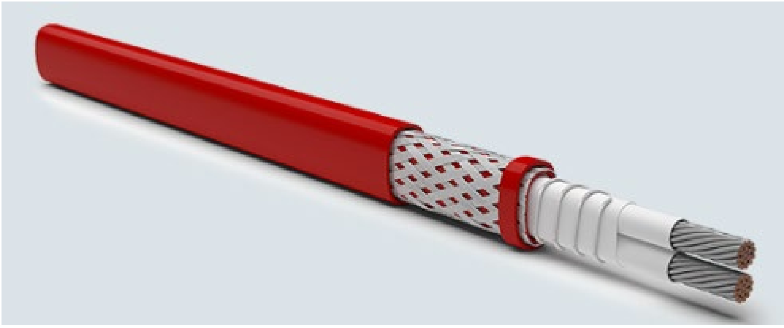
- Maintain temperatures up to 455F/230C
- Cut to length but zones must be respected
- Class 1 Div 2 approved

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:

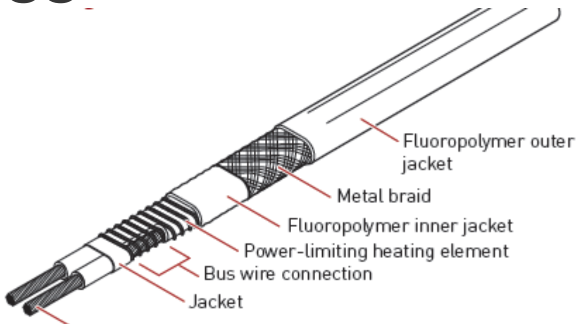
- Raychem VPL



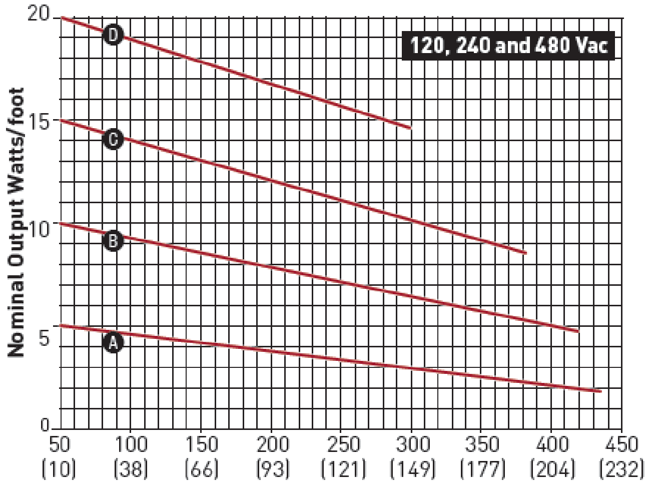
CEMS Umbilical Overview

❖ 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	–	–			

Maximum circuit length (in feet) per circuit breaker

	Ambient temperature at start-up	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

FM APPROVED
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

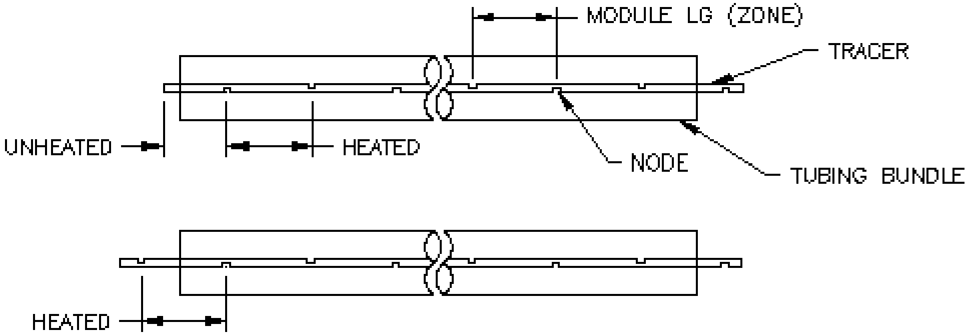
[1] For maximum surface temperature, see heating cable, design documentation or schedule

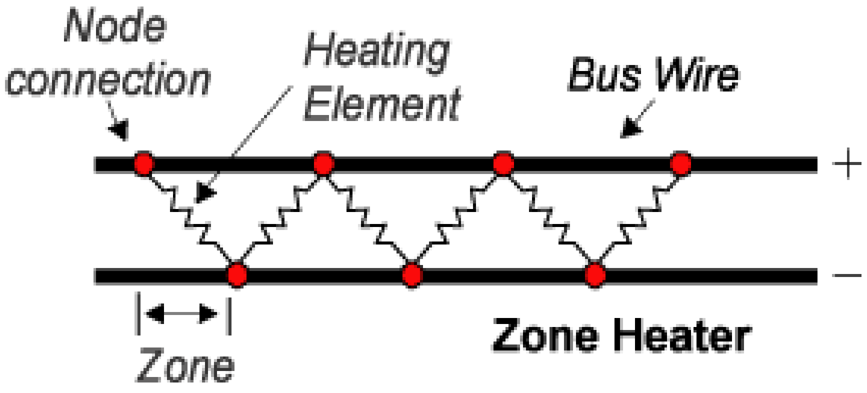
CEMS Umbilical Overview

❖ 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

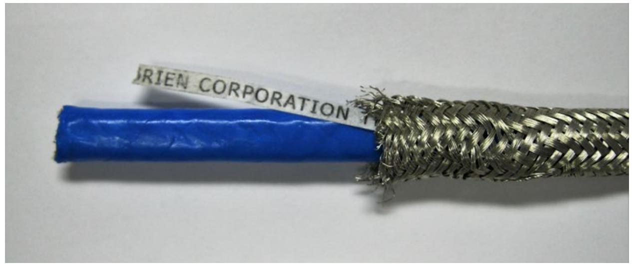
<u>Constant Power Density (CPD) Tracer</u>
Specific output tracer under all conditions

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:

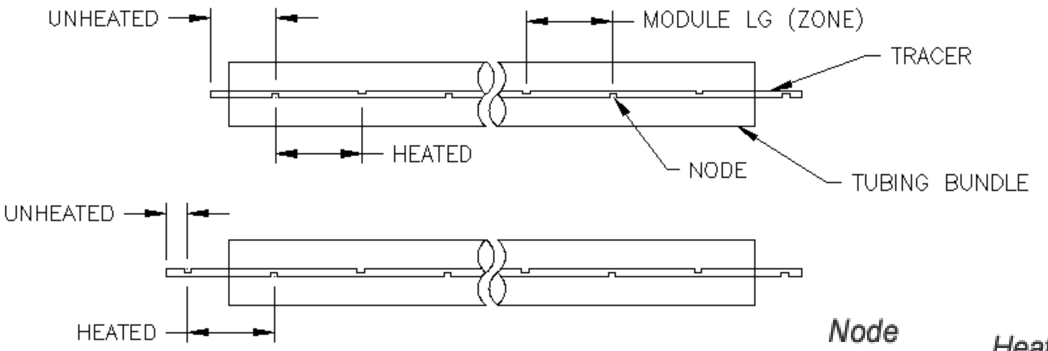
- O'Brien T-series (T18, TY18, TN18)

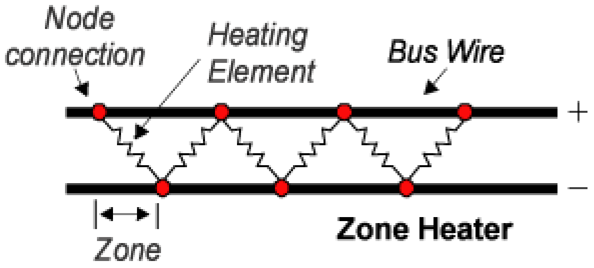
CEMS Umbilical Overview

❖ 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

VARIOUS POWER/TERMINATION EXAMPLES.
Be aware of zone locations.



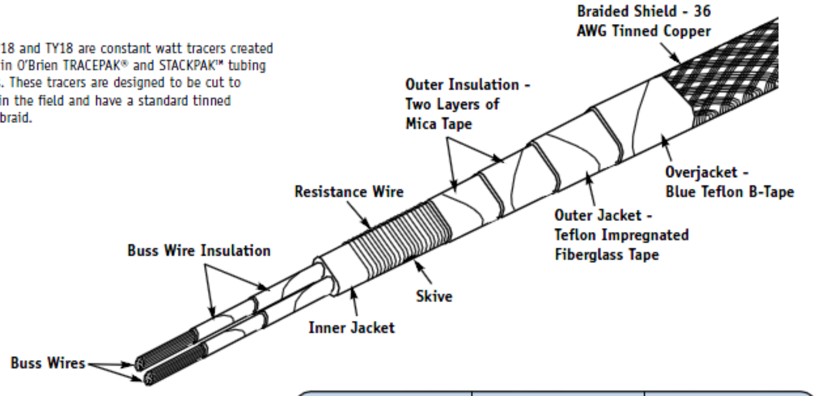


Process Accuracy Through Heat Transfer Expertise

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

<u>Series Resistance Tracer</u>

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

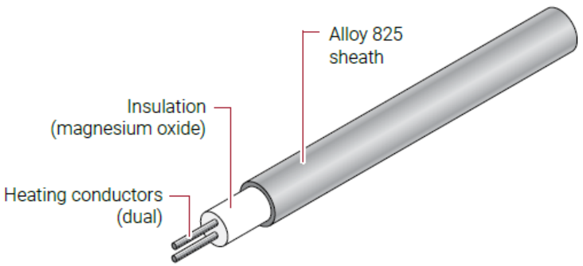
O'Brien examples:

- Raychem/Pyrotenax MI-Alloy 825

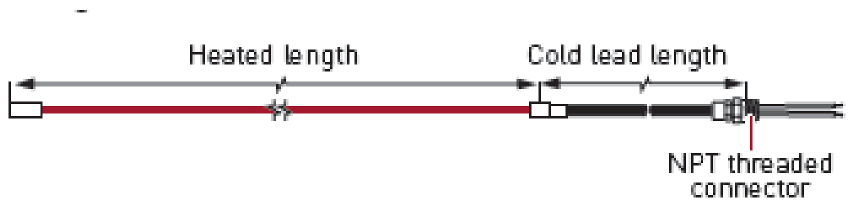
CEMS Umbilical Overview

❖ Design Process

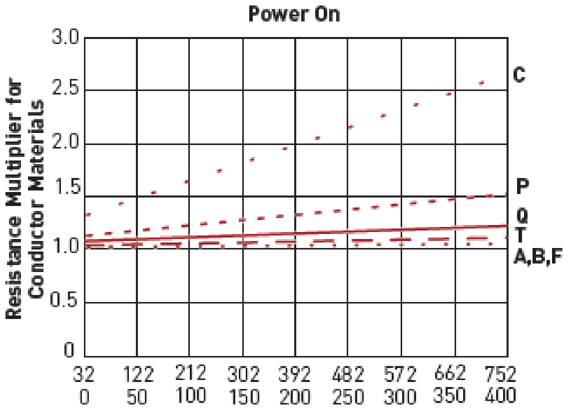
MI HEATING CABLE



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

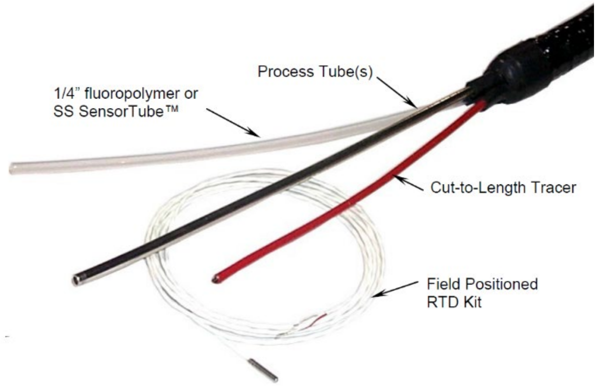
Zone 2

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

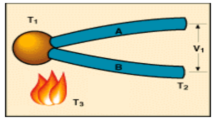
CEMS Umbilical Overview

❖ Design Process

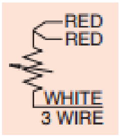
SensorTube
1/4” and 3/8”



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



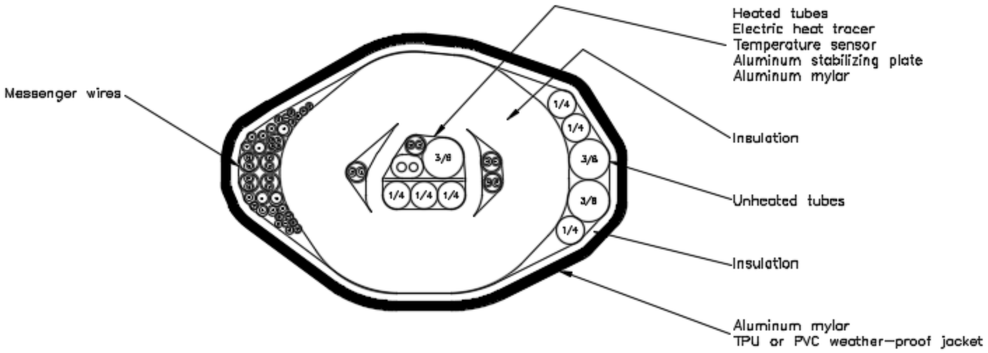
RTD 3-wire PT100
- Factory install
- Field install
- SensorTube



CEMS Umbilical Overview

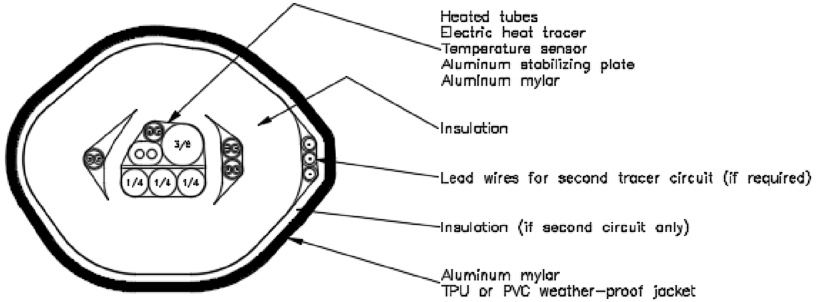
❖ Configurations

All-in-One

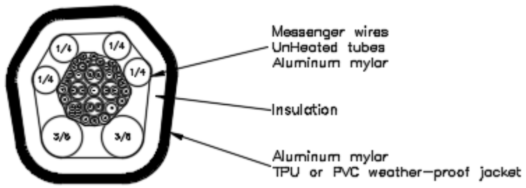


Two bundle

Heated

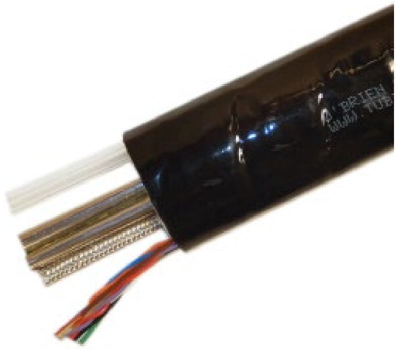


Unheated



CEMS Umbilical Overview

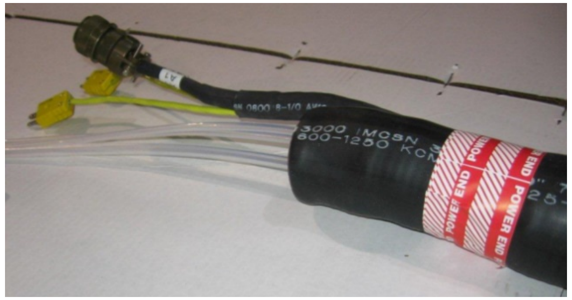
❖ Configurations



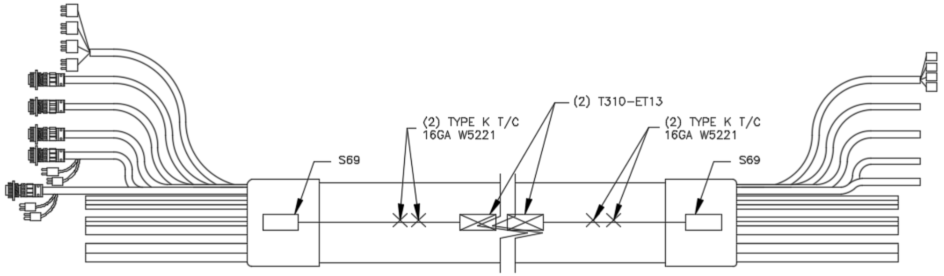
- All-in-One approach
  - Heated and unheated material in the same tubing bundle
  - Pros:
    - One bundle to install
    - Lower initial cost
  - Cons:
    - Larger, heavier bundle can be more difficult to install
    - If tracer fails, entire bundle must be replaced
- Two bundle approach
  - One bundle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

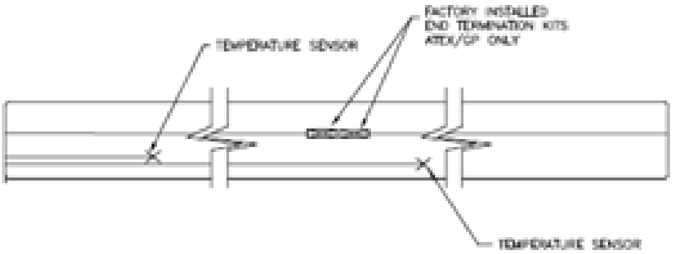
CEMS Umbilical Overview

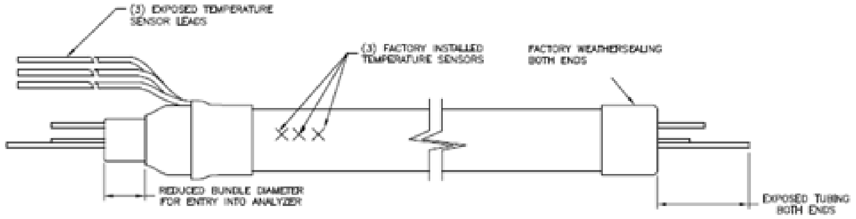
❖ Configurations

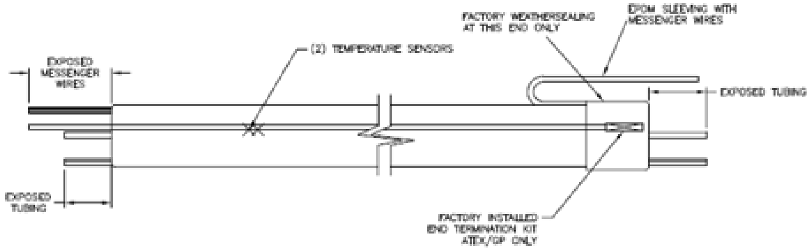


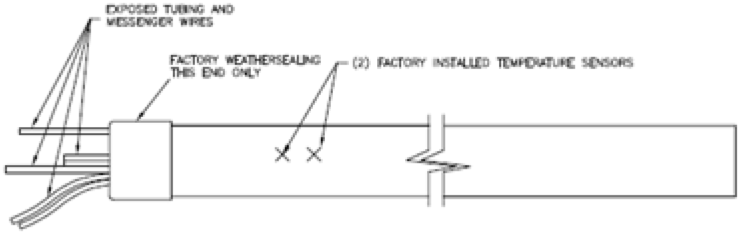
End Preparation Options











CEMS Umbilical Overview

❖ Configurations

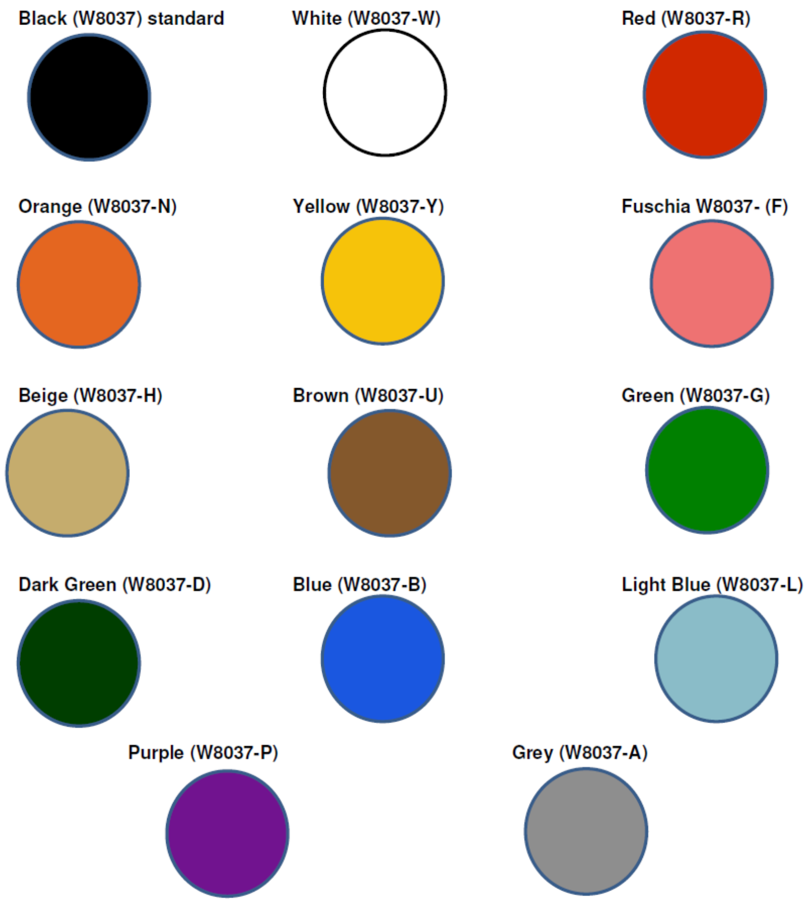
Jacket Materials

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

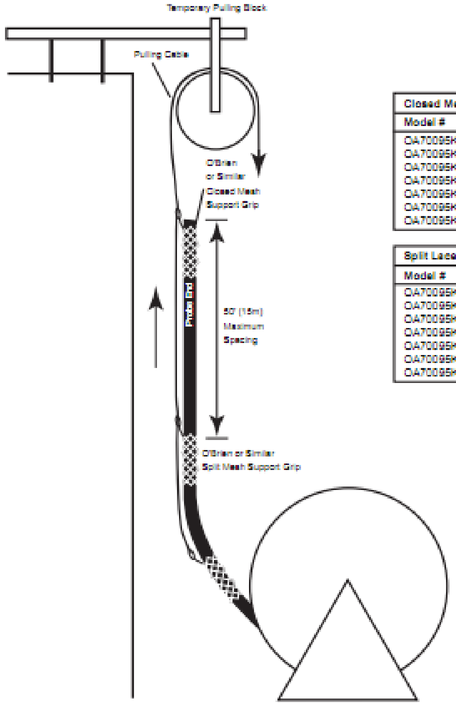
❖ Installation Instructions

Vertical Runs

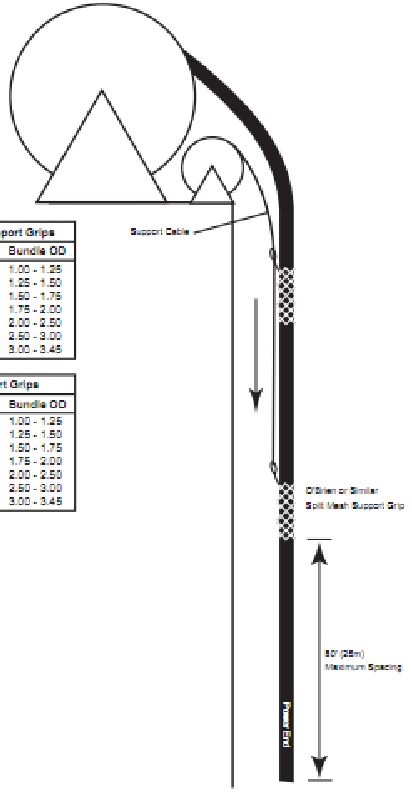
- Two methods are used, one pulls the probe or process end of the bundle into place and the other lifts the product spool to the highest point and lowers the instrument or analyzer end.

  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

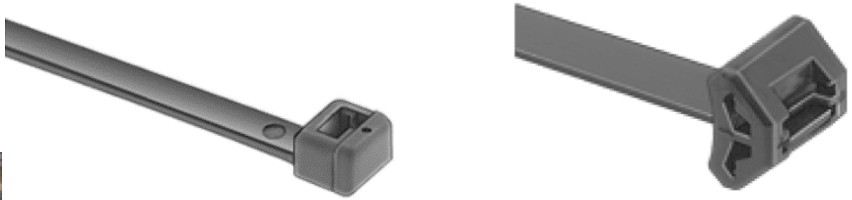
Split Lace Support Grips	
Model #	**Bundle OD**
OA70095K44	1.00 - 1.25
OA70095K45	1.25 - 1.50
OA70095K46	1.50 - 1.75
OA70095K47	1.75 - 2.00
OA70095K48	2.00 - 2.50
OA70095K49	2.50 - 3.00
OA70095K51	3.00 - 3.45

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

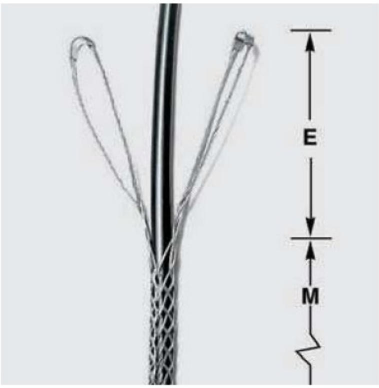
CEMS Umbilical Overview

❖ Installation Instructions

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



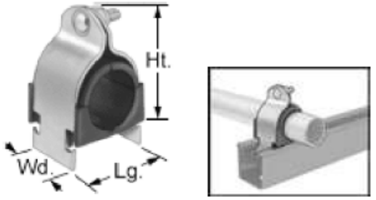
Kellems Grip for pulling into place all vertical runs
50ft maximum spacing
Once installed may be used as secondary support



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

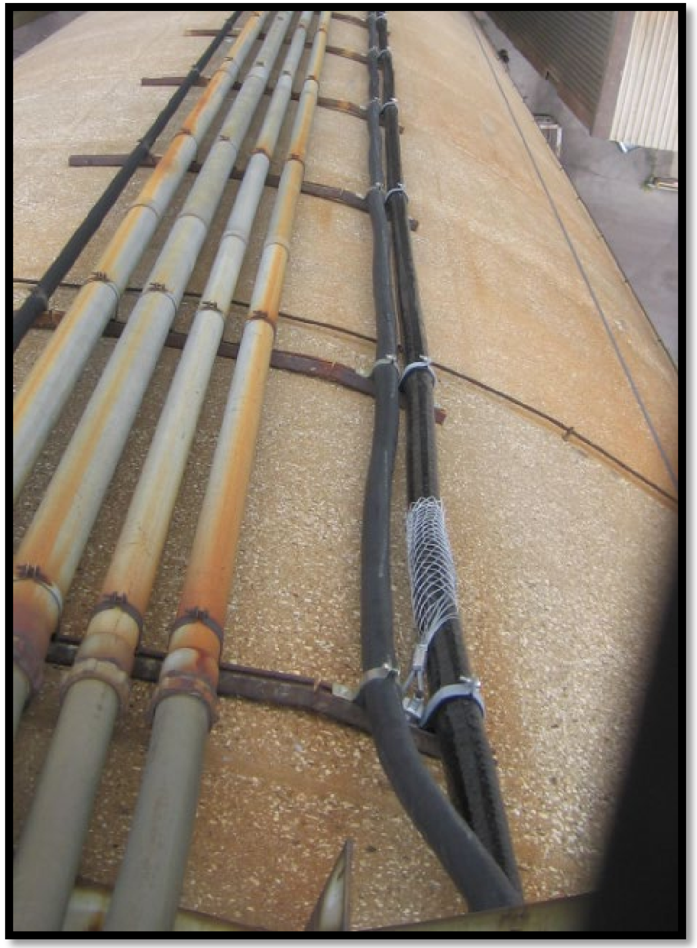
❖ Installation Instructions

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

CEMS Umbilical Overview

❖ Best Practices

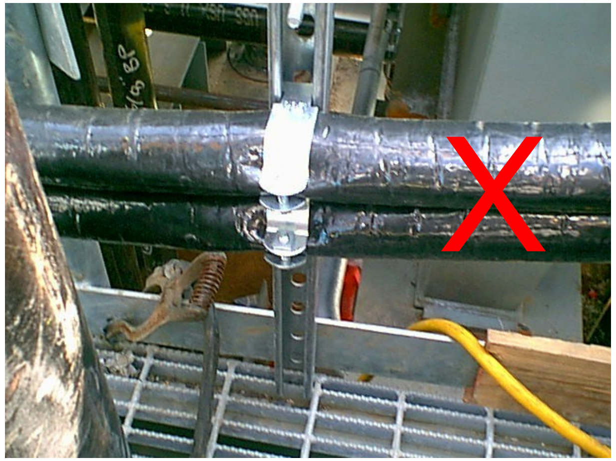
Bad : Possible Damage to entire construction: Jacket, Insulation, Heater Cable

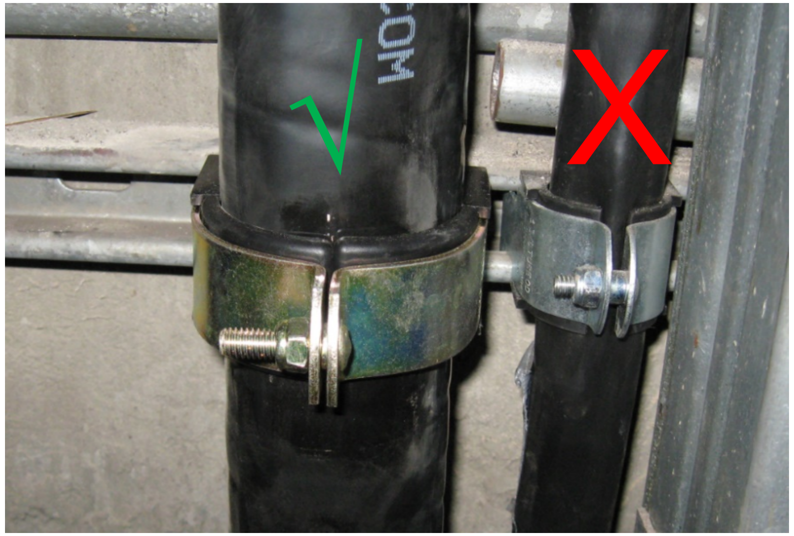


Good: Use Kellums grip or Closed Mesh Support Grip, proper rigging, and supports to protect bundle/umbilical

CEMS Umbilical Overview

- Best Practices





CEMS Umbilical Overview

❖ Best Practices

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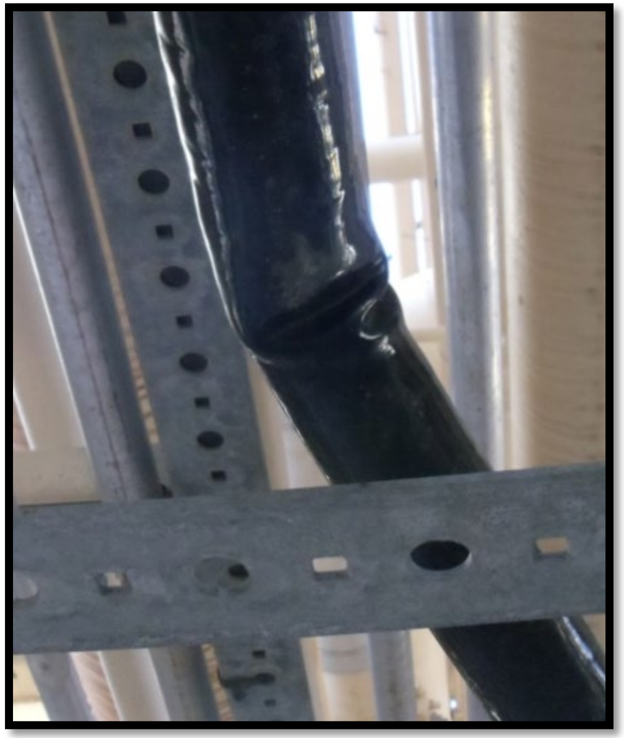
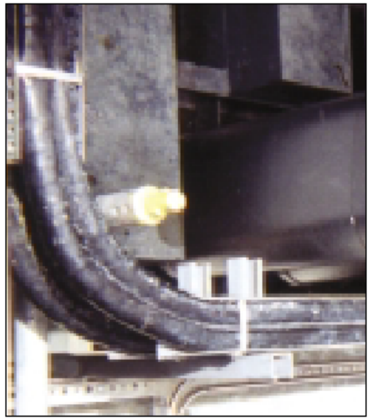


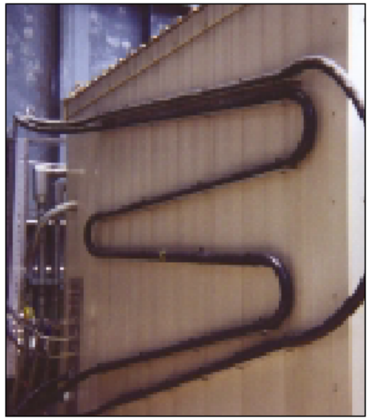
X

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.

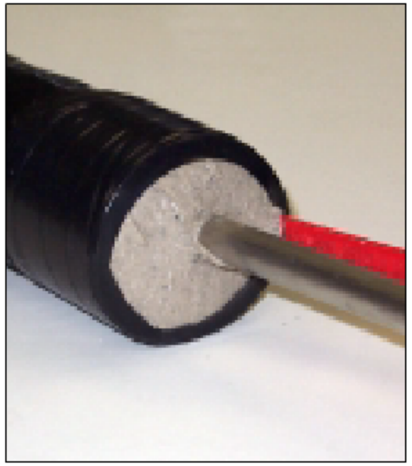
CEMS Umbilical Overview

❖ 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

❖ 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