

CATHODIC PROTECTION
OPERATIONS AND MAINTENANCE MANUAL

VA MEDICAL CENTER

WALLA WALLA, WA

"JONATHAN M MAINWRIGHT" 150,000 GALLON ELEVATED TANK

CORRPRO SYSTEM NO. 92130

PREPARED FOR:

**WALLA WALLA ELECTRIC
1225 WEST POPULAR STREET
WALLA WALLA, WA 99362**

ATTENTION:

Steve Alessio

PROJECT MANAGER

Monday, November 21, 2016

**Prepared By:
Juan Carlos Mendoza**

**Reviewed By:
John Rettig**

corrpro[®]
An Aegion® Company

**645 W. 24th STREET, SUITE 102
TEMPE, AZ 85282
(602)-269-7641
Corrpro job # S2002337**

CORRPRO WATERWORKS

OPERATIONS AND MAINTENANCE INSTRUCTIONS

TABLE OF CONTENTS

SECTION 1	INTRODUCTION
SECTION 2	UNDERSTANDING CATHODIC PROTECTIONS
SECTION 3	CATHODIC PROTECTION SUBMITTAL
SECTION 4	SERVICE REPORT & FINAL TESTING
SECTION 5	INSTRUCTIONS FOR TASC VIII RECTIFIER
SECTION 6	RECTIFIER SURVEILLANCE & TROUBLESHOOTING
SECTION 7	WARRANTY
SECTION 8	"SAMPLE" SERVICE AGREEMENT & ADDITIONAL SERVICES
SECTION 9	PREVENTATIVE MAINTENANCE & MONTHLY MONITORING LOG
SECTION 10	SYSTEM SHUTDOWN & RE-ENERGIZE MAINTENANCE SCHEDULE
SECTION 11	SAFETY
SECTION 12	MANUFACTURER'S INFORMATION, & LOCAL REPRESENTATIVE



SECTION 3

CATHODIC PROTECTION SUBMITTAL



CATHODIC PROTECTION SUBMITTAL

(REVISED)

**VA MEDICAL CENTER
WALLA WALLA, WA
"JONATHAN M MAINWRIGHT"
150,000 GALLON ELEVATED TANK
CORRPRO SYSTEM NO. 92130**

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1225 WEST POPLAR STREET
WALLA WALLA, WA 99362**

ATTENTION:

**STEVE ALLESSIO
PROJECT MANAGER**

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Tuesday, April 14, 2015
.....

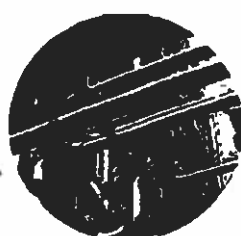
**Prepared By:
CORRPRO**

**Reviewed By:
JACK RIPLEY**

corrpro
Corrosion Control Systems, Inc.

**5141 W. MONTEBELLO AVE.
GLENDALE, ARIZONA 85301
(602) 269-7641**

Corrpro job # - 52002337



corrpro[®]

Environment
Energy
Infrastructure

The Complete Source for Corrosion Control Materials



COMPANY OVERVIEW

Corrpro is the leading North American supplier of corrosion protection and specialty coatings services to the energy and water infrastructure industries. We offer our clients one stop for all their corrosion solution needs including engineering, installation, pipeline integrity, materials, and coating inspection. Furthermore, Corrpro has over 28 offices in North America which serve our customers in the oil, gas, pipeline, refining, water, above and below ground storage tank, infrastructure, and offshore markets. In essence, no matter where corrosion occurs, Corrpro has a solution.

OUR MISSION

Through Teamwork and Superior Execution, Corrpro's Mission is to Deliver Unwavering Quality Services and Materials.

We Value
Results
Ethics
Safety
People
Environment
Customer
Teamwork

CORRPRO WATERWORKS

SUBMITTAL

TABLE OF CONTENTS

NSF-61 CLASSIFICATIONS

DESIGN CALCULATIONS

DESIGN DRAWINGS

TYPICAL DRAWINGS

CATHODIC PROTECTION MATERIALS

CUT SHEETS

- RECTIFIER
- ANODE MATERIAL
- WIRE
- SPLICE MATERIALS
- POLY BRAID ROPE
- FLOATS
- PRESSURE FITTING
- REFERENCE ELECTRODES
- CONDUIT

WARRANTY

ANSI / NSF – 61 CLASSIFICATION



5643 N. 52nd Avenue
Glendale, Arizona 85301
Phone 602-269-7641
Fax 623-842-9697

Attention: Project Engineer

**Reference: Cathodic Protection - Water Storage Tanks
NSF-61 Requirements**

The purpose of this letter is to inform the Project Engineer the successful bidder "Corpro", meets all of the requirements contained within the project specifications and the State regulated requirements associated with the provisions of NSF-61. The provisions of NSF-61 address the ANSI/NSF 61 Classification of all system components exposed to the Interior of the tank. The requirements of ANSI/NSF 61 were put in place by the American National Standards Institute (ANSI) and the National Sanitation foundation (NSF) as a result of the "Safe Drinking Water Act" to prevent contamination and ensure the quality of the water supplies within the United States. Many States, including yours, have adopted legislation to ensure that all components introduced within a water tank, conform to the requirements of NSF-61. If you are not familiar with the regulations within the State, please refer to The Association of State Drinking Water Administrators website (www.asdwa.org). NSF 61 classification of drinking water system components is achieved through a testing and compliance process that can be administered by NSF International or through Underwriters Laboratory, as well as, other accredited third party organizations. Both organizations are accredited through ANSI to provide NSF 61 compliance for materials used in drinking water systems. Each company maintains a separate listing of companies and system components under contract with their respective organization.

Corpro Waterworks, a division of Corpro maintains a contract with UL for our cathodic protection system components for drinking water applications. Our listing of cathodic protection system components which are NSF 61 classified for drinking water application can be found on the UL Website, www.ul.com/water/prodcert/components.html

1. Click on "Certifications" on the left side of page.
2. Type "Corpro" in Company Name. Press Enter.
3. Click on FDNP.MH17837 below Link to File.

Upon completion of the project, Corpro Companies Inc. will issue a certificate listing the components used on the project which certifies compliance. A copy of the certificate is attached for your review.

Corpro Waterworks bid was based upon complete conformance with the project specifications and State regulations, including the ANSI/NSF 61 classification for all materials as was stated on our proposal. Corpro Waterworks has a substantial investment involved with obtaining and maintaining the ANSI/NSF 61 classification for the materials utilized in our cathodic protection systems. The requirements of ANSI/NSF 61 include classification for all materials exposed to the tank interior.

Should you have any questions or require additional information, please do not hesitate to contact me.

Respectfully,

Jack C. Ripley
National Operations Manager
Corpro Companies, Inc.



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Drinking Water System Components,
Additives and Treatment Units

Drinking Water Products



Directory

www.ul.com/eph



Addendum A

ASDWA Member Survey on State Adoption of NSF/ANSI Standards 60 and 61

State	Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Effective Date of Regulation and Latest Update	
				Standard 60	Standard 61
Alabama	Yes	335-7-6.12/8.04	No	November 9, 1992	November 9, 1992
Alaska	Yes	18 AAC 80.030	No	May 18, 1994	May 18, 1994
Arizona	Yes ¹	AAC R18-4-213	Yes	January 1, 1993	January 1, 1993
Arkansas	Yes	PWS Reg. VILF	Yes (policy)	October 1, 1994	October 1, 1994
California	Yes ²	CCR Title 22: 64590/64591	Yes ²	January 1, 1994	March 9, 2008
Colorado	Policy		Yes (policy)		
Connecticut	No		No		
Delaware ⁶	Yes	PWS Reg. 2.11.1.1	No ³	August 11, 1999	August 11, 1999
Florida	Yes	62-555.320(3) + 3220 FAC	No	January 1, 1993	January 1, 1993 January 1, 1994 ⁴
Georgia	Yes	Rules 391-3-5	Yes	July, 1992	July, 1992
Hawaii	Yes ⁵	HAR 11-20-38	Yes	September 7, 1999	
Idaho	Yes	58.01.08.501.01 58.01.08.510.02	Yes	October 1, 1993	October 1, 1993
Illinois ⁶	Policy ⁶				
Indiana ⁶	Yes	327IAC 8-1-2	Yes	May 1, 1999	May 1, 1999
Iowa ⁶	Yes	41.4 (3) b; 43.3 (8)	Yes	October 1, 2000	August 11, 1999
Kansas	Policy ⁷		Yes (policy)		
Kentucky	Policy		Yes (policy)		
Louisiana	No		No		
Maine	Yes	10-144-231 Sec 3 F.7.8	Yes	July 1, 2008	July 1, 2008

¹ AZ: Legislation revised 7/96 to allow exceptions where 60-61 materials and equipment not available.

² CA: Requires annual testing and inspections for ANSI accredited certification of treatment chemicals to NSF 60.

³ DE: Uses NSF list or equivalent guide but does not require for compounds not listed under either standard.

⁴ FL: 1993 is for coatings and chemicals. 1994 is for other components.

⁵ HI: Adopted for Standard 60; Legislation for Standard 61, section 9 signed May 2, 2001.

⁶ State policy or regulations reference the "10 State Standards for Water Works" which references Standard 60 for treatment chemicals and Standard 61 for certain water treatment and distribution products.

⁷ KS: K.A.R. 28-15-18 (h) authorizes approval of treatment chemicals and protective coatings exposed to water for public consumption. KS has no regulations specifically for standards 60 or 61.

State	Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Effective Date of Regulation and Latest Update	
				Standard 60	Standard 61
Maryland	Yes	COMAR 26.04.01.33	Yes ⁸	December, 1992	December, 1992
Massachusetts ⁹	Yes	310 CMR 22.04(8)	Yes	November, 1992	November, 1992
Michigan ⁶	Yes	MI SDWA 325.1013 +325.12102	Yes	September 16, 1993	September 16, 1993
Minnesota ⁶	Policy		Yes (policy)		
Mississippi	Policy		Yes (policy)		
Missouri ⁶	Yes	10 CSR 60	Yes	April, 1992	April, 1992
Montana	Yes	ARM 17.38-101	Yes	September, 1992	September, 1992
Nebraska	No		No		
Nevada	Yes	NAC 445A.6663	Yes	February, 1997	February, 1997
New Hampshire	Yes	Env-Ws 305	Yes	June, 1997	June, 1997
New Jersey	Yes	NJAC 7:10-8	Yes	June, 1997	June, 1997
New Mexico ⁶	Yes	WSR 20.7 10.400K	Yes	July, 1992 Revised 2007	July, 1992 Revised 2007
New York ⁶	Policy		Yes (policy)	July, 1993	July, 1993
North Carolina	Yes	15A NCAC 18c .1537	Yes	July 1, 1994	July 1, 1994
North Dakota	Yes	NDAC 33-17-01-19.4	Yes	January 31, 1997	January 31, 1997
Ohio ⁶	Yes	OAC 3745-83-01(d)	Yes	Revised April 21, 2001	Revised April 21, 2001
Oklahoma	Yes	OAC 252.626-11.1 + 19.1	Yes (policy)	Update effective June 1, 2003	Update effective June 1, 2003
Oregon	Yes	333-61-0087(05)&(06)	Yes (policy)	November 13, 1989	November 13, 1989
Pennsylvania ⁶	Yes	25 PA Code 109.606	Yes	October 8, 1994	October 8, 1994
Rhode Island ⁶	Yes	DWQ 4613 4.1A	Yes	January, 1993	January, 1993
South Carolina ⁵	Yes	R.61-58.2 (B) 4& (E) 3	Yes	July 28, 1995	December 31, 1995
South Dakota	Policy		Yes (policy)		
Tennessee	Yes	1200-5-1-.17(36)	Yes	January, 1995	January, 1995
Texas	Yes	TAC 290.42(j): 43 (c) (8); 44 (a) (1,2); 44 (j) (2) (B/H)	Yes	January 1, 1993	January 1, 1993
Utah	Yes	R.309-105-10(1)(a)/10(2)(c)	Yes	July, 1989	July, 1989

⁸ MD: Also accepts third party certifications.

⁹ MA: Also requires maximum lead content of 3% in brass products.



State	Adopted Legislation or Regulations	State Citation	ANSI-Accredited Certifier Required	Effective Date of Regulation and Latest Update	
				Standard 60	Standard 61
Vermont	Yes	VWSR Ch. 21 App. A 5.2.2	Yes	September 24, 1992	September 24, 1992
Virginia	Yes	12 VAC 5-590-860 & 1110	Yes	November 15, 1995	November 15, 1995
Washington	Yes	WAC-246-290-220	Yes	April, 1999	April, 1999
West Virginia	Yes	64 CFR 77	Yes	July, 2000	July, 2000
Wisconsin ⁴	Yes	NR811.07(4)(c), (f)	Yes	May, 1993	May, 1993
Wyoming	Policy ¹⁰				

¹⁰ WY: Recommends use of the standards. Cannot require because state does not have primacy for drinking water regulations.



FDNP.MH17837 Drinking Water System Components

[Page Bottom](#)

Drinking Water System Components

[See General Information for Drinking Water System Components](#)

CORRPRO WATERWORKS
1055 W SMITH RD
MEDINA, OH 44256 USA

MH17837

ANSI/NSF STANDARD 61

Mechanical Devices

Trade Dsg	Water Contact Temp (°C)	Water Contact Mtl	Surface Area to Volume Ratio
Automatically Controlled Impressed Current Systems			
ACIC-(a)	23	Multiple	-
Galvanic Systems			
G-(b)	23	Multiple	-
Manually Controlled Impressed Current Systems			
MCIC-(a)	23	Multiple	-

(a) - Combinations of 1-2, 3 or 4, and 7-16. Greater than 25,000 gal.

(b) - Combinations of 1-2, 5 or 6, and 7-16. Greater than 25,000 gal.

NOTE - Product is classified as an entire system when using various combinations of the Corpro Cathodic Protection System Model Components: 1. Insulated Cable/Wiring; 2. Sealer; 3. Platinized Niobium (P/N) Anode; 4. Titanium Anode; 5. Galvo-Rod Magnesium Anode; 6. Galvo-Mag Magnesium Anode; 7. IHRP801CT Reference Electrode; 8. Rope; 9. Pressure Entrance Fitting; 10. Floats; 11. Shock Card; 12. Rubber Gasket and Insulator; 13. Suspension Stabilizer; 14. Electrical Tape; 15. Heat Shrink Tube; 16. Cable Ties. Components of the Classified product can be replaced in the field with components that appear on the "Authorized Wetted Parts List".

[Last Updated](#) on 2011-02-11

[Questions?](#)

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[Page Top](#)

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UNDERWRITERS LABORATORIES INC.

An independent, not-for-profit organization testing for public safety

CORPRO WATERWORKS MANUFACTURE REFERENCE No. **MH17837**
COMPANY NAME

1055 West Smith Road CERTIFICATE No. _____
ADDRESS

Medina, OH 44256
CITY, STATE, ZIP CODE

The above company is qualified under the Classification and Follow-up Service of Underwriters Laboratories Inc. to furnish Drinking Water Treatment Components Classified with respect to Standard ANSI/NSF 61.

The above mentioned company is therefore authorized to issue this Certificate for the bulk shipment of material described below as it's representation that such material is manufactured in compliance with requirements established by Underwriters Laboratories Inc. for this class of product. This Certificate does not indicate proper application or use of the material and does not apply to other material, which may be used at the location specified.

-- SEE U L PLUMBING AND ASSOCIATED PRODUCTS DIRECTORY --

TRADE DESIGNATION: _____ CATEGORY **Mechanical Devices**
USE LEVEL: **25,000 Gallon Tanks or Larger**



ANSI / NSF 61
DRINKING WATER SYSTEM COMPONENTS
7N53

Date of Issuance of Certificate: _____

Date Material Supplied: _____

Carrier: **Waterworks Crew** City/State _____

Description of Container: **Corpro Waterworks Crew Vehicle**

Bill of Lading No. **N/A**

Shipped To: _____ City/State _____

Signature of Authorized Person : _____



Underwriters Laboratories Inc.®

Applicant: MH17837
CORRPRO WATERWORKS
 1055 W SMITH RD
 MEDINA OH 44256

Contact: Teresa Cover
 phone: 330-764-9282

Manufacturer: 874056001
 Corpro Waterworks
 1055 W. Smith Road
 Medina, OH 44256

Authorized Wetted Parts List for Automatically Controlled Impressed Current Systems, Galvanic Systems, and Manually Controlled Impressed Current Systems

(overall volume = 94635 liters)

This document must be available for review by the UL Field Representative upon request

Part Number	Description	Material	Manufacturer	Volume (liters)	Weight (lb)	Supplier	Supplier Address
001	Insulated Wire	#4 cu-HW WPB Electrical Wire	Electrical Wire	0.256	24194	Kelas Manufacturing, Inc. (T2314)	25 Main St. P.O. Box 328, Denver, PA. 717 316-5575 17517
001	Insulated Wire	#4 cu-HW WPB Electrical Wire	Stranded Electrical Wire	0.256	24194	(alternate) Kris-Tech Wire Company (Rome, NY) (T2325)	921 Seneca Street, P.O. Box 4377, Rome, NY 13442
001	Insulated Wire	#4 cu-RHW-2/US-2 Electrical Wire	Electrical Wire	0.256	24194	(alternate) Kris-Tech Wire Company (Rome, NY) (T2325)	921 Seneca Street, P.O. Box 4377, Rome, NY 13442
002	Sealer	K2-A Series Power Cable Splice Kit No. 82-A	Various		one kit	(alternate) 3M (Minnesota Manufacturing & Mining) (CX441)	Electrical Products Division, 6801 River Place Blvd, Austin, TX 78726
002	Sealer	Vulco-Wrap Vulcanizing Tape	Product # 34412, Self-Vulcanizing SHEET VULCANIZING TAPE	0.085	463	(alternate) TPC Wire & Cable (Independence, OH) (T2312)	7061 E. Pleasant Valley Road, Independence, Ohio, 800-521-7935 44131
002	Sealer	Seachest Brand Resin #4	Made of part A & B	0.034	3226	3M (Minnesota Manufacturing & Mining) (T4243)	Electrical Products Division, 6801 River Place Blvd, Austin, TX 78726
003	Platinized Niobium Anode	Platinized Niobium Anode	0.02 diameter max	0.034	3226	Anomel Products (Shrewsbury, MA) (T2315)	820 Boston Turnpike, Shrewsbury, MA 01545
004	Activated Titanium Anode	Titanium Anode (250 in diameter max)	formula on file for 0.062 in. diameter maximum	0.026	2415	Eltech Systems Corporation (HQ) (T2316)	160 Seventh Ave., Suite #500, Chardon, OH 44024
005	Magnesium Anode	Galvotec SuperROD GA-MG-R1 315	Various	0.631	59677	(alternate) Galvotec Alloys, Inc. (T10934)	6712 S. 16th St., McAllen, TX 78503, 956-630-3500
005	Magnesium Anode	Galvotec SuperROD GA-MG-R2 024	Various	0.631	59677	(alternate) Galvotec Alloys, Inc. (T10934)	6712 S. 16th St., McAllen, TX 78503, 956-630-3500
005	Magnesium Anode	Galvo Rod Magnesium Anode	2" diameter max	0.631	59677	Winca Group, Inc. (Shandong, China) (T4775)	One Chemical Road, Weizhen, Shandong, China 271400 China
005	Magnesium Anode	GROD Magnesium Anode	Magnesium AZ31B	0.631	59677	(alternate) Timminco Corporation (former Dow Corning) (Aurora, CO) (T4786)	3351 Maline Street, Aurora, CO 80010

CONFIDENTIAL PRODUCT INFORMATION

Reviewed By: Keith Pellason

Issued: 2009-02-17

File MH17837

Vol. 1

Sec. 1

Page 1 of 2

Revised: 2010-07-07



Underwriters Laboratories Inc.®

Item Number	Description	Material	Material	Material	Material	Material	Material
006	Magnesium Anode	GMAG Magnesium Anode	Magnesium MIC	0.631	59677	(alternate) Timminco Corporation (former Dow Corning) (Aurora, CO) (T4786)	3393 Molino Street, Aurora, CO 80010
006	Magnesium Anode	Galvo Mag Magnesium Anode	2" diameter max	0.631	59677	(alternate) Winca Group, Inc (Shandong, China) (T4775)	One Chemical Road, Fecian, Shandong, China 273400 China
	Magnesium Anode Assembly	Magnesium Anode Assembly	Various			(alternate) Corpro Waterworks (XX512)	11616 W 39th St, Sand Springs, OK 74061
007	Reference Cell	Permaceil IHRP-801-CT	Various	0.017	1613	Corpro Companies, Inc (XX383)	
008	Rope	Poly Rope (R3020S1000)	5/16" Diameter Natural Polyester Double Braided Rope	0.153	14516	Gladding Braided Products (South Otselc, NY) (T4721)	One Gladding Street, P.O. Box 164, South Otselc, NY 13155-0164
009	Pressure Fitting - 1" 4 wire (01950063)	Pressure Entrance Fitting	Various	0.017	1613	Technical Fabrication Corporation (XX472)	3227 Cottonwood School Road, Rosenberg, TX 77471
009	Pressure Fitting - 1.25" 4 wire Flange (A129734WT)	Pressure Entrance Fitting	Various	0.017	1613	(alternate) Technical Fabrication Corporation (XX472)	3227 Cottonwood School Road, Rosenberg, TX 77471
009	Pressure Fitting - 1.5" 5 wire (01950058)	Pressure Entrance Fitting	Various	0.017	1613	(alternate) Technical Fabrication Corporation (XX472)	3227 Cottonwood School Road, Rosenberg, TX 77471
009	Pressure Fitting - 1.5" 6 wire (01950059)	Pressure Entrance Fitting	Various	0.017	1613	(alternate) Technical Fabrication Corporation (XX472)	3227 Cottonwood School Road, Rosenberg, TX 77471
010	Float	Model 1100	K-50 Floatation Buoy		five floats	Gladding (N.Hollywood, CA) (T2320)	3216 Vineland Ave., N. Hollywood, CA 91601
010	Float	Model 04-5623-91	Plasticized Polyvinyl Chloride		five floats	(alternate) Spongex Corporation (Shelton, CT) (T2321)	6 Dredge St, Shelton, CT 06484
011	Shock Cord	Shock Cord	1/2" Diameter Poly-Rubber Shock Cord	0.061	6452	Gladding Braided Products (South Otselc, NY) (T4721)	One Gladding Street, P.O. Box 164, South Otselc, NY 13155-0164
012	Rubber Gasket	Gasket, 6" diameter	SHR Rubber	0.051	4839	Philpot Rubber (T2324)	1010 Industrial Pky, Brunswick, OH
013	Suspension Stabilizer Model 2119	Suspension Stabilizer	Model 2119	0.034	3226	Porcelain Products (Carey, OH) (T2319)	225 N. Patterson Street, Carey, OH 43316
013	Suspension Stabilizer Models 5107, 5116, 5119	Suspension Stabilizer	Models 5107, 5116, 5119	0.034	3226	(alternate) Porcelain Products (Carey, OH) (T2319)	225 N. Patterson Street, Carey, OH 43316
014	Electrical Tape	3M Super 33+ Vinyl Electrical Tape - No Lead	Vinyl Electrical Tape	0.01	929	3M (Minnesota Manufacturing & Mining) (T4243)	Electrical Products Division, 6801 River Place Blvd, Austin TX 78726
015	Heat Shrink Tube	ITCSN Heavy Wall Heat Shrink Tubing (ITCSN-1500)	Adhesive-Lined Polyolefin	0.005	466	3M (Minnesota Manufacturing & Mining) (T4243)	Electrical Products Division, 6801 River Place Blvd, Austin TX 78726
016	Cable Ties	Nylon Cable Ties 50 pound	Not to exceed 12" length	0.01	919	Bay State Cable Ties (T4788)	

Meets Health Effects criteria of ANSI/NSF Standard 61

CONFIDENTIAL PRODUCT INFORMATION		Reviewed By: Keith Peltason	Issued: 2009-02-17
File MH17837	Vol. 1	Sec. 1	Page 2 of 2
			Revised: 2010-07-07



DESIGN CALCULATIONS



150,000 GALLON RESERVOIR VA MEDICAL CENTER WALLA WALLA, WASHINGTON

Insert input data here:			Results		
Bowl Diameter	34	feet	Current Required	1.1	amps
Bowl Height	32	feet	Voltage Required	7.0	volts
Coating Efficiency	75.0%	coated steel	Minimum Anode Matr. Req'd.	54	feet
Current Density	1	mA/sq. ft.	Actual Length of Anode Matr.:	57	feet
Anode Type	.062"	Titanium MMO	Actual Rating of Rectifier Unit:	30 volts / 8 amps	
Water Resistivity	4500	ohm-cm	Design Life of Anode System:	21	years

DESIGN CALCULATIONS 150,000 GALLON RESERVOIR VA MEDICAL CENTER WALLA WALLA, WASHINGTON

COMPUTATIONS:

1 Surface Area to be Protected:

Bare surface Area = Total Surface Area x (1 - Coating efficiency)

$$A_T = \pi (R^2 + 2R L_p)$$

where:

$$R = \text{Tank Radius} = 17.0 \text{ ft.}$$

$$L_p = \text{Tank Height} = 32.0 \text{ ft.}$$

$$A_T = \pi (17.0^2 + 2 \times 17.0 \times 32.0)$$

$$A_T = 4,326 \text{ sq. ft.}$$

Factoring in coating efficiency, the area of bare steel is:

$$A_B = A_T \times (1 - C_I)$$

where:

$$C_I = \text{Coating Efficiency} = 0.75$$

$$A_B = A_T \times (1 - 0.75)$$

$$A_B = \underline{1,081} \text{ sq. ft.}$$

2 Current Required:

The amount of current required to achieve protection is based upon the total submerged surface area of the tank bowl, the type of coating and the condition of the coating as well as a chemical analysis of the water expressed in ohm-cm.

$$I_T = A_B \times C_d$$

where:

$$I_T = \frac{C_d}{1,081.5} \times 1. \quad \text{Current density} = 1.0 \text{ mA/sq. ft.}$$

$$I_T = 1,081 \text{ mA or } \underline{1.1} \text{ Amps}$$

3 Anode Type: Titanium Mixed Metal Oxide Wire Anode:

Dimensions:

diameter:	0.062	inches
length:	684	inches
anode rating:	20	mA/ft

$$L = I / I_A$$

where:

L = Minimum Bowl Anode Wire Length (feet)

I = Total Current Required in Bowl (amps)

I_A = Anode Rated Output (amps/ft)

$$L = 1.1 / 0.020 \quad (\text{this is for anode material rated @ 20mA/ft.})$$

$$L = 54 \text{ feet (minimum length required)}$$

57 feet - actual length utilized within system design to ensure even current distribution within the tank.

4 Rectifier Voltage Rating:

Dwight's equation for the anode's resistance to water is:

$$R = \frac{\rho}{L} \left(\ln \left(\frac{4 \times L}{r} \right) - 1 \right)$$

R = Anode to Water resistance

ρ = Water resistivity = 4,500 ohm-cm

r = Anode radius = 0.031 inches

L = Anode length = 684 inches

$$R = \frac{4500}{684.0} \left(\ln \left(\frac{4 \times 684}{0.031} \right) - 1 \right)$$

$$R = 4.29 \text{ ohms}$$

$$E = (I) (R) (1.5)$$

where:

$$E = I R S F$$

E = Rectifier Voltage (volts)

I = Required Current 1.081 amps

R = Anode Resistance 4.285 ohms

Sf = Safety Factor 50 %

$$E = 1.1 \times 4.3 \times 1.5$$

$$E = 7.0 \text{ D.C. Volts}$$

5 Anode System Design Life:

$$L = \frac{C_{dr} \times 20}{C_{da}}$$

where:

L = Anode Life in Years

C_{dr} = Rated Anode Output = 20mA/ft

C_{da} = Actual Anode Output (mA/ft)

$$C_{da} = \frac{I}{L}$$

where:

I = Maximum Current Output in mA

L = Total Length (feet) of Anode Material Actually Utilized

$$C_{da} = 1,081.5 / 57 = 19.$$

$$L = \frac{(20)(20)}{18.97}$$

$$L = \underline{\underline{21}} \text{ year design life}$$



NACE
INTERNATIONAL

Certificate of Recognition

This certifies that

Cade Johnson

has satisfied the requirements of the Association
for recognition as a

Cathodic Protection Specialist

August 2012

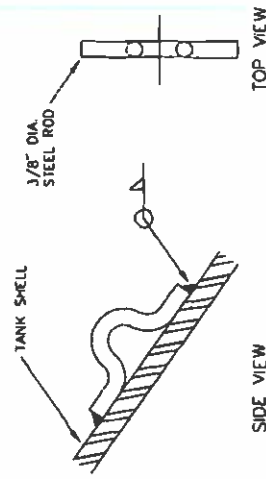
Certification Number 22520

Robert H. Chalker- Executive Director



This certificate is the property of NACE International and must be surrendered when recognition ceases.
This certificate remains in force only as long as the above named person complies with the requirements of this
program. Confirm current status by contacting NACE International, 1440 South Creek Drive, Houston, TX 77084

DESIGN DRAWINGS

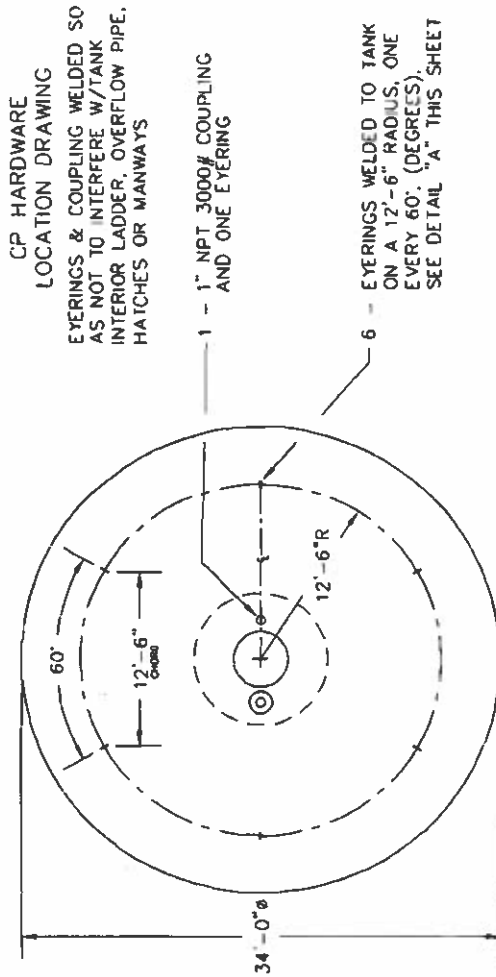


SIDE VIEW

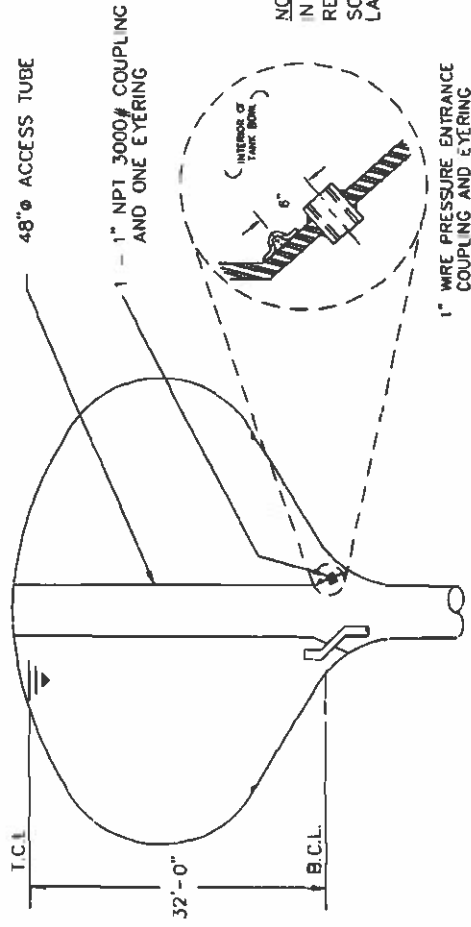
TOP VIEW

NOTE: CP HARDWARE TO BE PAINTED IN ACCORDANCE
WITH PROJECT SPECIFICATION

NOTE: WIRE ENTRANCE COUPLING IS USED IN ASSOCIATION WITH JUNCTION BOX AND REQUIRES A MINIMUM 8" (IN) CLEARANCE SO AS NOT TO INTERFERE WITH HATCHES, LADDERS OR OVERFLOW PIPE



48" Ø ACCESS TUBE

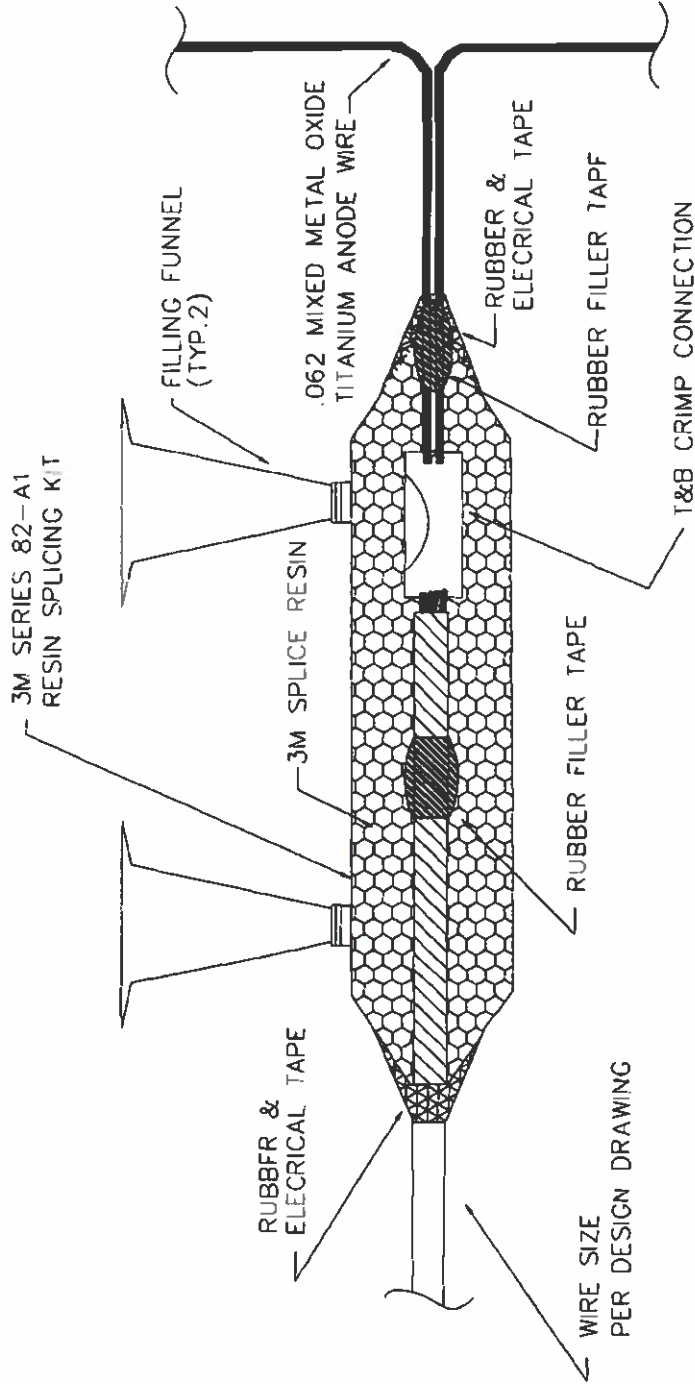


1" WIRE PRESSURE ENTRANCE
COUPLING AND EYERING

NO.	DATE	BY	REVISION	CORRPRO SYSTEM NO. 92130	REFERENCE DRAWINGS	VA MEDICAL CENTER "JOHNATHAN MAINWRIGHT" WALLA WALLA, WASHINGTON	CATHODIC PROTECTION SYSTEM 150,000 GALLON SPHEROIDAL 32'-0" B.C.L. HARDWARE DETAIL DRAWING	DRAWN BY DESIGNED BY DATE SCALE SHEET 1 OF 2 DWG No.	JCR CORRPRO 1-6-15 NONE 921
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TYPICAL DRAWINGS



CORRPRO SYSTEM NO.		REFERENCE DRAWINGS		ANODE TO CABLE HEADER SPLICE DETAIL		CATHODIC PROTECTION SYSTEM		DRAWN BY JCR	
								DESIGNED BY	
								DATE	10/16/14
								SCALE	NONE
								SHEET	OF
								DWG No	SPLICE DETAIL
NO.	DATE	BY	REVISION						

CATHODIC PROTECTION MATERIAL **CUT SHEET**

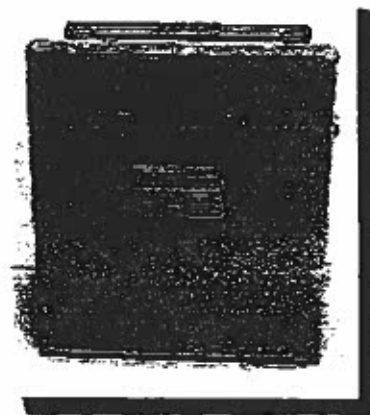
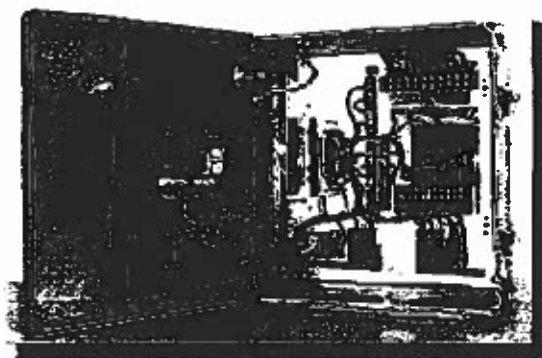
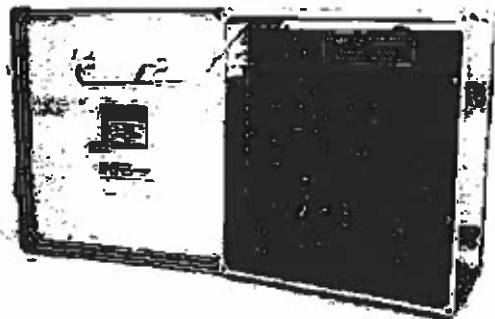
RECTIFIER

CORRPRO® RECTIFIERS**T.A.S.C.® Rectifier****Description**

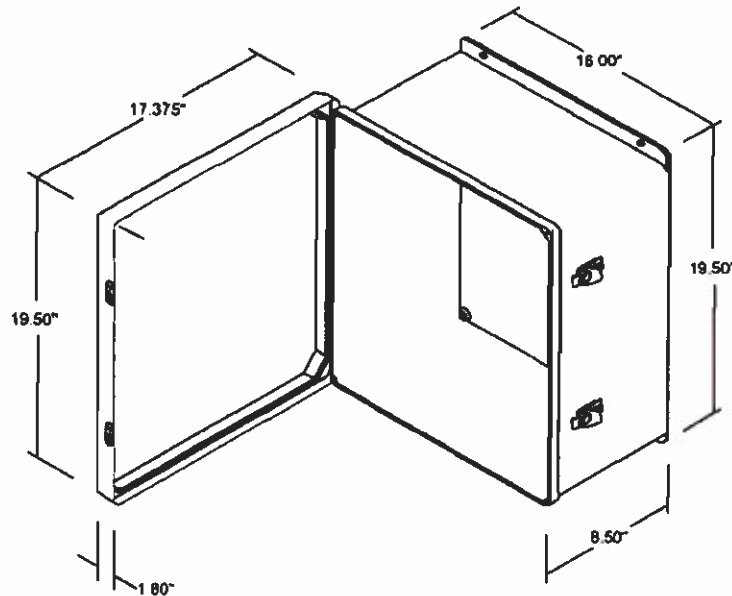
The Corpro Tank Automatic Sampling Controller (T.A.S.C.®) Rectifier is specifically designed to provide accurate, economical corrosion control for the submerged surfaces of steel water storage tanks and water / wastewater treatment units. The T.A.S.C.® is designed by NACE accredited cathodic protection specialists for optimum performance in accordance with ANSI/AWWA D104, IR Drop Free control standards. The T.A.S.C.® automatically monitors and adjusts the DC output required for optimum corrosion control. The T.A.S.C.® control unit is equipped with an automatic potential limit, which is adjusted to maintain AWWA D104 and NACE criteria for optimum cathodic protection corrosion control while preventing over or under protection of the coated surface. Superior design, engineering and operation provide owner/operators with long life, low maintenance performance. The standard digital display meters facilitate ease of monitoring, with performance indicator lights on the front cabinet available as an optional extra feature. Each T.A.S.C.® is both factory and job site tested to ensure quality workmanship and performance.

Features

- Totally automatic control
- Eliminates "IR" drop error
- Controls from 0 to 100% of rated output
- Automatic current limiting
- Silicon rectifier stacks
- Upgraded lightning protection (AC and DC)
- Plug-in automatic control circuit board
- Manual operation mode
- NEMA 4X enclosure
- High intensity LED digital meters
- Individual circuit shunts
- CSA (Canadian Standards Association) approved
- Full height silkscreened instrument panel



ENCLOSURE DIMENSIONS



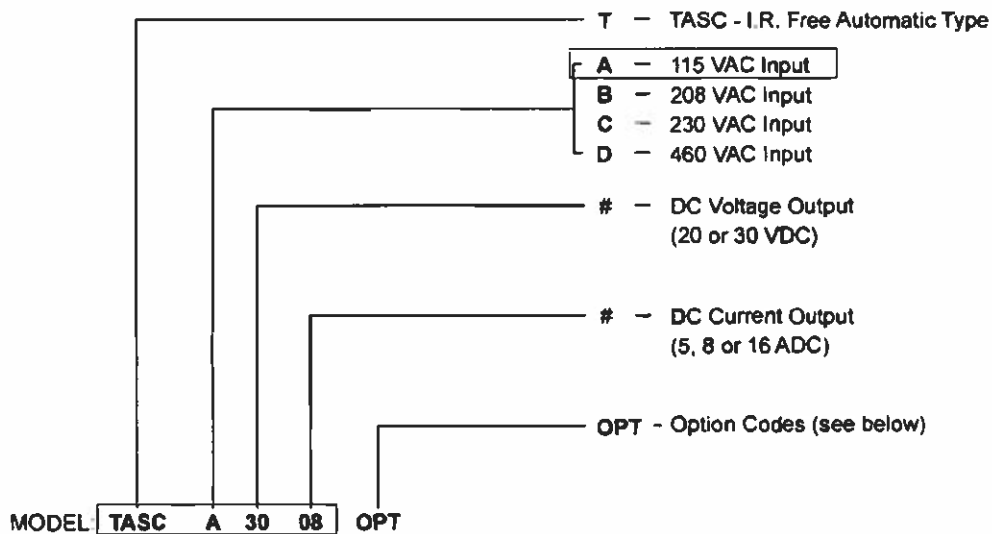
MOUNTING DIMENSIONS (CENTER TO CENTER)

WIDTH - 12.00"
HEIGHT - 18.75"
HOLE SIZE - 0.34" (11/32)

OVERALL CLEARANCE DIMENSIONS:

WIDTH - 18.00"
HEIGHT - 19.50"

ORDERING GUIDE



OPTIONAL CODE SUMMARY

C - Secondary Anode Circuit
J - Potential Monitor Alarm

R - Non Standard Enclosure Finish
Z - Unlisted Option (Customer Defined)

(Other options are limited for this series, please consult factory)

ANODE MATERIAL

MIXED METAL OXIDE ANODES**Corrpro® Mixed Metal Oxide Wire Anodes****Lightweight and Dimensionally Stable**

The many benefits obtained by using mixed metal oxide anodes are well known. These include low consumption rates, dimensional stability and high current densities. Wire mixed metal oxide anodes possess all these characteristics and also offer greater installation flexibility. The anodes are composed of a copper core, which is surrounded by a titanium substrate. Metallurgically bonded to the substrate is a mixed metal oxide coating. The combination of these three materials produces an anode capable of superior operating performance. The titanium is inherently resilient and stable, allowing the wire anode to be extremely flexible. Because this metal does not discharge current, electrical current transfer is accomplished through the mixed metal oxide coating. The coating is immune to abrupt current reversals, and may receive high current overloads for initial polarization without causing harm to the anode.

Corrpro wire anodes can be used in numerous geometries. In water storage tanks, the anode is often suspended by rope in configurations that follow the circumference of the structure. This design permits even current distribution. It also produces a cathodic protection system that is not susceptible to damage from icing. Because the anode is a continuous wire, failures due to poor wire connections are eliminated.

Applications

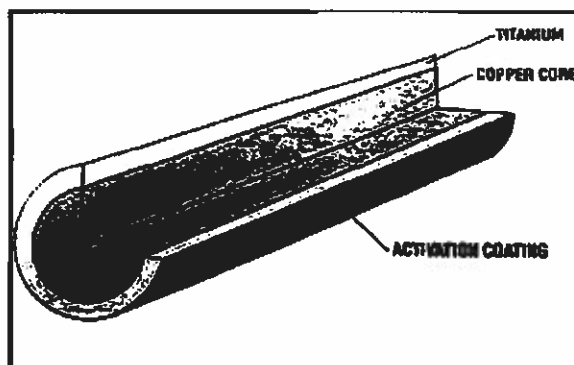
Corrpro mixed metal oxide anodes can be used in both aqueous and soil electrolytes. They deliver superior protection in fresh, brackish or salt waters, and have been found to be resistant to acid attack. The anodes can operate in temperatures of up to 175°C. They should not be used in electrolytes containing barium or cadmium.

Ordering Procedure

The mixed metal oxide wire anode is available in different current output ratings. To order the right wire anode for your particular application, indicate that you need a mixed metal oxide wire anode. Specify the lineal feet desired and the wire type. An example is provided to illustrate this process.

Ordering Procedure Example

Quantity Lineal Feet	1000 ft
Anode Material	Mixed Metal Oxide Wire Anode
Anode Type	TIR2000 Standard



WIRE



ANNEALED
(SOFT) COPPER

CROSS-LINKED
POLYETHYLENE
(XLP)



Underground Service
Entrance Cable

600 Volt

Copper Conductors

Cross-Linked
Polyethylene (XLP)
Insulation

High-Heat, Moisture,
and Sunlight Resistant

Sizes 6 Through
4/0 AWG Also
Rated SIS

APPLICATIONS

Suitable for use as follows:

- Southwire Type RHH or RHW-2 or USE-2 conductors are used with conduit as specified in the National Electrical Code¹
- When used as Type USE-2, conductor is suitable for use as underground service entrance cable for direct burial at conductor temperatures not to exceed 90°C
- When used as RHH, conductor temperatures shall not exceed 90°C in dry locations
- When used as RHW-2 or USE-2, conductor temperatures shall not exceed 90°C in wet or dry locations
- Voltage rating for RHH or RHW-2 or USE-2 conductors is 600 volts

STANDARDS & REFERENCES

Southwire Type RHH or RHW-2 or USE-2 meets or exceeds UL Standard 44 (for RHH or RHW-2), UL Standard 854 (for USE-2), Federal Specification A-A-59544, and requirements of the National Electrical Code.

CONSTRUCTION

- Southwire Type RHH or RHW-2 or USE-2 copper conductors are annealed (soft) copper
- Insulation is an abrasion, moisture, heat, and sunlight resistant black cross-linked polyethylene (XLP).

SPECIFICATIONS

- Conductors shall be UL-listed Type RHH or RHW-2 or USE-2, suitable for operation at 600 volts or less in wet or dry locations, including direct burial in the earth.
- Conductors shall be annealed copper, cross-linked polyethylene (XLP) insulated, as manufactured by Southwire Company or approved equal.

2005 Edition





COPPER CONDUCTORS

RHH/RHW/USE

WEIGHTS, MEASUREMENTS AND PACKAGING

CONDUCTOR		INSULATION THICKNESS (mils)	NOMINAL O.D. (mils)	ALLOWABLE AMPACITIES†			APPROX. NET WEIGHT PER 1000 FT. (lbs)	STANDARD PACKAGE
SIZE (AWG or kcmil)	NUMBER OF STRANDS			60°C	75°C	90°C		
14	7	45	160	15	15	15	21	A
12	7	45	177	20	20	20	30	A
10	7	45	201	30	30	30	44	A
8	7	60	262	40	50	55	72	B
6	7	60	297	55	65	75	106	B
4	7	60	344	70	85	95	156	B
2	7	60	400	95	115	130	238	B
1	19	80	484	110	130	150	309	B
1/0	19	80	523	125	150	170	381	B
2/0	19	80	567	145	175	195	472	B
3/0	19	80	617	165	200	225	586	B
4/0	19	80	673	195	230	260	729	B
250	37	95	751	215	255	290	867	B
300	37	95	804	240	285	320	1029	B
350	37	95	854	260	310	350	1191	B
400	37	95	899	280	335	380	1352	B
500	37	95	983	320	380	430	1674	B
600	61	110	1089	355	420	475	2012	C
700	61	110	1158	385	460	520	2332	C
750	61	110	1191	400	475	535	2492	C
800	61	110	1223	410	490	555	2652	C
900	61	110	1283	435	520	585	2970	C
1000	61	110	1340	455	545	615	3288	C

†Allowable Ampacities:
 Allowable ampacities shown are for general use as specified by the National Electrical Code, 2005 Edition, section 310.15.
 60°C - When terminated to equipment for circuits rated 100 amperes or less or marked for 14 through 1 AWG conductors.
 75°C - When terminated to equipment for circuits rated over 100 amperes or marked for conductors larger than 1 AWG.
 90°C - RHH dry locations. RHW-2 and USE-2 wet or dry locations. For ampacity derating purposes.

STANDARD PACKAGE CODES

A - 2500 ft. reel
 B - 1000 ft. reel
 C - 500 ft. reel

Solid or Stranded Soft-annealed Uncoated Copper



**Type THHN/THWN-2
Single Conductor 90°C
600 volts**

Conductors shall be UL listed type THHN or THWN or THWN-2 or MTW or AWM suitable for operation at 600 volts at conductor temperatures not to exceed 105°C.

Technical Data Sheet Communication Cables



WEST PENN WIRE

2833 West Chestnut Street
Washington, PA 15301
Toll Free: (800) 245-4964
Fax: (724) 222-6420
www.westpenn-wpw.com

PART NUMBER:	303
DESCRIPTION:	18/3 Stranded bare copper conductors, shielded with an overall jacket.
NEC RATING:	CMR, NEC Article 800
APPROVALS:	(UL) C(UL) Listed or c(ETL)us Listed
APPLICATION:	Indoor for: Intercom, Security, Sound, Audio, Background Music, and Power Limited Control Circuits.

Construction Parameters:

Conductor	18 AWG Bare Copper
Stranding	7x26
Insulation Material	PVC
Insulation Thickness	0.010" Nom.
Number of Conductors	3
Shield	100% Aluminum Polyester Foil
Drain	Stranded Tinned Copper
Jacket Material	PVC
Jacket Thickness	0.015" Nom.
Overall Cable Diameter	0.178" Nom.
Approximate Cable Weight	27.7 Lbs/1M' Nom.
Flame Rating	UL 1666 Riscr Flame Test

Electrical & Environmental Properties:

Temperature Rating	-20°C To +60°C
Operating Voltage	300 V RMS
Max. Capacitance Between Conductors @ 1 KHz	68 pF/ft Nom.
Capacitance Between Conductors to Shield @ 1 KHz	122 pF/ft Nom.
DC Resistance per Conductor @ 20deg C	6.6 Ohms/1M' Nom.
Insulation Colors	Black, Red, White
Jacket Color	Gray
RoHS Compliant	Yes

Mechanical Properties:

Max. Recommended Pull Tension	81.2 lbs.
Min. Bend Radius (Install)	1.75"

Specification Issuc Date: 7/06 Rev.1 5/07

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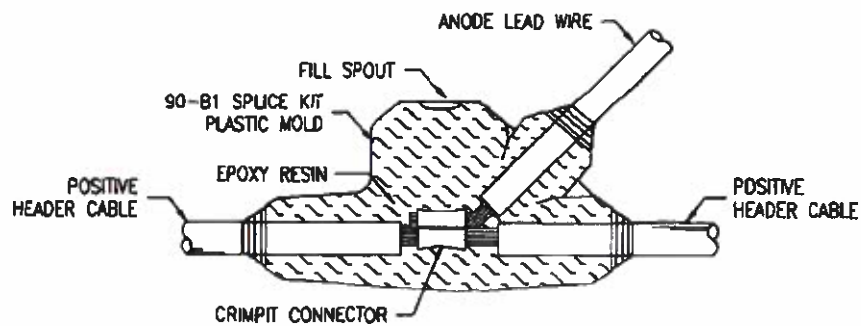
Standard Lengths are 1000ft.
The Jacket is sequentially footmarked.
The information presented here is, to the best of our
knowledge, is true and accurate. However, since
conditions of use are beyond our control, all
recommendations or suggestions are presented
without guarantee or responsibility on our part. We
disclaim all liability in connection with the use of
information contained herein or otherwise.



SPLICE MATERIALS

CABLE, WIRE, AND SPLICING

Cable, Wire, Splicing Materials, Bonding Materials, and Accessories



Scotchcast Ordering Information

Kit Number	Typical Use	Maximum Conductor Size AWG (mm)
85-10	Multi-mold Odd Shaped Connections	#4 Stranded (25)
85-12	Multi-mold Odd Shaped Connections	2/0 Stranded (70)
85-14	Multi-mold Odd Shaped Connections	4/0 Stranded (120)
85-16	Multi-mold Odd Shaped Connections	750 kcmil (400)
82-A1	Inline Splices	#2 Stranded (35)
82-A2	Inline Splices	#2 - 3/0 Stranded (35 - 95)
82-A3	Inline Splices	3/0 - 400 kcmil (85 - 203)
82-B1	Wye Splices	#2 Stranded (35)
82-B2	Wye Splices	2/0 Stranded (70)

Cable, Wire, and Splicing

1-866-267-7776

SPLICING KITS**Scotchcast™ In-line Resin Splicing Kit:**

82A Series, Voltage Rating Up to 5 kV Non-shielded, UL 486D Listed, File #EI 02356

Use 82A series kits to insulate and moisture-seal single conductor, non-shielded cables through 5kV and multi-conductor cables through 1000V. Each kit contains a snap-together mill body which fits around the splice, two funnels, tape for sealing mold ends, and Scotchcast 4 epoxy electrical insulating resin in a Unipak™ container for clean and easy handling. These kits may be used for above ground or direct buried applications.

Product Specifications				
Product UPC	Voltage Rating (Max)	Conductor Size	Max Cable O.D.	Max Conn O.D. Sleeve Type
82-A 25016	5 kV	10 - 2 AWG 6 - 30 mm)	0.750" (19 mm)	0.406" (10 mm)
82-A1 25024	5 kV	Up to 2 AWG (30 mm)	0.625" (16 mm)	0.406" (10 mm)
82-A2 25032	5 kV	2 3/0 AWG (35 - 80 mm)	1.0" (25 mm)	0.625" (16 mm)
82-A3 25040	5 kV	3/0 AWG - 400 kcmil (90 - 200 mm)	1.438" (40 mm)	1.0" (25 mm)

Scotchcast™ Wye Resin Splicing Kit: 82-B1, Voltage Rating Up to 5 kV Non-shielded

82-B1 kit insulates and moisture seals wye splices on non-shielded cable through 5 kV and on multi-conductor cables through 1000V. Its rigid two-part transparent molds snap around splices for a tailor-made field splice. Within 30 minutes after the resin is poured, the splice is ready for a long, reliable life. The kit contains Scotchcast 4 electrical insulating resin. This kit may be used for above ground or direct buried applications.

Product Specifications				
Product UPC	Voltage Rating (Max)	Connector Split Bolt (Max)	Connector Crimped (Max)	Max Cable O.D.
82-B1 25057	5kV Single Con 1000V Multiple Cond	4 AWG	2 AWG (19 mm)	0.250" - 0.625" (6 - 16 mm)

Scotchcast™ Flexible Power Cable Splicing Kit: 82-BF1, Voltage Rating Up to 1000V

Scotchcast flexible power cable tape splicing kit 82-BF1 is a permanent splice for use on non-shielded portable power cables and cords with copper conductors rated up to 1000V. It can be used on single conductor or multiple conductor cables using a compression "C" tap connector. The kit contains one piece removable mold tape for sealing mold ends, abrasive cloth and Scotchcast 2130 compound in the Unipak™ container for clean and easy handling. The completed splice is designed for use in weather exposed, direct bury or submerged locations.

Product Specifications			
Product UPC	Voltage Rating (Max)	Connector Size Range	Number of Conductors
82-BF1 08309	1000	Up to 1/0 AWG (50 mm)	1
	1000	-	Multi

Burndy

Split Bolts and Crimpits

For Superior Circuit Reliability

Spliced wire connections are common to both galvanic and impressed current cathodic protection systems. Split bolts and crimpits by Burndy are the mechanical means for making these connections. They are composed of high purity copper and provide superior conductivity for anode leads, negative returns, grounds, or any other type of spliced wire connection.

Burndy crimpits are "C" type connectors, which can be used with a wide range of wire diameters, from #14 to 4/0 AWG. Because they are attached under high compression using special crimping tools, they form a permanent bond, which can be electrically insulated with standard encapsulation kits. Split bolts can also accommodate many different conductors. Their free-running threads and easy to grip wrench flats ensure maximum pressure and a secure mechanical bond. In addition, they are resistant to cracking and corrosion.

Burndy split bolts and crimpits have a proven track record for long-life performance. They are manufactured under strict quality control standards and meet all the requirements established by Underwriters Laboratories and the Canadian Standards Association.



Typical Applications

Mechanical and compression connectors such as split bolts and crimpits are used for making wire splices. They are most often used on run and tap style connections used to join header cables to anode leads. To protect these connections against corrosion and moisture, a wire splice kit or other type of electrical insulating material should be used.

 **CORRPRO**
COMPANIES INC
For Every Corner of Your World

1090 Enterprise Drive / Medina, OH 44256
Tel: 1-330-723-5082 / Fax: 1-330-723-0694
<http://www.corpro.com>

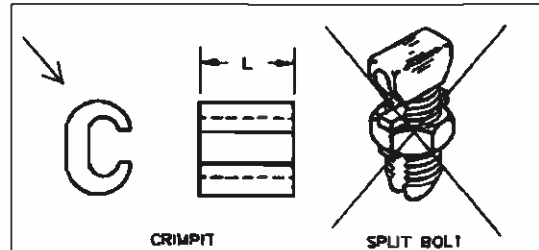
SPLICING MATERIALS

Burndy Split Bolts and Crimpits

Ordering Procedure

Corrpro is an authorized Burndy distributor. To order the right mechanical connector for your particular application, indicate the connector type, quantity, and order number. Crimpits are attached to structures using specially manufactured crimping tools, which are also stocked by Corrpro. An example is provided to help illustrate this process.

Ordering Procedure Example	
ITEM	EXAMPLE
Quantity	50
Product	<i>Burndy Crimpits</i>
Catalog Number	YC2C4



Burndy Split Bolt Ordering Information

CATALOG NUMBER	RANGE FOR EQUAL RUN AND TAP (AWG)	MIN. TAP WITH MAX. RUN (AWG)	RECOM. TIGHTENING TORQUE (LBS.)
KS90	12 Stranded-10 Stranded	16 Stranded	80
KS15	10 Stranded-8 Stranded	14 Stranded	80
KS17	8 Stranded-6 Solid	14 Stranded	165
KS17-3	8 Stranded-6 Solid	16 Stranded	165
KS20	8 Stranded-4 Solid	14 Stranded	165
KS20-3	8 Stranded-4 Solid	14 Stranded	165
KS22	6 Stranded-2 Solid	14 Stranded	275
KS22-3	6 Stranded-2 Solid	14 Stranded	275
KS23	6 Stranded-2 Stranded	14 Stranded	275
KS25	4 Stranded-1/0 Stranded	14 Stranded	385
KS26	2 Stranded-2/0 Stranded	14 Stranded	385
KS27	1 Stranded-3/0 Stranded	8 Solid	500
KS29	1 Stranded-250	8 Stranded	650
KS31	1/0 Stranded-350	1/0 Stranded	650
KS34	2/0 Stranded-500	2/0 Stranded	825
KS39	4/0 Stranded-750	4/0 Stranded	1000
KS44	300-1000	4/0 Stranded	1100

Burndy Crimpit Ordering Information

CATALOG NUMBER	RUN (AWG)	TAP (AWG)	LENGTH (IN)
YC10C10	12 Solid-10 Stranded	12 Solid-10 Stranded	0.375
YC8C8	8 Solid-8 Stranded	10 Solid-8 Stranded	0.5
YC4C8	6 Solid-4 Stranded	8 Solid-8 Stranded	0.625
YC4C6	6 Solid-4 Stranded	6 Solid-6 Stranded	0.625
YC4C4	6 Solid-4 Stranded	4 Solid-4 Stranded	0.625
YC2C4	3 Solid-2 Stranded	8 Solid-4 Stranded	0.75
YC2C2	2 Solid-2 Stranded	2 Solid-2 Stranded	0.75
YC26C2	1/0-2/0 Stranded	8 Solid-2 Stranded	0.938
YC26C26	1/0-2/0 Stranded	1/0-2/0 Stranded	0.938
YC28C2	3/0-4/0 Stranded	6 Solid-2 Stranded	1.063
YC28C26	3/0-4/0 Stranded	1/0-2/0 Stranded	1.063
YC28C28	3/0-4/0 Stranded	3/0-4/0 Stranded	1.063



For Every Corner of Your World

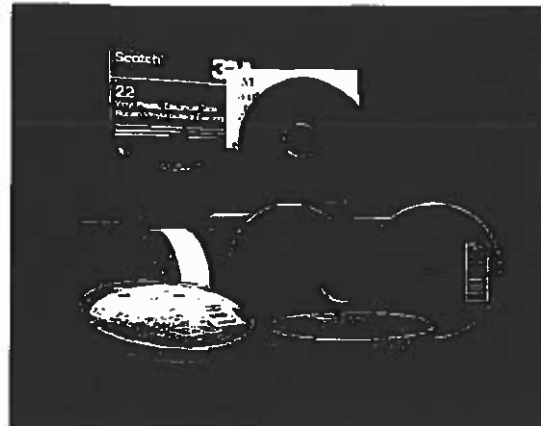
1090 Enterprise Drive / Medina, OH 44256
Tel: 1-330-723-5082 / Fax: 1-330-723-0694
<http://www.corrpro.com>

Scotch® Brand Electrical Insulating Tapes

The Tapes That Stick

When a wire splice or repair has to be made to a cathodic protection system you want to use a tape that works. No tape is easier to use or performs better than Scotch. That is why it is the world's leading brand of electrical insulating tape. Corpro stocks a wide assortment of Scotch brand tape, from vinyl plastic electrical to rubber and mastic splicing. Vinyl tapes are commonly used to repair or seal aboveground cathodic protection wiring. They are also employed over buried wire splices as a secondary cover. They can be stretched easily and are resistant to UV rays. Rubber and mastic tape is thick and extremely moisture resistant. It can withstand a wide range of temperatures and is typically applied to buried wire connections.

Regardless of which type of Scotch brand tape is needed, you can rest assured that it will effectively insulate your wire connection from moisture and corrosion. That's because all 3M tapes go through extensive research testing before they are marketed, and are manufactured according to strict quality control standards. They have excellent adhesion properties and form strong bonds with wire connections for improved circuit reliability.



Typical Applications

There are many different applications for Scotch brand tapes on cathodic protection systems. They can be used to protect both above and below grade connections and are compatible with most types of dielectric cable insulations, including PVC and polyethylene. All 3M tapes meet the requirements established by Underwriters Laboratories and the American Society for Testing Materials.

CORPRO
COMPANIES INC
For Every Corner of Your World

1090 Enterprise Drive / Medina, OH 44256
Tel: 1-330-723-5082 / Fax: 1-330-723-0694
<http://www.corpro.com>

Scotch® Brand Electrical Insulating Tapes

Ordering Procedure

Corrpro is an authorized distributor for 3M Scotch brand tape. To order the right tape for your particular application, indicate the type of tape and the number of rolls required. An example is provided to help illustrate this process.

Ordering Procedure Example	
ITEM	EXAMPLE
Quantity	5 rolls
Product	Scotch Brand Tape
Tape Line	Super 88
Width	0.75 in.
Length	60 ft.

Scotch Brand Tape Ordering Information			
SCOTCH TAPE	TYPE OF TAPE	NOMINAL DIMENSIONS	
		WIDTH in. (mm)	LENGTH ft./roll (m/roll)
Super 33+	Vinyl Electrical	0.75 (19)	20-66 (6-20)
Super 88	Vinyl Electrical	0.75-2.0 (19-50.8)	44-108 (3.4-32.9)
22	Heavy Duty Vinyl Electrical	0.75 (19)	108 (32.9)
23	Rubber Splicing	0.75-2.0 (19-50.8)	30 (9.1)
130C	Linerless Rubber Splicing	0.75-2.0 (19-50.8)	30 (9.1)
2200	Vinyl Mastic	3.25 x 4.5 or 6.5 x 4.5 pads (82.5 x 114.3) or (165.1 x 114.3)	
2210	Vinyl Mastic	4.5 (101.6)	10 (3)
Scotchfil	Insulating Putting	1.5 (38.1)	60 (18.3)
Scotchrap	All Weather Vinyl	1.0-6.0 (25.4-400.4)	100 (30.4)



For Every Corner of Your World

1090 Enterprise Drive / Medina, OH 44256
Tel: 1-330-723-5082 / Fax: 1-330-723-6694
<http://www.corrpro.com>

Sta-Kon

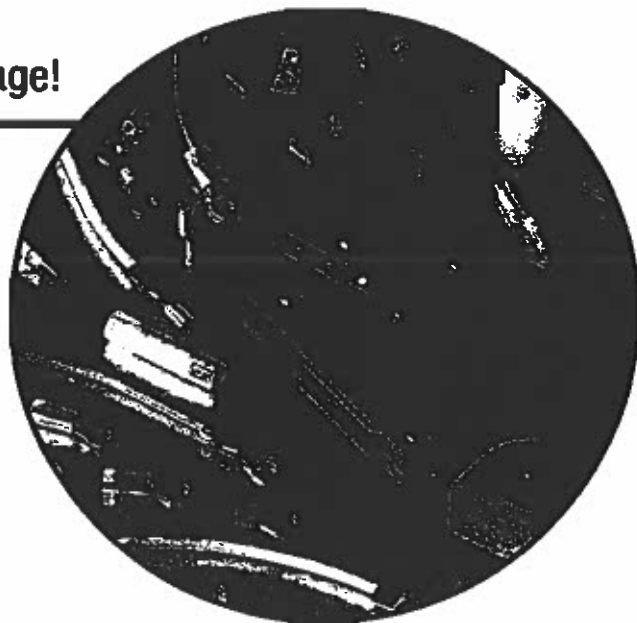
Overview — Why Sta-Kon® Terminals Are Better

Experience the Sta-Kon® advantage!

Thomas & Betts developed the first tool-applied solderless terminals and connectors more than 70 years ago in response to industry awareness of the need for better performance of electrical systems.

Key Features and Benefits

- Metal insulation grip sleeve is included on all nylon terminal for strain relief
- Long barrel selective annealed
- UL® Listed E9808 unless otherwise specified



Deep Internal Serrations

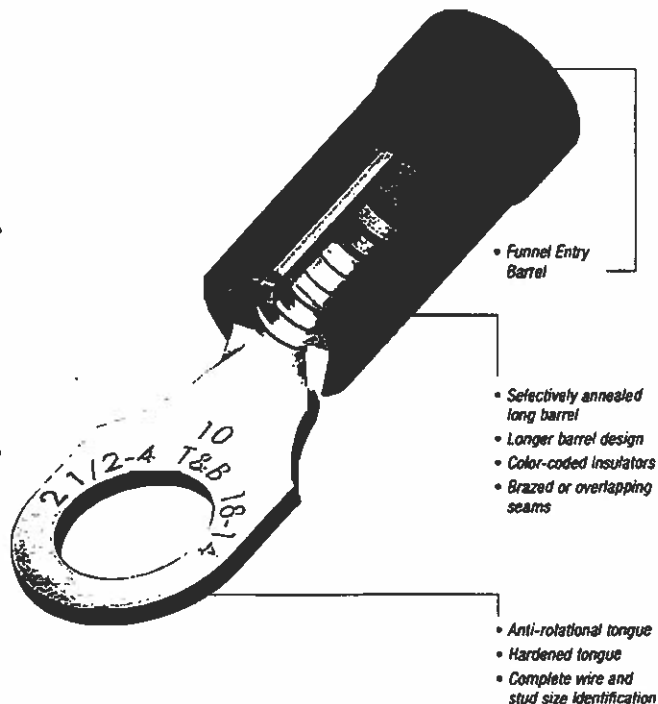
After the insertion of a wire into the terminal's barrel, a deep, serrated interior ensures a large area of contact that lowers the resistance of a connection. With the mechanical force of the tool, the wire strands cold flow into the serrated interior. This guarantees electrical resistance lower than the wire to which it is applied. This feature also prevents pullout from vibration and mechanical strain. Deep internal serrations can be compared to the effective holding power of a well-treaded tire on a wet highway.

Funneled Terminal Barrel Entry

This feature makes wire insertion faster and easier. A funneled barrel eliminates wire strand "hang up" upon insertion into the terminal's barrel. The loss of even a couple of wire strands can have negative results on electrical efficiency and resistance to mechanical strain.

Sta-Kon® Long Barrel Design

If lowering electrical resistance, preventing wire pullout, eliminating a "missed" crimp, and an insulator that stays on the barrel during installation are your goals, then you must design a terminal with a long barrel. Most competitive barrel lengths range from 20–50% shorter than Sta-Kon® terminals. The results are usually a stream of electrical failure, rework, and added expense. This also provides the insulator with additional surface area, holding tight to the barrel. Many competitive insulators come off during crimping due to a limited barrel length.

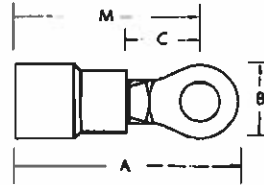


Thomas & Betts

Sta-Kon

Nylon-Insulated Ring Terminals

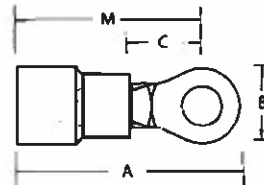
Nylon-Insulated Ring Terminals (continued)



CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RB14-4	100	18-14	.162	#4	ERG2001	.72	.26	.14	.59	.03
RB1323	1,000	18-14	.162	#4		.72	.26	.14	.59	
RB14-8	100	18-14	.162	#6		.89	.31	.25	.71	
RB863	1,000	18-14	.162	#6		.89	.31	.25	.71	
RB1333	1,000	18-14	.162	#6		.74	.26	.14	.59	
RB14-8	100	18-14	.162	#8		.89	.31	.25	.71	
RB863	1,000	18-14	.162	#8		.89	.31	.25	.71	
RB14-10	100	18-14	.162	#10		.89	.31	.25	.71	
RB873	1,000	18-14	.162	#10		.89	.31	.25	.71	
RB14-14	100	18-14	.162	1/4"		1.08	.47	.31	.81	
RB713	1,000	18-14	.162	1/4"		1.08	.47	.31	.81	
RB14-516	100	18-14	.162	1/2"		1.08	.47	.31	.84	
RB723	1,000	18-14	.162	1/2"		1.08	.47	.31	.84	
RB14-38	100	18-14	.162	3/8"		1.17	.53	.35	.87	
RB733	1,000	18-14	.162	3/8"		1.17	.53	.35	.87	
RB14-12	100	18-14	.162	1/2"		1.25	.72	.50	.90	
RB753	1,000	18-14	.162	1/2"		1.25	.72	.50	.90	

CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RC10-6	50	12-10	.210	#6	ERG2001	1.00	.37	.27	.81	.04
RC333	500	12-10	.210	#6		1.00	.37	.27	.81	
RC10-8	50	12-10	.210	#8		1.00	.37	.27	.81	
RC863	500	12-10	.210	#8		1.00	.37	.27	.81	
RC10-10	50	12-10	.210	#10		1.00	.37	.27	.81	
RC863	500	12-10	.210	#10		1.00	.37	.27	.81	
RC10-14	50	12-10	.210	1/4"		1.12	.53	.32	.86	
RC713	500	12-10	.210	1/4"		1.12	.53	.32	.86	
RC10-516	50	12-10	.210	1/2"		1.21	.53	.31	.94	
RC703	500	12-10	.210	1/2"		1.21	.53	.31	.94	
RC10-38	50	12-10	.210	3/8"		1.27	.59	.35	.98	
RC733	500	12-10	.210	3/8"		1.27	.59	.35	.98	
RC10-12	50	12-10	.210	1/2"		1.37	.72	.52	1.02	
RC753	500	12-10	.210	1/2"		1.37	.72	.52	1.02	

Nylon-Insulated Ring Terminals — Expanded Entry



CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RB14-4X	100	18-14	.190	#4	ERG2001	.80	.26	.14	.67	.03
RB1324	1,000	18-14	.190	#4		.80	.26	.14	.67	
RB14-8X	100	18-14	.190	#6		.95	.31	.25	.79	
RB864	1,000	18-14	.190	#6		.95	.31	.25	.79	
RB14-8X	100	18-14	.190	#8		.95	.31	.25	.79	
RB864	1,000	18-14	.190	#8		.95	.31	.25	.79	
RB14-10X	100	18-14	.190	#10		.95	.31	.25	.79	
RB874	1,000	18-14	.190	#10		.95	.31	.25	.79	
RB14-14X	100	18-14	.190	1/4"		1.16	.47	.31	.92	
RB714	1,000	18-14	.190	1/4"		1.16	.47	.31	.92	
RB14-516X	100	18-14	.190	1/2"		1.16	.47	.31	.92	
RB724	1,000	18-14	.190	1/2"		1.16	.47	.31	.92	
RB14-38X	100	18-14	.190	3/8"		1.25	.53	.42	.95	
RB734	1,000	18-14	.190	3/8"		1.25	.53	.42	.95	

CAT. NO.	PKG. QTY.	WIRE RANGE	MAX. INS.	BOLT HOLE	REC. TOOL	DIMENSIONS				STOCK THICK.
						A	B	C	M	
RC10-6X	50	12-10	.250	#6	ERG2001	1.10	.37	.27	.91	.03
RC334	500	12-10	.250	#6		1.10	.37	.27	.91	
RC10-8X	50	12-10	.250	#8		1.10	.37	.27	.91	
RC864	500	12-10	.250	#8		1.10	.37	.27	.91	
RC10-10X	50	12-10	.250	#10		1.10	.37	.27	.91	
RC864	500	12-10	.250	#10		1.10	.37	.27	.91	
RC10-14X	50	12-10	.250	1/4"		1.22	.53	.32	.96	
RC714	500	12-10	.250	1/4"		1.22	.53	.32	.96	
RC10-516X	50	12-10	.250	1/2"		1.32	.53	.31	1.05	
RC704	500	12-10	.250	1/2"		1.32	.53	.31	1.05	
RC10-38X	50	12-10	.250	3/8"		1.38	.59	.48	1.09	
RC734	500	12-10	.250	3/8"		1.38	.59	.48	1.09	
RC10-12X	50	12-10	.250	1/2"		1.48	.72	.52	1.13	

UL Listed E9809

Thomas & Betts

www.tnb.com



POLY BRAID ROPE



MADE IN THE USA SINCE 1816

GLADDING
Braided Products, LLC
One Gladding Street
South Otselic, NY 13155
315-653-7211 (fax 4492)

5/16" Round Polyester Braided Rope

Gladding Part Number #10ESTYBX1000
Specification sheet



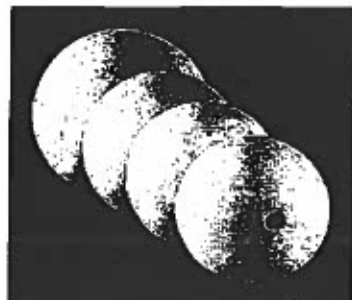
Gladding's double braided polyester ropes combine high-tenacity polyester yarns into a unique firm round braided rope. The unique construction first twists the yarns in opposite directions and then braids those twisted strands into a stable braided core. Next, the braided core is inserted inside a braided sleeve/jacket made from the same twisted yarns. This twisting process adds stability to the rope resulting in a rope that will not twist and kink. The twisted yarns in both the core and sleeve add excellent abrasion resistance because the twisted fibers aligned with the axis of the rope. This unique rope combines the 100% polyester yarns into a rope that features high strength, low stretch, easy splicing, and excellent abrasion resistance.

Raw Material (Sleeve and core)	100% Polyester
Cover Braid	Sleeve 12 PPI (per 4.5mm)
Core Braid	100% polyester 8c
Diameter	5/16"
Circumference	1"
Approx weight per 100 ft.	3.5
Approx average Breaking Strength in pounds	3,270
Braided construction	Non rotating balanced braid
Specific Gravity	1.38

FLOATS K-50

Industrial Rope Floats

Industrial Floats



INDUSTRIAL ROPE FLOAT SELECTION CHART

MODEL NUMBER	SIZE	STD. ROPE-HOLE	BUOYANCY	PACK	SHIPPING WEIGHT	STD. COLOR
4400-RF	12" dia.	1-1/4"	22 lbs.	4	21 lbs.	WHITE
4401-RF	15" dia.	1-1/4"	42 lbs.	4	36 lbs.	WHITE
4402-RF	18" dia.	2"	90 lbs.	1	13 lbs.	WHITE
4403-RF	24" dia.	2"	209 lbs.	1	28 lbs.	WHITE
4404-RF	30" dia.	2"	400 lbs.	1	40 lbs.	WHITE
429-RF	18 dia. x 30"	2"	240 lbs.	1	30 lbs.	ORANGE
4418-RF	12 dia. x 18"	1-1/4"	Approx. 60 lbs.	1	10 lbs.	ORANGE

* Call for other rope hole sizes

Features Include:

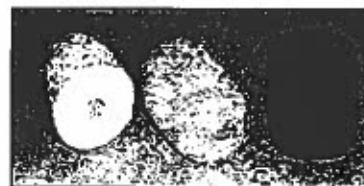
Hard shell high-density polyethylene construction, urethane foam filled
All models available in White, Orange and Yellow, specify color

Rope Floats

Hard Shell Rope Floats

HARD SHELL ROPE FLOAT SELECTION CHART

MODEL NUMBER	LENGTH	DIAMETER	BUOYANCY	ROPE SIZE	SHIPPING WEIGHT	PER PACK
1100-Y	9-1/4"	7"	10-11 lbs.	1-3/8"	44 lbs.	21
1100-O	9-1/4"	7"	10-11 lbs.	1-3/8"	44 lbs.	21



JIM-BUOY®

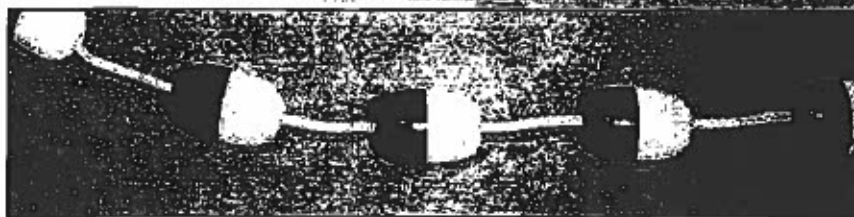
Features Include:

Hard shell high-density polyethylene construction, urethane foam filled
Available in Yellow and Orange, specify Y or O

Economy Rope Floats

Features Include:

Polystyrene Float
2 Color high visibility



#1504

ECONOMY ROPE FLOAT SELECTION CHART

MODEL NUMBER	LENGTH	DIAMETER	BUOYANCY	ROPE SIZE	SHIPPING WEIGHT	PER PACK	COLOR
1504	5"	3"	2 lbs.	1/2"	3 lbs.	24	RED & WHITE
1506	8"	7"	7-1/2-8 lbs.	1-1/2"	14 lbs.	27	WHITE

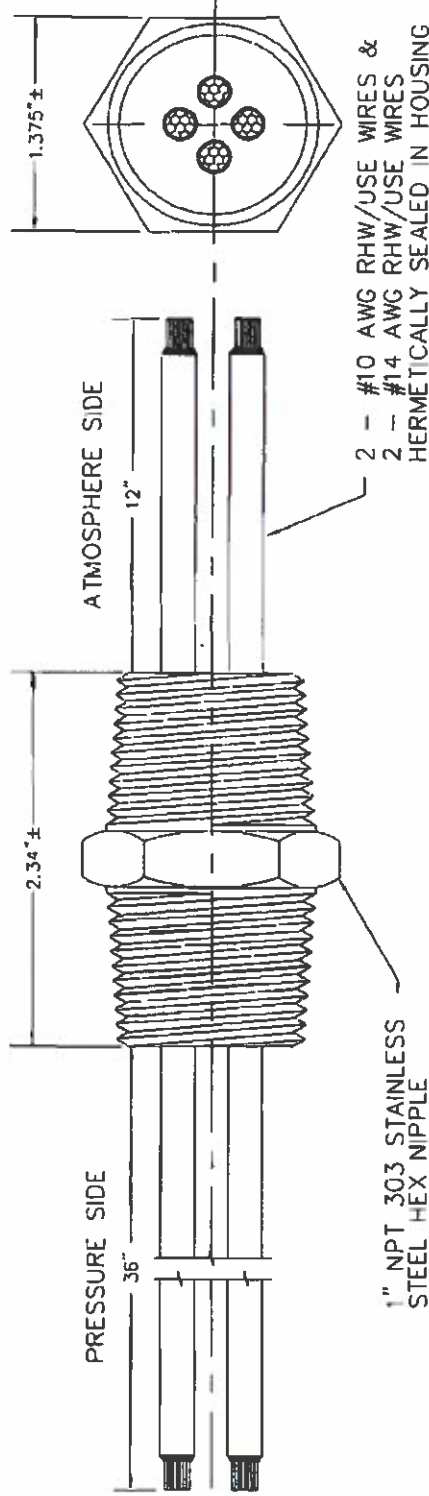


JIM-BUOY®

PRESSURE FITTING

CLEVELAND • ATLANTA • CHICAGO
HOUSTON • NEW ORLEANS • OKLAHOMA CITY
PHILADELPHIA • SAN FRANCISCO

corrpro
5643 N. 52nd Ave. GLENDALE, AZ 602 269 7641



SPECIFICATION:

WATER TEMPERATURE RANGE: 32° TO 190° F
AMBIENT TEMPERATURE RANGE: MINUS 20° TO 120° F
VOLTAGE RATING: NO. 10 AWG - 600 VOLTS @ 30 AMPS
VOLTAGE RATING: NO. 14 AWG - 600 VOLTS @ 15 AMPS
PRESSURE RATING: 200 PSI
NSF 61 CLASSIFIED

FOR USE IN POTABLE WATER:
HIGH CONCENTRATION OF CHLORINE DURING DISINFECTION
COULD REACH LEVELS OF 200-mg/L AVAILABLE CHLORINE

REFERENCE DRAWINGS		1" NPT WIRE PRESSURE ENTRANCE FITTING		STANDARD 4 WIRE DETAIL DRAWING	
NO.	DATE	BY	REVISION	DESIGNED BY	DRW. NO.
				CORRPRO	1 NPT SPEC
				DATE	1-23-08
				SCALE	NONE
				SHEET	1 of 1



REFERENCE ELECTRODES



corrpro**CORRPRO • PERMACELL • REFERENCE CELLS****Permacell 801 Permanent Reference Cells****For Accurate Readings in Fresh Water Environments**

Routine monitoring is an important part of any cathodic protection maintenance program. To simplify this testing procedure, different types of permanent reference cells can be used. For structures located in fresh water, Corpro offers the Permacell 801 copper/copper sulfate cell. The cell is made using a 99.99% pure copper coiled element, which is surrounded by a supersaturated paste of copper sulfate. To ensure a low-resistance connection, a lead wire is mechanically bonded and soldered to the copper element. This electrical junction is then encapsulated by a moisture-resistant shrink sleeve for a truly sealed connection. Electrical contact to the electrolyte is accomplished through a filtering plug at the end of the reference electrode. The plug allows accurate potential measurements to be obtained while preventing cell contamination.

In order for a reference to be effective, it must remain electrically stable over time. Corpro's 801 reference cell delivers unsurpassed stability due to strict quality control procedures implemented during the manufacturing process. Deionized water is used to create the supersaturated solution of copper sulfate, and the copper element is treated with a special cleansing agent before it is installed into the cell's plastic housing. Each cell is also tested for resistance and electrical potential, and the values obtained are recorded and marked on shipping tags attached to the cells. These extra quality steps give the Permacell 801 a 30-year design life and the ability to maintain an electrical potential of within ± 5 millivolts.

Typical Applications

The Permacell 801 is ideal for use in cathodic protection systems operated in fresh water environments. This includes elevated water storage tanks, clarifiers, traveling screens, pasteurizers, locks, dams, and fresh water dock structures. The cell can be operated at temperatures of up to 135°F, but should not be used in waters containing high concentrations of chloride ions.

Ordering Procedure

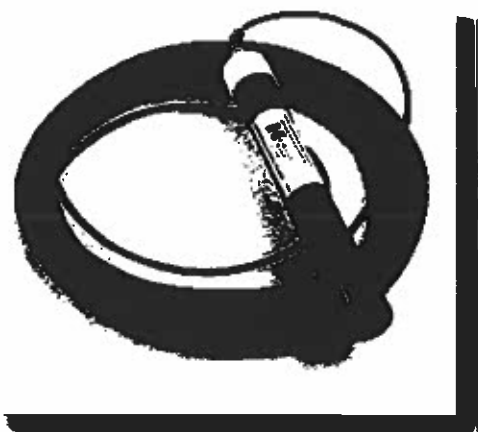
Permacell 801 is provided standard with fifty feet of insulated lead wire, but it can also be custom manufactured to meet the customer's specifications. To order this reference cell for your particular application, indicate that you need a Corpro Permacell 801 permanent reference cell, and specify the quantity desired and the lead wire length, size, and insulation, if different from the standard provided. An example is included to illustrate this process.

Example	
Quantity	10
Product	Permanent Reference Cell
Permacell Model	801
Lead Wire Length 50 ft = Standard	50 ft
Size #14 AWG = Standard	14 AWG
Insulation HMWPE = Standard	HMWPE

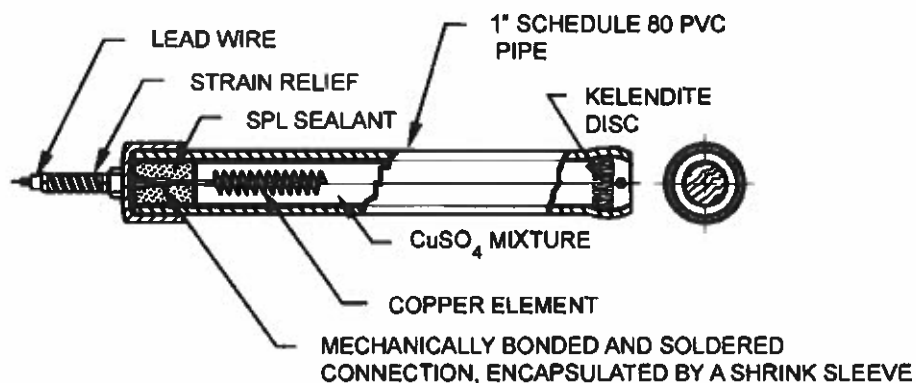
Custom assemblies available, able to use #16, #14, #20, #10, or 8 wires for these assemblies.

REFERENCE CELLS

Reference Cells / Electrodes and Accessories



Permacell 801 Permanent Reference Cell



Product Specifications

Nominal Dimensions Ø Length	Weight		Electrical Stability	Maximum Temperature		Design Life
	lbs	kg		°F	°C	
1" X 11" (25.4mm x 279.4mm)	2	0.91	±5 millivolts with 3.0 microamp load	135 °F	57.2 °C	30 Years

Reference Cells / Electrodes & Accessories

1-866-267-7776



RIDGID CONDUIT

Allied **RIGID** Specifications

PROVIDES FULL ELECTRICAL SYSTEM PROTECTION

Allied RIGID is precision manufactured for dependable, long-lasting value and protection for the electrical raceway system.

Manufactured from high-strength steel, Allied RIGID combines damage-resistant strength with ductility to assure easy bending, cutting and joining. It also provides smooth, continuous raceways for fast wire-pulling. No need to worry about damage to the conduit system even when pulling through multiple 90° bends.

Allied RIGID is hot-dipped galvanized inside and out. It is top-coated with a compatible organic layer to inhibit white rust and increase corrosion resistance.

Allied RIGID is impact and crush resistant for maximum conductor protection.

The 3/4" taper NPT threads (ANSI B1.20.1) are full cut and hot galvanized after cutting. Color-coded end-cap thread protectors keep the threads clean and sharp and also provide instant trade size recognition. Even trade sizes are color-coded blue, 1/2 trade sizes are black, and 1/4 trade sizes are red.

EMI SHIELDING

Allied RIGID greatly reduces electromagnetic fields, effectively shielding computers and sensitive electronic equipment from the electromagnetic interference caused by power distribution systems. For further information, visit our website for a free download of the GEMI (Grounding and ElectroMagnetic Interference) analysis software and related research papers.

FULL CODES AND STANDARDS COMPLIANCE

Allied RIGID is covered by article 344 of the National Electrical Code. It is listed to Underwriters Laboratories Safety Standard U.L. 6, and is manufactured to ANSI C80.1, both of which have been adopted as Federal Specifications in lieu of WWC 581. Allied RIGID is recognized as an equipment grounding conductor by NEC Article 250. Documentation for compliance with NEC Article 250 is also available in the GEMI (Grounding and ElectroMagnetic Interference) analysis software and related research studies found at the www.alliedeg.com website.

Installation of Rigid Metal Conduit shall be in accordance with the National Electrical Code and U.L. General Information card #DYIX. Master bundles conform to NEMA standard RN2.

SPECIFICATION DATA

RIGID Metal Conduit shall be hot-dip galvanized steel equal to that manufactured by Allied Tube & Conduit Corporation. Threads shall be hot galvanized after cutting. RIGID shall be produced in accordance with U.L. Safety Standard #6 and ANSI C80.1 and shall be listed by a nationally recognized testing laboratory with follow-up service. Where

Kwik-Couple RIGID is used it shall also meet U.L. Safety Standard #514-B. It is noted that these U.L. standards have been adopted by the federal government and separate military specifications no longer exist.

For more information, contact Allied at (800) 882-5543, or visit our website at www.alliedeg.com

Weights and Dimensions for Galvanized Rigid Tubing

Trade Size Designator		Approx. Wt. * Per 100 Ft. (30.5M)		Nominal Outside Diameter ¹		Nominal Wall Thickness		Quantity In Master Bundle	
U.S.	Metric	lb.	kg	in.	mm	in.	mm	ft.	m
1/2	16	62	37.2	0.840	21.3	0.104	2.60	2500	762.5
3/4	21	109	49.4	1.050	26.7	0.107	2.70	2000	610.0
1	27	161	73.0	1.315	33.4	0.126	3.20	1250	381.3
1-1/4	35	218	98.9	1.660	42.2	0.133	3.40	900	274.5
1-1/2	41	263	119.3	1.900	48.3	0.138	3.50	800	244.0
2	53	350	158.7	2.375	60.3	0.146	3.70	600	183.0
2-1/2	63	559	253.5	2.875	73.0	0.193	4.90	370	112.9
3	78	727	329.7	3.500	88.9	0.205	5.20	300	91.5
3-1/2	91	880	399.1	4.000	101.6	0.215	5.50	250	76.3
4	103	1030	467.1	4.500	114.3	0.225	5.70	200	61.0
5	129	1400	634.9	5.563	141.3	0.245	6.20	150	45.8
6	155	1840	834.5	6.625	168.3	0.266	6.80	100	30.5

* For more information only; not a spec requirement.

NOTE: Length = 10 ft. (3.05m) with a tolerance of +/- .25 in. (6.35mm).

* NEMA Standard

Weights and Dimensions for Kwik-Couple Rigid

Trade Size Designator		Approx. Wt. Per 100 Ft. (30.5M)		Nominal Outside Diameter ¹		Nominal Wall Thickness ²		Quantity In Master Bundle	
U.S.	Metric	lb.	kg	in.	mm	in.	mm	ft.	m
2-1/2	63	559	253.5	2.875	73.0	0.193	4.90	400	122.0
3	78	727	329.7	3.500	88.9	0.205	5.20	300	91.5
3-1/2	91	880	399.1	4.000	101.6	0.215	5.50	250	76.3
4	103	1030	467.1	4.500	114.3	0.225	5.70	200	61.0

¹Outside diameter tolerances: +/- .025 in. (64mm) ²For information only; not a spec requirement.



Allied Tube & Conduit
Registered to ISO 9001:2000
File Numbers A2109, A1084, A1276

ALLIED ELECTRICAL GROUP

• Allied Tube & Conduit • AFC Cable Systems* • Cope® Cable Tray • Power-Strut® Metal & Fiberglass Framing

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www.alliedeg.com



WARRANTY



This **WARRANTY CERTIFICATE** is provided to the purchaser of Corpro's products and/or services and is subject to Corpro's terms and conditions applicable to such sale.

WARRANTY ON CORPRO SERVICES

Corpro warrants that, for the duration of the Warranty Period and subject to the other limitations herein, each Corpro Service has been performed in accordance with Corpro's applicable specifications, procedures, and directions for such Corpro Service. As used in this warranty, "Corpro Service" means service provided by Corpro, its employees, and authorized subcontractors.

WARRANTY ON CORPRO PRODUCTS

Corpro warrants that, for the duration of the Warranty Period and subject to the other limitations herein, Corpro Products will be free from defect in materials and workmanship. As used in this warranty, "Corpro Products" means only (a) products manufactured solely by Corpro and (b) components of cathodic protection systems installed as part of Corpro Services. Except as stated in the preceding sentence, Corpro does not warrant products manufactured or supplied by other parties, and purchaser shall be entitled to rely on the warranties, if any, only to the extent extended to purchaser by such other parties.

WARRANTY PERIOD

"Warranty Period" means (a) for Corpro Services and Corpro Products installed as part of Corpro Services, the one (1) year period beginning the date the applicable Corpro Services are completed; and (b) for Corpro Products not installed as part of Corpro Services, the ninety (90) day period beginning with the date of shipment from Corpro. The providing of Warranty Service does not extend or restart a new Warranty Period.

WARRANTY SERVICE

Claims arising out of the above warranties must be made in writing and delivered to the Corpro location which provided the Corpro Services or Corpro Products, or if such location has moved, to its new location or to Corpro's headquarters. As a condition to Corpro's obligations herein, the claimant must provide the warranty certificate and original invoice applicable to such Corpro Product or Corpro Service and shall set forth the specific circumstances of the claim in reasonable detail. Any claim not made within the applicable Warranty Period shall be conclusively deemed waived by claimant.

Corpro's obligation to honor its warranty on defective Corpro Services is in all cases limited to, at Corpro's sole option: 1) re-performing such Corpro Service, 2) performing additional Corpro Service, or 3) providing a refund or credit. Notwithstanding anything herein to the contrary, the value of the foregoing shall in no event exceed the amount paid for the original Corpro Service.

CORPRO COMPANIES, INC. WARRANTY CERTIFICATE

Corpro's obligation to honor its warranty on defective Corpro Products is in all cases limited to, at Corpro's sole option: 1) repair or replacement of the defective Corpro Product or component thereof, or 2) providing a cash refund or credit. Notwithstanding anything herein to the contrary, the value of the foregoing shall in no event exceed the amount paid for the original Corpro Product. Replaced Corpro Products shall become the property of Corpro. Corpro shall not be liable for any expense incurred by purchaser in order to remedy any warranted defect.

RELiance ON PURCHASER'S REPRESENTATIONS
Corpro shall be entitled to rely on representations made by or on behalf of Purchaser that all conditions necessary for the proper installation or performance of Corpro Products, systems, materials, components and Corpro Services have been satisfied, except to the extent Corpro is specifically contracted to make such determination. Corpro shall have no liability for any and all claims, losses, and causes of action arising out of, resulting from, or in any way attributable to failure of Purchaser to satisfy such conditions. Purchaser's failure to advise of existing site conditions affecting the work (including, but not limited to, the location of subsurface or concealed structures, systems or components thereof), or the use or operations of products, materials, or systems subsequent to any transfer to any third party. Corpro makes no representations or warranties with respect to, and disclaims liability arising out of, products or services sold by purchaser.

DAMAGE AND SUBSEQUENT EVENTS

Corpro shall have no obligation to provide warranty service and shall have no liability with respect to defective Corpro Services or Corpro Products if the Corpro Products, materials, systems of which they are a part, or structures they are intended to protect from corrosion have: 1) been modified, altered, relocated (in the case of cathodic protection systems), used for other than intended purposes, or otherwise changed without Corpro's written consent; 2) been damaged or abused; 3) not been operated or maintained in accordance with design specifications, instructions, operations and maintenance documents, or reasonable business practices; or 4) in the case of Corpro Products or Corpro Services, not been paid for in full.

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This warranty is the sole warranty offered by Corpro. No statement or affirmation by or on behalf of Corpro by words or actions other than as set forth herein shall constitute a warranty, and Purchaser shall not be entitled to rely on any oral or written statement including those of any employee.

agent, or representative of Corpro as being part of the terms and conditions of this warranty or of doing business unless such statement is in writing signed by a vice president of Corpro.

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SECTION 4

SERVICE REPORT & FINAL TESTING



FIELD SERVICES WORK ORDER

WA-14A-04 (2014)

503222

CUSTOMER:

Ship To:

WST
10-14-5

Customer Contact Name and Number: _____
Customer P.O. _____ Contract Date: _____ Schedule: _____
Tank Capacity and Type: _____ Type of Service: 5200 L337
Tank Address: _____
Rectifier Mfg.: _____ Ser. No.: _____ System No.: _____ Rating: _____
Anode Type & Configuration: 13-446383-09

NOTES:

Measurements for testing, evaluation and adjustment: Native/Off 648 mv On 1050 mv Does Tank "Ice Over" ☐ Y ☒ N _____ Other _____FOUND: a) Rectifier Tap Setting at: Course _____ Fine _____ Auto _____ Manual _____ Water Level 80%

b) Rectifier Operating at:

Bowl: Volts OFF Amps OFF Pot. Set OFF Pot. Level _____
Riser: Volts _____ Amps _____ Pot. Set _____ Pot. Level _____c) Resistance: Anode - Bowl 87 Riser _____ Aux. No. _____
Readings: Reference Cell - Bowl 5.2 K Ω Riser _____ Aux. No. 55 K Ω

LEFT: d) Independent Tank-to-Water Potential Profile Within Tank:

Tank Bottom	On	Instant Off	Cell To Cell Test: ^{CELL 1} Portable Test Cell Neg.
<u>CELL 1</u>	<u>1050+mv</u>	<u>-871 mv</u>	Permanent Cell: #1 _____ #2 <u>+38 mv</u>
<u>CELL 2</u>	<u>1030+mv</u>	<u>-878 mv</u>	

e) Rectifier Operation Adjusted To: Tap Setting: Course A Fine 3 Auto X Manual _____
Bowl: Volts 3.4 Amps 16 Pot. Set 900 mv Pot. Level 900 mv
Riser: Volts _____ Amps _____ Pot. Set _____ Pot. Level _____

EVALUATIONS:

Electrical: TESTED GOODAnode: TESTED GOODRectifier: TESTED GOODOverall System Performance: READY TO OPERATE WITHIN AWWA STANDARD D-104Recommendations: LEAVE OFF UNTIL AFTER 11-MONTH COATING INSPECTIONOPERATOR INSTRUCTIONS PROVIDED TO: D. J. [Signature]

Do NOT adjust rectifier in automatically controlled mode of operation. Record meter readings at intervals not to exceed sixty (60) days.

CREW TIME IN: 3:00 CREW TIME OUT: 4:30 FOLLOW-UP REQUIRED: NO

If you have any questions please call the office noted above. We appreciate the opportunity of being of service.

CORRPRO

SUBSCRIBER'S ACCEPTANCE

By: [Signature] Date: 7-14-16 By: [Signature] Date: 7-14-16Multi-Meter # 81660020

SECTION 5

INSTRUCTIONS FOR TASC VIII RECTIFIER

**OPERATING MANUAL
FOR TASC SERIES RECTIFIERS**

IR Drop Free Constant Potential Cathodic Protection Rectifier
Distributed By: Corrpro Canada Inc

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Thank you, for purchasing a Cathodic protection rectifier built by the Corrpro Rectifier Division. Our products are designed to give you many years of trouble-free operation.

Since 1980 Corrpro Canada Inc., Corrpro Rectifier Division (CRD) has been a leader in the manufacturing of quality Cathodic Protection Rectifiers. Our products have achieved worldwide recognition due to our efforts to ensure customer satisfaction.

CRD produces a wide range of Air-Cooled and Oil-Cooled rectifiers with both Manual or Automatic (Voltage, Current, "ON" Potential, "IR-FREE" Potential) control styles. CRD also supplies custom control panels, rectifier interrupters, and many other rectifier related accessories. For any fast service requirements, CRD stocks thousands of rectifier related parts for our rectifiers as well as our competitors.

Our products have been widely accepted in the energy, water, utility and marine industries.

Corrpro Cathodic Protection Rectifiers and other products are available through our many Corrpro Companies Inc. and subsidiary offices located in convenient locations throughout North America, Europe and distributors in the Middle East, Far East and South America.

For more information please visit www.corrpro.ca

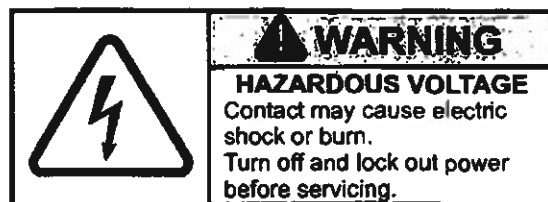


TABLE OF CONTENTS

	PAGE
Introduction.....	iv
Delivery Inspection	iv
Storage.....	iv
Automatic Rectifier Efficiency	1
Installation	2
Operation.....	3
Maintenance.....	7
Troubleshooting.....	9
Glossary	17
Warranty Information	19
Panel Layout Drawings.....	22
Chassis Layout Drawings	24
Enclosure Drawings.....	25
Options (If Applicable)	A-Z

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INTRODUCTION

This Operation Manual has been prepared for the Corpro TASC SCR controlled IR drop free constant potential rectifier models. It is recommended that this manual be kept inside the rectifier enclosure and in the protective pouch for quick reference. This manual should be stored in the space provided. Do not place this manual so that it will impede air flow through the enclosure.

CORRPRO Rectifiers are built by skilled personnel and are designed by an engineering staff with many years of experience. Every effort has been made to use the latest in reliable components, so that these rectifiers are of the highest quality consistent with reasonable costs.

CORRPRO maintains a file on every rectifier by serial number only. Therefore, the **SERIAL NUMBER** must be specified when requesting information or ordering parts for this rectifier unit.

DELIVERY INSPECTION

If any damage has occurred during shipment, **FILE A CLAIM WITH THE CARRIER IMMEDIATELY**. Even if the rectifier unit is not being installed at the field site immediately, the rectifier should still be removed from the carton and inspected for shipping damage prior to storage of the unit. If it is necessary to contact your supplier or the manufacturer concerning damaged or missing components, be sure to include all information such as Serial Number, Purchase Order Number and Invoice Number. This will ensure that you obtain proper and expeditious service.

STORAGE

If the units are to be stored prior to use for extended periods of time, it is recommended that they be stored in a dry area, preferably indoors. However, if this is not possible, cardboard wrapping should be removed from around enclosures that are stored outdoors to prevent holding rain or snow moistened packaging materials against the enclosure.

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IR DROP FREE ERROR DESCRIPTION

A phenomena exists in impressed current cathodic protection systems in which the structure-to-reference cell potential is used to continuously control the output of the rectifier. The desired structure-to-reference potential is electronically compared to the actual structure-to-reference potential generated by the cathodic protection current. An error exists in the structure-to-reference potential as normally measured and is equal to the product of the current and the resistance through the electrolyte, between the structure and reference cell. The only method which completely eliminates this IR drop error in the potential measurement is one which momentarily turns the cathodic protection current off and measures the reference cell potential while the current is zero. The structure-to-reference potential is thus sampled at the "instant-off" level. This instant-off potential is then compared with the preset desired value to control the rectifier. The TASC series controller accomplishes the above described sampling of the structure-to-reference potential to provide IR drop free automatic control.

While operating in IR drop free constant potential mode the rectifier samples the voltage from the reference cell at a rate equal to twice the input voltage frequency (120 times per second for 60 Hz) just before triggering the SCRs. When the DC output of the rectifier is below the current and voltage limit the sampled structure-to-reference electrode potential is compared with the user defined potential set-point. Should the sampled potential be a value greater than the set-point (less negative) the rectifier will increase its output in response. Conversely, should the sampled potential be greater than the set-point the rectifier output will decrease. If the DC output of the rectifier reaches a level equal to the voltage or current limit settings it will be held at that point and the required structure potential level may not be met.

The Corrpro TASC series of rectifiers has been designed to be a reliable, cost-effective device for the Cathodic Protection of submerged surfaces in water and wastewater facilities.



AUTOMATIC RECTIFIER EFFICIENCY

A relatively important factor when discussing Automatic C.P. type rectifiers is conversion efficiency. As the S.C.R. controller reduces the conduction time of the S.C.R.s less of the available AC secondary voltage is utilized in the conversion to DC voltage. This results in inherently poor conversion efficiencies for Automatic type rectifiers. To improve efficiency it is recommended the transformer taps be used (if available) to limit the input voltage to the bridge to the minimum amount required to maintain the desired structure-to-reference potential.



INSTALLATION

Proper rectifier installation procedures are necessary to ensure the integrity of the cathodic protection system. These procedures are as follows:

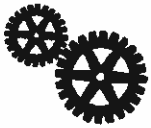
1. Check all electrical connections to make sure they are tight. Though this is done at the factory, it is a good idea to re-tighten all connections, especially those that carry electrical current. While tightening these connections use a wrench to hold one nut on the other side of the stud to prevent it from spinning or you may be inadvertently loosening other connections to the same stud.

Stud Size	Torque
1/4"	30 in-lbs
3/8"	120 in-lbs

Brass Stud Torque Table

2. Select the mounting site for the rectifier; paying special attention to accessibility, proper ventilation, shielding from sources of high ambient temperatures, and most importantly, convenience to A.C. and cathodic protection connections.
3. Mount the rectifier securely on a mounting pad, wall or post (as applicable).
4. Have a qualified electrician make all electrical connections, following the electrical and local codes. A disconnect switch is required ahead of the A.C. input to the rectifier. We do not recommend connecting the rectifier to the same AC circuit as other large pieces of equipment (such as a pump-jack motor) that may cause the AC input power to fluctuate.
5. **BEFORE ENERGIZING**, double check to ensure the rectifier is appropriately sized for the A.C. input being applied.
6. **ENSURE CORRECT POLARITY ON D.C. CONNECTIONS**, connecting negative to the structure being protected and positive to the anode leads.

7. Connect the reference cell(s) to the terminals marked "Ref" on the rectifier panel. Be sure to route reference cell wiring away from high voltage AC power or other electrical systems that may induce noise into the cables. Reference cell field wiring should be run in a separate conduit and runs more than 25 feet long should use shielded twisted pair (STP) cable.



OPERATION

1. Ensure that the potential adjust potentiometer is set fully counter-clockwise and that the transformer is set to its lowest tap setting (A1). Switch the rectifier's input breaker to the "ON" position. After the slow start period there should be little or no output current showing on the panel meter (dual reading meters may need to be switch activated).



Note: The automatic rectifier control card is equipped with a soft-start circuit to reduce inrush current and prevent overshoot. It is not unusual for the output to take a few seconds to come up after the breaker has been switched to the "ON" position in any of the steps that follow.

Note: To prevent possible coating damage the use of a temporary test load is recommended while performing the initial setup of the rectifier.

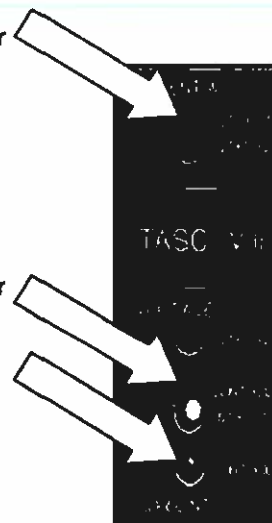
2. Select the reference cell you wish to use with the reference cell selector switch. The selected cell is both metered and in control of the rectifier. Only one reference cell may be in control at any given time.
3. Switch off the rectifier and increase the transformer taps to maximum, typically coarse "E" and fine "5". Turn the rectifier back on and push the set/read switch to the "set" position. The potential set-point will be displayed on the rectifiers' potential meter.

4. Adjust the potential set potentiometer clockwise while holding the set/read switch to "set" until the desired structure-to-water potential is displayed on the potential meter. As the set potential is adjusted to a value more negative than the existing reference cell potential the rectifier will respond by increasing its output.

Potential Adjust Potentiometer

Voltage Adjust Potentiometer

Current Adjust Potentiometer



5. Release the set/read switch and observe the rectifier output. A LED lamp on the control card will indicate which set-point is limiting the output. The colors indicate the following modes of operation:

LED Color	Mode of Operation (Limiting Factor)
Red	Voltage
Green	Current
Yellow	Potential

Control Card Operation Modes/LED Colors

6. Allow time for the structure to polarize. The potential value read from the meter is the "actual" reference cell potential at this time. Verify that it is decreasing (going more negative) and approaching the value of the set-point.

Note: The potential meter in IR drop free rectifiers reads the IR free structure-to-reference potential as sampled by the rectifier. This reading will not match the potential measured by a DVM while the rectifier is operating. This is an indication that the IR free mode of the rectifier is functioning correctly and should not be considered as a malfunction.

7. After the structure potential reaches and slightly exceeds the potential set-point, the control card will reduce the rectifier output and allow the potential to rise (less negative) to the user selected set-point.
8. When the actual structure-to-water potential becomes equal to the set-point the control card will adjust the DC output of the rectifier to a level required to maintain that potential. The yellow LED on the control card will be illuminated to indicate the card is in potential control mode.
9. To improve rectifier efficiency record the voltage and current required to maintain the set potential. Switch the rectifier breaker to the "OFF" position and place the rectifier in manual mode. Adjust the transformer taps to provide an output voltage and current slightly greater than or the one recorded. Return the breaker to the "ON" position and verify the output voltage. Return the rectifier to AUTO mode.
10. Optionally, you may adjust the current and voltage limits to allow for additional control over the rectifier output. These limits are factory set to the maximum output voltage and current of the rectifier. If you choose to adjust them the rectifier will limit the output to whichever limit is reached first and the appropriate LED on the control card will illuminate.

Note: If the target structure-to-reference cell potential cannot be attained and the rectifier is reaching either the voltage or current limits (red line) there is a problem with the cathodic protection system or the rectifier rating is insufficient to reach the desired potential.

11. The rectifier should be operated at the required D.C. output current for about one hour to determine that there are no defects in the connections. Shut the A.C. power **OFF** at the disconnect switch and use your meter to ensure the rectifier is electrically isolated. Immediately place your hand near current carrying connections to see that none of them are overheating. Connections may be warm, but should not feel excessively hot.



CAUTION: When/if checking temperatures with your hand, the connections and parts may be hot enough to cause a serious burn. Always ensure the power is disconnected by external switch prior to reaching behind the panel.

12. Air-cooled rectifiers utilize natural air convection for cooling and are typically manufactured with screened openings on the top and bottom of the enclosure. Ensure these vents are not obstructed by plugged screens or by placing the rectifier manual over the bottom vent.

13. The rectifier is shipped with the potential monitor alarm low and high setpoints factory configured for -850mV and -1250mv respectively. If you wish to reconfigure the setpoints perform the following steps after the rectifier is operating normally:
 - a. Start with both potentiometers fully counter-clockwise. This will ensure the low potential setting is at its minimum and the high potential setting is at its maximum.
 - b. Determine the low potential set-point (least negative potential) at which the alarm is to be activated. Place and hold the set/read switch in the "SET" position and adjust the set potential potentiometer to the desired low potential set-point.
 - c. While still holding the switch in the "SET" position slowly adjust the trim potentiometer labeled "LOW" clockwise until the yellow LED becomes illuminated.
 - d. Determine the high potential set-point (most negative potential) at which the alarm is to be activated. Place and hold the set/read switch in the "SET" position and adjust the set potential potentiometer to the desired high potential set-point.
 - e. While still holding the switch in the "SET" position slowly adjust the trim potentiometer labeled "HIGH" clockwise until the red LED becomes illuminated.
 - f. Return the potential setpoint to the level you wish the rectifier to maintain and release the "SET" switch.
 - g. The alarm board will now automatically monitor the potential, illuminating the yellow LED and the red external fault lamp should the potential drop below the "LOW" set-point and illuminating the red LED and the red external fault lamp should the potential rise above the "HIGH" set-point. If the potential remains between the "HIGH" and "LOW" set-points the green internal/external lamp will be illuminated.
14. Periodically monitor the rectifier, re-adjusting as necessary to maintain the level of cathodic protection current required.



MAINTENANCE



C.P. rectifiers have few moving parts therefore maintenance is largely of a preventative nature. Bear in mind there are primarily three conditions that will affect the life of a C.P. rectifier:

1. Excessive component temperatures.
2. Voltage surges and lightning.
3. Excessive current output.

Maintenance can be the best deterrent against rectifier failure due to excessive temperatures. Regular checks for blocked venting and/or heat from an external source should be undertaken. Periodic re-tightening of electrical connections is good insurance against future trouble. (See installation section, clause 1)

CAUTION: Hazardous voltages are present within the rectifier. **ALWAYS** interrupt the A.C. power at the nearby disconnect. The rectifier A.C. breaker **DOES NOT** totally remove all incoming A.C. power from the rectifier.

If excessive heating of rectifier components and/or wiring is suspected, a temperature probe is a very useful maintenance tool. The following is a guide for maximum temperatures. These temperatures are based on a 45°C ambient. The difference between 45°C and the ambient temperature at time of testing should be subtracted from the readings in this table:

COMPONENT	MEASUREMENT POINT	MAXIMUM TEMPERATURE
Modular Bridge	Module Body	110 °C
Discrete Diode	Case	115 °C
Main Transformer	Primary Winding	160 °C
Filter Inductor (Choke)	Winding	160 °C
Filter Capacitor	Case	80 °C
Secondary/DC O/P Fuse	Metal End Cap	130 °C
Current Shunt	Center Element	75 °C
Electrical Connections	Bolt Body	90 °C
Electrical Wiring	Wire Harness	90 °C

Component Temperature Table

Maintenance against voltage surges is largely one of ensuring the lightning and surge protection supplied with the unit is intact. Whenever possible, keep large motor driven

equipment (such as a pump-jack motor) or similar surge producing electrical equipment from being attached to the same A.C. power line as the rectifier. Lightning rods may prove invaluable in excessive lightning areas.

As the S.C.R. control card has the ability to limit the current and voltage output of this rectifier, excessive currents should not be a problem so long as the factory set calibration is not altered and the control card is functioning properly.

Meter readings should be verified with an external Digital Voltmeter. A quick check for ammeter accuracy can be made by measuring the millivolt drop across the shunt. This should be done with a high input impedance meter set to the "mV" range. The actual reading is given by the formula:

$$I_{DC} = \frac{mV \times I_{SHUNT}}{mV_{SHUNT}}$$

Where: I_{DC} = The DC Current though the shunt
 mV = The voltage (millivolts) read across the shunt terminals
 I_{SHUNT} = The current rating stamped on the shunt
 mV_{SHUNT} = The mV rating stamped on the shunt (usually 50mV)

Meter accuracy should be within 2% of the full-scale deflection of the meter combined with an allowance for temperature of 0.85% per 10°C for temperatures other than 25°C.

A periodic check of rectifier conversion efficiency will also indicate if the rectifier is functioning properly. If a portable A.C. wattmeter is unavailable, the utility pole mounted watt-hour meter could be used. This, of course, is if no other electrical loads are drawing power when the A.C. draw is being determined.

$$AC\ Power\ (Watts) = \frac{3600 \times K \times N}{T}$$

Where: K = The Watt-Hour meter constant (shown on meter face)
 N = Number of revolutions of watt-hour disk
 T = Time (seconds) for the number of revolutions to take place.

$$DC\ Power\ (Watts) = DC\ (Volts) \times DC\ (Amps)$$

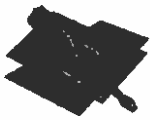
Where: $DC\ (Volt)$ = The DC voltage measured at the rectifier output terminals

DC (Amp)= The DC current measured at the shunt or read from the meter

Rectifier conversion efficiency will be:

$$\text{Rectifier Efficiency (\%)} = \frac{\text{DC Power Out}}{\text{AC Power In}} \times 100$$

For a TASC rectifier, the conversion efficiency is dependent on the tap setting and the output voltage of the rectifier. For details on achieving optimal efficiency refer to the "Automatic Rectifier Efficiency" section in this manual.



TROUBLESHOOTING



Although quality construction and preventative maintenance will reduce rectifier down time, failures will occasionally occur. A good knowledge of rectifier operation will enable a potential problem to be quickly traced and repaired.

RECTIFIER TEST EQUIPMENT:

At a minimum, the following test and safety equipment should be readily available to anyone servicing the rectifier:

- i) All PPE (Personal Protective Equipment) required by law.
- ii) A high quality DMM (Digital Multimeter) with the following functions and features:
 - (1) Minimum CAT III 600V
 - (2) Rugged and weatherproof
 - (3) AC & DC Volts
 - (4) AC & DC Amps
 - (5) Resistance (Ohms)
 - (6) Continuity with tone
 - (7) Diode test
 - (8) Frequency (Hz)
- iii) A proximity voltage detector (such as a voltage pen)
- iv) A suitable resistive test load
- v) A clamp on ammeter capable of reading both AC and DC current
- vi) A complete set of hand tools, extra wire and a good variety of crimp terminals
- vii) A fuse puller

The following optional equipment is useful for rectifier troubleshooting:

- i) A two channel Scopemeter

- ii) A LCR meter capable of measuring capacitance greater than 15,000 μ F and inductance greater than 10mH
- iii) A infrared temperature probe
- iv) A variable DC power supply with both voltage and current limiting features
- v) Hi-Pot tester



TROUBLESHOOTING SAFETY

The following procedures should be adhered to when troubleshooting any rectifier:



1. Visually inspect your environment, look for non-electrical hazards such as water or animals.
2. Approach the case with caution. Test the case with a voltage pen prior to grasping the latch/handle. Consider testing for any voltage on nearby metal objects such as fences and mounting framework.
3. Identify and locate an external disconnect switch for the rectifier. **Never work behind a rectifier panel with only the panel breaker off as there may still be hazardous voltages at the circuit breaker line terminals.**
4. Follow all local and company safety rules and regulations.

BASIC TROUBLESHOOTING PROCEDURES

Basic troubleshooting begins with a visual inspection of the rectifier. You are looking for burnt or discolored wires and components, loose or hanging parts and anything out of place. Evidence of arcing or heat discoloration on the frame can indicate surge damage or overheating. If there is no visual evidence of damage thoroughly identify the symptoms of the problem and compile a list of possible causes. Follow this by systematically isolating and testing the individual components whenever possible. Don't hesitate to call the manufacturer or sales office for assistance if you are unsure about anything.

The majority of rectifier faults are easy to diagnose. They include loss of A.C. input, blown fuses, loose terminals, faulty meters, blown M.O.V. suppressors, open circuits, faulty cathodic load connections and lightning damage. Automatic rectifiers often contain additional components such as chokes, capacitors, SCR's, control transformers and control circuitry. Not all automatic rectifiers are field serviceable and, in some cases, will need to be returned an authorized service center for repair.

The initial inspection should be followed by a systematic isolation of various rectifier components to determine the cause of failure. This should be conducted as follows (refer to the schematic for test point locations).



CAUTION: Beware of hazardous electrical voltages and where they are present in the rectifier. If doing any work on a rectifier other than taking voltage or current measurements, **DISCONNECT THE A.C. POWER**, preferably at the rectifier disconnect, not just using the rectifier circuit breaker.

1. Check whether A.C. voltage is present at the rectifier input terminals and that it is the correct level for the rectifier input rating. Provided the input breaker has not tripped **OFF**, this voltage check should be done with the rectifier **ON**. This will eliminate any static voltage reading such as might be experienced if only one A.C. line entering the rectifier is broken.
2. If the input breaker continues to trip **OFF** when energized, this usually indicates a short circuit within the rectifier. Proceed as follows;

- a) Check the bridge assembly and replace defective components if required. (See #8 below)
- b) With the rectifier disconnected from the A.C. supply, isolate the AC surge arrestor from the rest of the rectifier circuit. Do an ohmmeter check between ground lug and the load side(s) of the input breaker (right side of CB1 on schematic). Any detectable resistance will indicate a primary to ground breakdown. A "Megger" test instrument is preferred for this test if available. Any fault will necessitate replacement of the transformer.

NOTE: The installation of certain options (heaters, GFI outlets, alarm cards etc.) may result in additional components connected to the load side of the breaker. The existence of these components will affect the results of this test.

- c) Visually inspect the transformer for any signs of burned or shorted windings.
- d) Check for shorted A.C. lightning arrestors.
3. An intermittent voltage reading nearly always indicates a loose or burned connection.

4. Check if the rectifier has an automatic/manual switch. If this switch is present disconnect the power or turn off the panel breaker and place the switch in the manual mode. Adjust the taps for the desired output voltage and re-

energize the rectifier. If the rectifier operates properly in the constant voltage (manual) mode the problem is most likely limited to the control card.

(THIS IS RECOMMENDED UNDER DIRECT SUPERVISION)

5. Verify if there is transformer secondary voltage. If the rectifier has taps measure the voltage across **COARSE 'E'** and **FINE '5'**. This voltage should be 1.35 to 1.6 times the D.C. output voltage rating of the rectifier. If the rectifier does not have taps this measurement must be taken across the AC terminals of the SCR/Diode bridge.
6. If the rectifier has taps, verify the **COARSE** steps as being approximately 20% of the measurement (item 4 above) and that the **FINE** steps are approximately 20% of the voltage of each **COARSE** step.
7. If no LEDs are illuminated on the control card verify the presence of AC voltage (115 or 230 VAC) across pins 20 and 22 of the edge connector.
8. The SCR / Diode bridge is the device that converts the alternating current (AC) from the secondary of the transformer to direct current (DC) for use in cathodic protection. This device can fail due to a voltage surge into the AC or DC side of the unit (generally protected by the surge arrestors and fusing in the unit). The SCR / Diode bridge can fail to a "short circuit" or an "open circuit" condition. If the AC input circuit breaker in the unit trips, the rectifier bridge could be "shorted" and may need replacement. Each device in the bridge can be easily checked for a short circuit with a DVM on diode check by measuring across the device terminals (refer to the electrical schematic supplied with this manual and the table shown below). Alternately, if rated current cannot be achieved from the unit, part of the bridge in the unit could have become discontinuous (or "open") and it may again, need replacement. The SCR devices are not easy to check with a DVM for this condition as, until a gate signal is applied, they are always "open".

The tables on the following pages outline the test procedure for typical single phase and three phase SCR/Diode modules

Test Step	DVM Lead Positive	DVM Lead Negative	DVM Reading (Diode Check Range)	Comments	Typical Diagram
1	Bridge (-)	AC1	Low (0.3-0.7) Single Beep	Diode 1 Forward Bias	
2	AC1	Bridge (-)	High (OL) No Audio	Diode 1 Reverse Block	
3	Bridge (-)	AC2	Low (0.3-0.7) Single Beep	Diode 2 Forward Bias	
4	AC2	Bridge (-)	High (OL) No Audio	Diode 2 Reverse Block	
5	SCR 1 (G1) Gate	Bridge (+)	Low (0.05 – 0.1) Continuous Tone	SCR 1 Gate	
6	SCR 2 (G2) Gate	Bridge (+)	Low (0.05 – 0.1) Continuous Tone	SCR 2 Gate	
7	AC1	Bridge (+)	High (OL) No Audio	SCR 1 Forward Block	
8	Bridge (+)	AC1	High (OL) No Audio	SCR 1 Reverse Block	
9	AC2	Bridge (+)	High (OL) No Audio	SCR 2 Forward Block	
10	Bridge (+)	AC2	High (OL) No Audio	SCR 2 Reverse Block	

Single Phase SCR/Diode Module Test Procedure

Test Step	DVM Lead Positive	DVM Lead Negative	DVM Reading (Diode Check Range)	Comments	Typical Diagram
1	Bridge (-)	AC1	Low (0.3-0.7) Single Beep	Diode 1 Forward Bias	
2	AC1	Bridge(-)	High (OL) No Audio	Diode 1 Reverse Block	
	Bridge (-)	AC2	Low (0.3-0.7) Single Beep	Diode 2 Forward Bias	
4	AC2	Bridge (-)	High (OL) No Audio	Diode 2 Reverse Block	
5	Bridge (-)	AC3	Low (0.3-0.7) Single Beep	Diode 3 Forward Bias	
6	AC3	Bridge (-)	High (OL) No Audio	Diode 3 Reverse Block	
7	SCR 1 (gate)	Bridge (+)	Low (0.05 – 0.1) Continuous Tone	SCR 1 Gate	
8	SCR 2 (gate)	Bridge (+)	Low (0.05 – 0.1) Continuous Tone	SCR 2 Gate	
9	SCR 3 (gate)	Bridge (+)	Low (0.05 – 0.1) Continuous Tone	SCR 3 Gate	
10	AC1	Bridge (+)	High (OL) No Audio	SCR 1 Forward Block	
11	Bridge (+)	AC1	High (OL) No Audio	SCR 1 Reverse Block	
12	AC2	Bridge (+)	High (OL) No Audio	SCR 2 Forward Block	
13	Bridge (+)	AC2	High (OL) No Audio	SCR 2 Reverse Block	
14	AC3	Bridge (+)	High (OL) No Audio	SCR 3 Forward Block	
15	Bridge (-)	AC3	High (OL) No Audio	SCR 3 Reverse Block	

Three Phase SCR/Diode Module Test Procedure

- Check for the presence of voltage at the D.C. positive and negative terminals of the bridge and at the rectifier D.C. output terminals. If the voltage is present at the stack but not at the terminals, check for open circuits in the wiring (or a blown D.C. fuse).

NOTE: With no load, a sensitive electronic meter may read a static potential which is much higher than the actual D.C. voltage. It may be necessary to place a small load across the rectifier output lugs that will eliminate the false reading of the electronic voltmeter.

10. **If the correct D.C. voltage is measured at the rectifier D.C. output terminals but no D.C. output current is measured, there is an open circuit in the D.C. output circuit.** This open circuit could be either in the cables leading to the C.P. load or in the connection to the C.P. load.
11. Ensure that you verify rectifier panel meter readings with an external Digital Voltmeter (DVM). Rectifier meters may indicate a rectifier fault when no actual fault exists.
12. Meter switches are often a source of meter reading faults, especially in corrosive or H₂S environments. If the rectifier switches are a continuous problem, environmentally sealed switches should be used to replace normal types. The added cost for these may save future repair work and rectifier troubleshooting time. Jumpers carefully placed across the closed contacts of a suspect switch will reveal any high resistance contact problems that may exist.
13. Lightning and surge suppressors can be checked for shorts by removing their connections from the rectifier circuit and checking them with an ohmmeter. Normally these should exhibit an open circuit (infinite resistance).
14. If the rectifier has no/low output use your DVM to check the voltage from the reference cell. The rectifier control card is designed to reduce the DC output to a minimum level if the reference cell fails or if the wires connecting the reference cell are broken. On TASC rectifiers this problem may also be caused by a defective reference cell selector switch or a switch in the wrong position.

Note: The potential meter in IR drop free rectifiers reads the IR free structure-to-reference potential as sampled by the rectifier. This reading will not match the potential measured by a DVM while the rectifier is operating. This is an indication that the IR free mode of the rectifier is functioning correctly and is not a malfunction.

15. Potential controlled rectifiers can sometimes act erratically if the reference cell cable is too long and is picking up interference from other electrical systems nearby. If you measure frequent "spikes" or read an unstable voltage at the reference cell terminals with your DVM you may have induced noise on the line which is causing the rectifier to sample false potentials from the cell. To counteract this effect it is recommended to run the cable in a separate conduit and to use shielded twisted pair (STP) cable if the reference cell cable will be more than 25 feet long.

If you require any assistance when troubleshooting the rectifier, please contact the local Corrpro office or the factory for technical assistance. A few minutes of technical help can, in many cases, save many hundreds of dollars in on-site time or repair freight charges.

GLOSSARY

Alternating Current

An electrical current whose magnitude and direction vary cyclically.

Capacitor

An electrical device that can store energy in the space between two closely spaced conductors or plates. Capacitors are commonly used in rectifiers for filtering.

Cathodic Protection

A technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell.

Constant Current Rectifier

A type of automatic rectifier that adjusts the output voltage to maintain a constant current though the load.

Constant Potential Rectifier

A type of automatic rectifier that adjusts the output voltage to maintain a constant structure to reference cell potential.

Constant Voltage Rectifier

A type of rectifier, manual (tap adjust) or automatic that maintains a constant voltage across the load. This is the most common type of rectifier in use.

Current

The flow (movement) of electric charge.

Diode

An electronic component which allows current to flow in one direction and blocks it in the opposite direction.

Diode Bridge

An assembly of four or more diodes into a Full-Wave bridge.

Diode Module

An electronic device having two or more diodes integrated into a single component.

Direct Current

An electrical current whose direction remains constant.

Filter

The process of smoothing the rectifier output to improve efficiency and reduce ripple.

<u>Frequency</u>	The rate at which a periodic waveform repeats its self in one second.
<u>Fuse</u>	An overcurrent protection device which contains a piece of wire or "fusible link" designed to melt when a prescribed amount of electric current passes through it.
<u>IR Drop Free Constant Potential Rectifier</u>	A type of Constant Potential Rectifier that always samples the structure-to-reference potential right after zero crossing of the DC output waveform to eliminate IR drop error from the measurement.
<u>M.O.V</u>	Acronym for Metal Oxide Varistor. Used to protect circuits against excess transient voltages (surges).
<u>Potential</u>	In the Cathodic Protection industry it describes the voltage as measured between the structure being protected and a copper sulfate, zinc or other half-cell. Short for pipe to soil or structure to reference cell potential.
<u>Rectification</u>	The process of converting alternating current (AC) to direct current (DC).
<u>Resistance</u>	A measure of the degree to which an object opposes the passing of electrical current. Measured in Ohms.
<u>S.C.R</u>	An acronym for Silicon Controlled Rectifier. The SCR is a member of a family of devices called Thyristors.
<u>Thyristor</u>	A solid state semiconductor device that acts as a switch, conducting when the gate receives a current pulse and continues to conduct for as long as it is forward biased.
<u>Transformer</u>	An electrical device that transfers energy from one circuit to another by magnetic coupling.
<u>Voltage</u>	A difference of electrical potential between two points. Voltage can be thought of as an electrical "pressure" which allows current to flow.

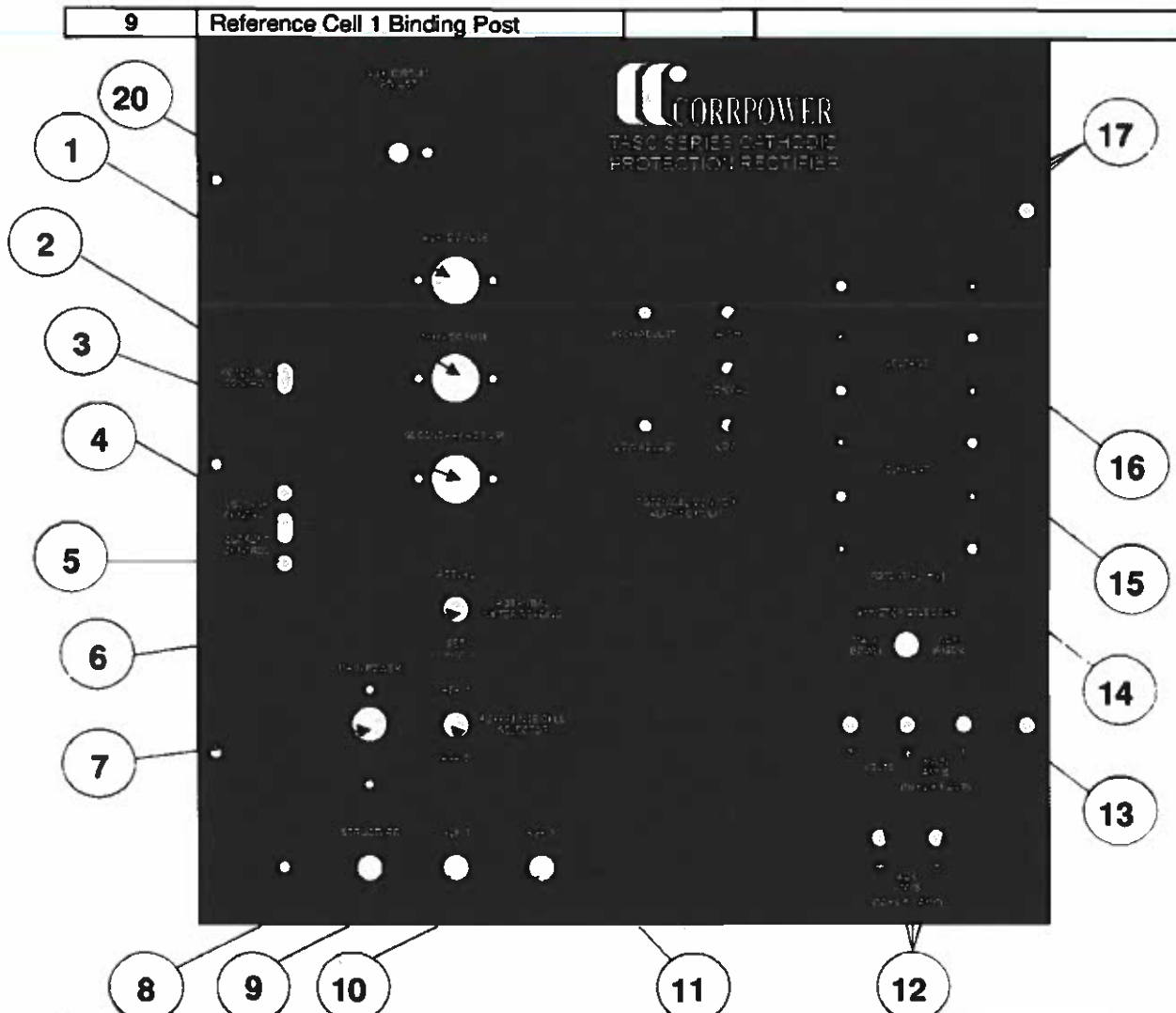
Appendix A: Warranty



corrpro®

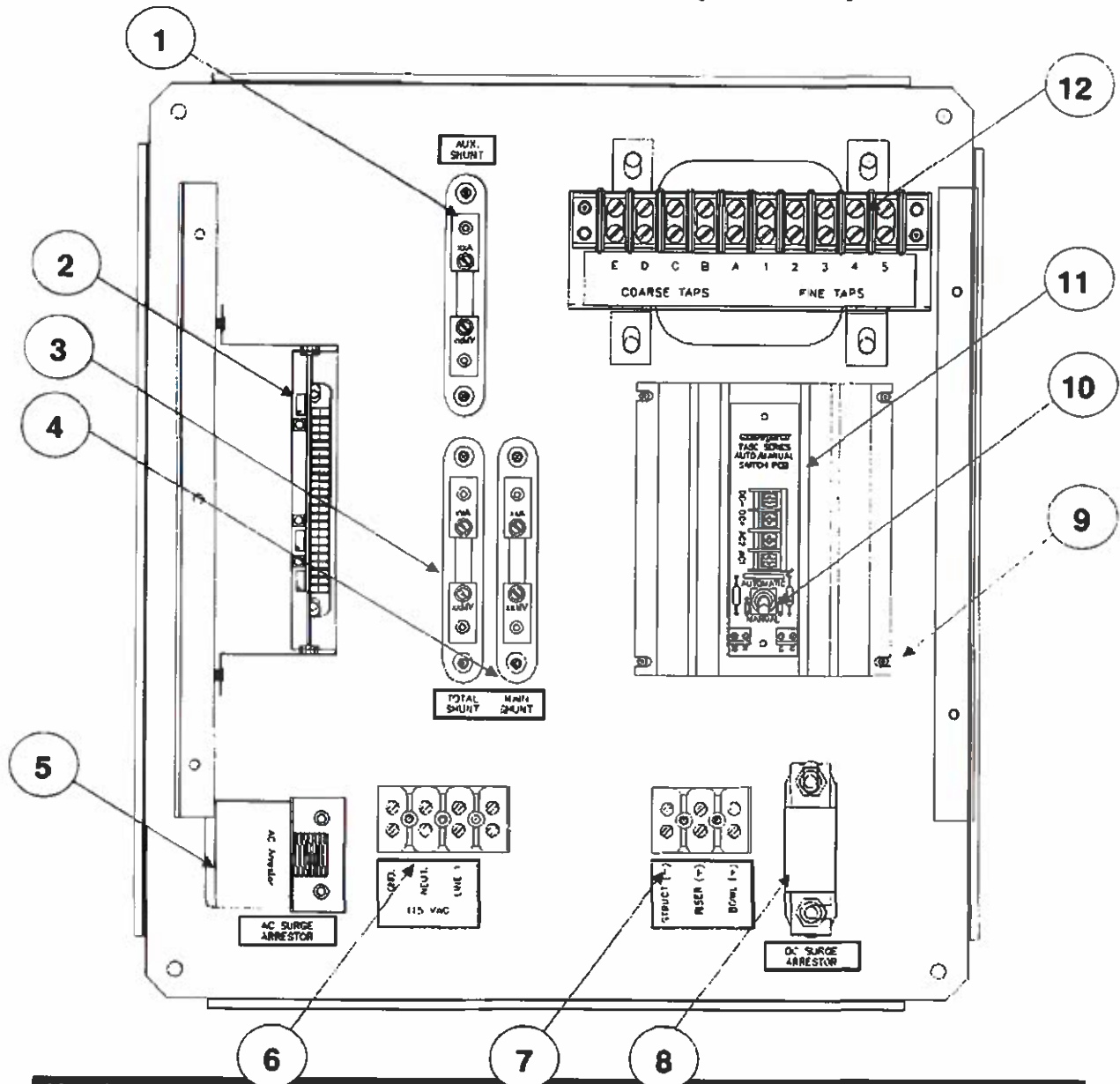
ONE YEAR GUARANTEE ON ALL CORRPRO CATHODIC PROTECTION RECTIFIERS

Unless otherwise specified, all products designed and manufactured by the CORRPRO Rectifier Division are guaranteed against defects in material and/or workmanship for a period of one (1) year, from date of purchase by the original purchaser. The obligation of the CORRPRO Rectifier Division under this guarantee is limited to repair, adjustment or replacement at our factory of any rectifier, or parts thereof, which may, after being returned with transportation charges prepaid, be found defective in material and/or workmanship upon detailed examination. CORRPRO reserves the right to make any change in design or specification that it deems an improvement, with no liability to make same changes on existing equipment. This guarantee is in lieu of all other guarantees or warranties, expressed or implied, which might otherwise exist. The purchaser is relying only upon this guarantee and not upon any representations not herein expressed. This warranty is void if any damage is caused by vandalism, misuse, incorrect installation, or any alterations to the product by un-authorized personnel. This warranty does not cover damage caused by lightning, flooding, or any other acts of GOD. Any materials being returned to the factory must first have a return materials authorization number (RMA) from the CORRPRO Rectifier Division repair department, for an RMA number please contact (780) 447-4565 extension 381.



Number	Description	Number	Description
1	Main DC Fuse	11	Reference Cell Selector Switch
2	Potential Control Status & Adjustment	12	Metering Test Points
3	Secondary AC Fuse	13	Ammeter Selector Switch
4	Voltage Control Status & Adjustment	14	Potential Meter
5	Current Control Status & Adjustment	15	Ammeter
6	Potential Set/Read Switch	16	Voltmeter
7	Main Circuit Breaker	17	Potential Alarm Indicator Lights
8	Structure Reference Binding Post	18	Potential Alarm Set Point Adjustment
9	Reference Cell 1 Binding Post	19	Riser/Aux. Circuit Rheostat
10	Reference Cell 2 Binding Post	20	Riser/Aux. Circuit DC Fuse

Appendix C: TASC Chassis Component Layout



Number	Description	Number	Description
1	Aux (Riser) Shunt	7	DC Output Terminals
2	TASC Control Card	8	DC Surge Arrestor
3	Totalizing Shunt	9	Heatsink
4	Main (Bow) Shunt	10	Auto/Manual Switch
5	AC Surge Arrestor	11	SCR/Diode Bridge PCB
6	AC Input Terminals	12	Transformer & Tap Terminals



POLYESTER POWDER COATING

ADVANTAGES OF DRY PAINT-

Powder materials and applications technology have added great value to the metal finishing industry. They can produce a quality finish that rivals that of liquid coatings, while offering superior surface properties.

POLYESTER – Powder Coating are a family of rugged thermosetting enamels for a wide range of metal substrates and end uses. They have applications and performance properties similar to those of EPOXY Powder Coatings. However POLYESTER powders are designed to give significantly better resistance to chalking and color change for exterior exposure and better resistance to color change from aging.

END USERS – POLYESTER Powder Coatings are especially suitable: (1) where multiple-coat solvent based systems may be replaced by a single powder coat: (2) as a replacement for electroplating: (3) to achieve extreme ruggedness: (4) as a replacement for porcelain enamels, or (5) where pollution regulations preclude solvent-based coatings.

AN ENVIRONMENTAL ISSUE – Powder coating offer better process economics over wet paint. Lower energy costs and the elimination of solvent emissions make it far easier to comply with the even more stringent environmental regulations. First, there is no need to use energy for spray booths and oven ventilation.

Secondly, materials utilization efficiencies are in the 95% range because overspray is captured and recycled not like wet systems where it is wasted causing possible hazards while handling sludge or solvent material.

COATING PERFORMANCE – On an equivalent thickness basis POLYESTER Powder coatings are comparable to solvent-based acrylics and polyesters widely used in the metalworking trade. For example, as a single-coat on light gauge, phosphatized cold rolled steel they offer.

Hardness, Good Chip Resistance
Good resistance to chalking and color change
Good chemical and stain resistance

In addition, abrasion and chemical resistance are excellent. We believe the properties of POLYESTER are comparable to our better than the best acrylic powders on the market.

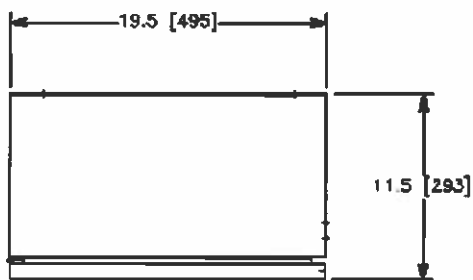
CSA AND UL APPROVALS

All our N4X enclosures have met and surpassed the requirements for an N4X rating by CSA, UL and NATIONAL ELECTRICAL MANUFACTURES ASSOCIATION.

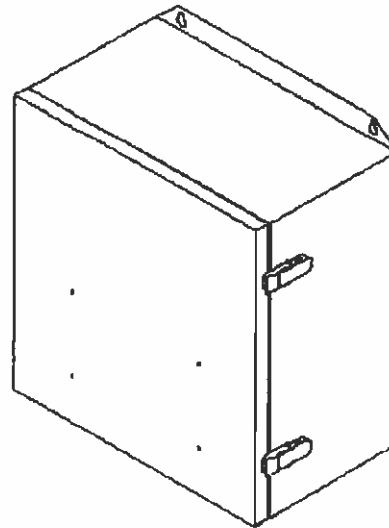
For such an approval, enclosures must undergo stringent laboratory testing. Enclosures are subjected to a 200 hour salt spray test of 65 gallons (426 liters) per minute with results of pitting no worse than that of a #304 stainless steel enclosure tested under the same conditions.

NOTE OF CAUTION: N4X corrosion tests are applied for 200 hours. Testing is done using salt and not other chemicals. The proper selection of enclosure type to meet environmental conditions is the responsibility of the purchaser.

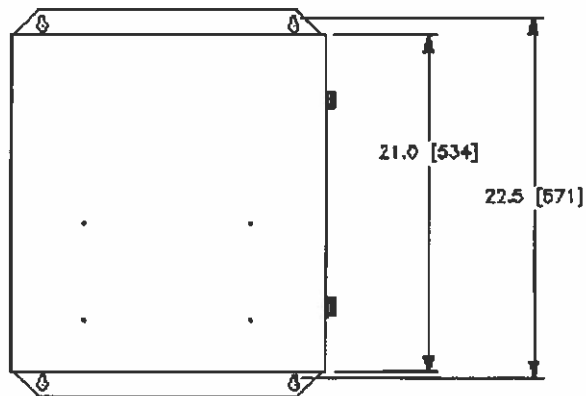
Appendix E: Enclosure Drawings 21x19x10 Steel



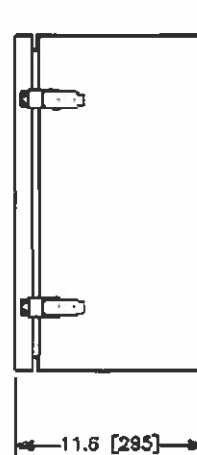
TOP



ISOMETRIC VIEW



FRONT



LEFT SIDE

SECTION 6

RECTIFIER SURVEILLANCE & TROUBLESHOOTING

RECTIFIER SURVEILLANCE

CRITERIA

Ensure the rectifier is operable and that output levels are within accepted target values.

EQUIPMENT

High input impedance voltmeter with 1 to 100 VAC and 0 to 100 VDC scales. The following meter is approved.

SEQUENCE

Data shall be obtained on a monthly basis to ensure proper operating status. A written record of the monthly operating status shall be maintained. A monthly log sheet is provided with this manual for your use.

RECORDING

All pertinent rectifier data shall be recorded on a "Rectifier Maintenance" sheet on a monthly basis. These forms shall be dated and signed, and any charges or unusual circumstances that may have had an influence on the readings shall be noted.

MALFUNCION

A malfunction is when output levels are outside of the target values given on the rectifier maintenance sheets. In the even an abrupt change in the rectifier output levels occur the rectifier becomes inoperable; utilize the rectifier troubleshooting information contained with this manual. If the problem persists, notify Corpro Waterworks C.P.

SUMMARY

The rectifier unit converts C power to DC power which is supplied to the impressed current anodes situated inside the structure. This current is then discharged from the anodes, travels through the water to the structure, and then returns to the rectifier via negative cables attached to the structure. Rectifier surveillance is required to ensure that the rectifier unit operates on a continuous basis at desired output levels.

PROCEDURE

Rectifier Surveillance

1. Record the rectifier voltage and amperage values as indicated by the corresponding meter. These meters are mounted on the panel board within the rectifier cabinet.
2. Open all rectifier doors and ensure the unit is relatively clean and free of debris.
3. The voltage output is measure directly by reading across the output lugs with a standard voltmeter. Current output is measure indirectly by readings across the calibrated shunts provided within each rectifier with the same portable voltmeter. The rating of each embossed on the shunt bar.
4. Record any adjustments to the rectifier output in terms of the final transform tap settings. These changes should only be made at the direction of a qualified corrosion engineer.

Water Tank Potential Monitoring

A. CRITERIA

Tank-to-water potentials between -0.85 volts (-850 millivolts) and -1.10 (1100 millivolts) with respect to a copper-copper sulfate reference electrode at all points tested.

B. EQUIPMENT

1. High-input impedance 20 mega-ohm minimum DC voltmeter with a 0-2 volt full scale meter (digital or analog acceptable). The following meters are approved:
 - a. M.E. Miller Model LC-4
 - b. Beckman Model HD-100
 - c. Fluke DVM
2. A freshly charged copper-copper sulfate reference electrode with a 50' (min.) lead wire. The following are approved:
 - a. M.C. Miller Portacell - Model I EHR8
 - b. Tinker & Razor - Model 88 or 6A
3. Two (2) five-foot long test leads, one end equipped with "banana" plugs for connection to the voltmeter and the other end with "alligator" clips.

C. SEQUENCE

Testing shall be conducted quarterly by the facility maintenance personnel to ensure the effectiveness of the cathodic protection systems afforded the water tanks. Annually a survey should be performed by a qualified corrosion engineer.

D. RECORDING

Test measurements are to be recorded. This form must be dated, and any activities that may have had an influence on any of the measurements shall be noted on this sheet. Quarterly readings are to be obtained at the surface, middle and bottom from each of the tank man ways.

E. TEST FAILURE

In the event the test measurements do not meet the accepted criteria, investigate to determine the cause. Possible reasons for test failures would include inoperable rectifiers, severed anode cables, or depleted anodes. Check the rectifier associated with the tank evaluated. If attempts to correct these deficiencies fail, notify Corpro Waterworks.

F. SUMMARY

Cathodic protection current shifts the tank-to-water potentials in a more negative direction, this test is to verify that sufficient current is being received by the internal submerged tank walls.

G. PROCEDURE

1. Water Tank

- a. Locate the tank as noted on the quarterly survey sheets.
- b. Climb the tank ladder and open the man way atop the tank.
- c. Connect the copper sulfate reference cell to the 50' lead wire. Tape the connection to ensure the threaded copper portion of the cell does not contact the water.
- d. Lower the reference cell into the water to the bottom of the tank. Connect the negative lead of the voltmeter to the lead wire on the reference cell.
- e. Connect the positive test lead of the voltmeter directly to the rim of the man way. Clean the metal to ensure good contact is made.
- f. Turn the voltmeter "ON" and to the 2 volt D.C. scale. Record the potential at the bottom of the tank, halfway to the surface, and at the water surface.
- g. This procedure is to be repeated at each of the water storage tanks on a quarterly basis.

2. Special Notes

- a. Copper-copper sulfate reference electrodes are usually received in a dry condition from the supplier. It will be necessary to fill the cell with distilled water before using. (Fill to within approximately one inch of the top)
- b. Examine the cell regularly, keeping the liquid level full. When the copper rod becomes badly discolored, discard the solution, sand the copper rod to bright copper, and add new *Cu/CuSO₄* crystals and distilled water. Sufficient *Cu/CuSO₄* crystals should be added to obtain a saturated solution.
- c. When not in use, keep the cell's porous tip covered.

RECTIFIER TROUBLESHOOTING

RECTIFIER TROUBLESHOOTING

Adherence to maintenance and periodic testing program as previously described will greatly reduce the possibility of ultimate rectifier failure. However, failures may occur. The following procedures are recommended to enable maintenance personnel to find and repair trouble(s) quickly in order to maintain cathodic protection on the structure being protected.

1. Precaution:

The following precautions should be observed when troubleshooting rectifiers:

- a. Turn the rectifier off when handling components within the rectifier. Turn off the circuit breaker at the AC panel board and at the rectifier cabinet.
- b. Check the rectifier-wiring diagram before starting to troubleshoot.
- c. Make certain that meters used in troubleshooting are properly connected. The voltmeter should be connected across the point where the voltage is to be measured while the ammeter should be placed in series with the circuit being tested. A millivolt meter should be connected across the terminals on the rectifier shunt. Correct polarity must be observed when using DC instruments.

2. Procedures:

Most rectifier troubles are simple and do not require extensive detailed troubleshooting procedures. Most common problems are: blown fuses, faulty meter, loose terminals, open anode leads, and lightning strike damage. These troubles are usually found by a simple visual inspection of the rectifier. For more difficult troubles, however, it is usually better to systematically isolate the rectifier components until the defective part is found. This may be done as follows:

- a. Check to see whether voltage is being applied to the rectifier by placing the leads from an AC voltmeter across the line side of the circuit breaker.
- b. Check across the load side of the circuit breaker to determine whether it is defective. The voltage should be the same as that of the line side.
- c. With an AC voltmeter, check the transformer secondary windings to determine whether voltage is present. If the circuit breaker trips, indicating a short circuit, the transformer may be isolated from the DC circuit by removing the secondary tap changing link bars or shorts within the transformer. If it no longer trips, the short is not in the transformer, but either in the rectifier stack or in the DC circuit.

d. Measure the AC voltage supplied to the rectifier stack. This voltage should be the same as that measured at the transformer secondary. If AC voltage is present at the transformer secondary but not at the stack AC terminals, check the leads from the transformer to the stack as follows: Place the AC Voltmeter leads between the transformer secondary and the stack. If no voltage is present, the lead between the two is probably open. Verify by measuring the AC voltage.

e. If the circuit breaker trips, the stack may be isolated from the rest of the DC circuit by removing one or both of the DC leads. If the breaker continues to trip, the stack is defective and should be replaced.

f. If the circuit breaker does not trip when a DC lead on the stack is removed but does trip when it is connected, the short circuit is probably in the anode circuit or structure leads. This may be verified by removing one of the external leads from the rectifier and turning the rectifier on again.

g. If DC voltage is present at the stack but not at the rectifier output terminals, check for loose connections or open leads between the stack and the positive terminal or between the stack and the negative terminal. This may be done by measuring the DC voltage between the positive and negative at the stack and between the positive and negative output terminals.

h. If DC voltage is present at the rectifier output terminals but no current is flowing, there is an open circuit in one of the external DC leads.

i. Faulty meters may cause the rectifier to appear defective when it is actually operating. The meters may be checked with portable meters known to be accurate.

3. Troubleshooting Techniques:

Many rectifier problems have symptoms that are obvious; however, the obvious should never be overlooked. Loose connections, signs of arcing, strange odors, etc., indicate troubles that do not require elaborate test procedures to uncover. Some helpful troubleshooting techniques are: If no output voltage or current is present, the trouble and remedy may be:

a. Breaker tripped (or fuse blown):

(1) If apparently due to steady overload, reduce the output slightly.

(2) If the breaker trips repeatedly even with the output reduced, the cause may be a short circuit in some component. Isolate the component as described before and repair or replace.

(3) If the breaker trips occasionally for no obvious reason, the cause may be:

(a) Line voltage surges.

(b) Intermittent short-circuits. Isolate the component as described before. Check for loose brackets or connections. Check with ohmmeter while moving leads, etc. (Make certain power is turned off when using the ohmmeter).

b. No AC line voltage. Check the AC breaker. Do not overlook the possibility that the AC panel board circuit breaker may have tripped.

c. Open circuit in some component or connection:

(1) Check all connections, fine and coarse transformer tap adjustments, and stack connections.

(2) Rectifier stacks. Use an AC voltmeter to see if voltage is applied to the stacks. If so, they may be open-circuited and should be checked with an ohmmeter and possibly replaced.

d. Defective meters. Check the wires between the meters and the calibrated shunt and output lugs. If the wires are intact but the problem persists replace the meter.

e. Defective transformer. If AC line voltage is applied to the primary but one is present at the secondary, check to see whether there is an audible hum coming from the transformer. If so, the primary is operating-but the secondary is probably open.

f. Circuit breaker. If the contacts do not close, they should be repaired or the breaker.