Section 1: Introduction

MISSION

Polycorp Ltd. is dedicated to enhancing the growth and prosperity of our customers and stakeholders. We are committed to leadership in our industry by utilizing our resources and processes to manufacture world class product which meets our customer's requirements for quality, cost and delivery.

QUALITY POLICY

Polycorp Ltd is committed to providing the highest level of quality for all products. Our policy is to develop, produce and deliver on time, in a safe and environmentally responsible manner, products that will satisfy our customer expectations by meeting or exceeding their requirements.

Our quality policy is to have 100% of our employees fully trained, functioning competently and in total compliance with the processes that comprise our Quality Management System (ISO 9001: 2008).

Achieving these objectives ensures customer satisfaction and continual process improvement. This is the foundation upon which the reputation of our company rests and we are committed to this policy.

HISTORY

The commercial use of rubber linings remained insignificant until the early nineteen hundreds. In 1924 the BFGoodrich Company discovered the first cement system that permitted the bonding of rubber to steel. The commercial importance of this rubber to metal bond was realized and, shortly afterwards, it resulted in a wide use of rubber linings for anti-corrosion applications.

Since the beginning BFGoodrich rubber linings have been widely acclaimed for their outstanding performance in a wide variety of applications. The success of the lining and bonding system through the years has been a result of the intensive research, development and testing programs that were carried out over the decades.

Until 1970 BFGoodrich was heavily involved in the applied rubber lining business through its shops in Tuscaloosa, Alabama and Akron, Ohio. At that time the decision was made to establish a network of authorized independent applicators and discontinue the application of rubber linings at the two BFGoodrich plants. The newly authorized applicators soon benefited from BF Goodrich's many years of experience, technical data and application procedures. In addition to the applicator having access to the large chemical and physical test laboratories in Akron, they also had the availability of the BFGoodrich Research Center in Brecksville, Ohio.

Through the 1980's BFGoodrich continued to expand its manufacturing presence in the United States and Canada, as well as constantly adding to the library of lining formulations to suit all customer requirements. To enhance focus on the protective lining business segment, centers of excellence were established in Livonia, Michigan and Kitchener, Ontario. This move proved to be the catalyst for an increase in customer commitment and satisfaction for BFGoodrich rubber lining products.

In 1988 the BFGoodrich Company decided to divest itself of all industrial rubber product businesses and concentrate their efforts in the aerospace and aircraft maintenance market segments. Eventually the US rubber lining business was sold to RJF International Corporation as the Polymeric Protective Linings division with manufacturing remaining in Livonia. Canadian operations were sold to Polycorp Ltd. in 1996 and relocated to a new facility in Elora, Ontario.

On August 26, 2002 Polycorp purchased Polymeric Protective Linings. This purchase reunited two companies that had once been part of BFGoodrich. The combined production lines were consolidated in the Polycorp facility in Elora. This strategic initiative established Polycorp as the largest manufacturer of rubber linings in North America. Further, it allowed Polycorp to

maintain its product leadership position by combining the technical and marketing abilities of both companies. Of greater importance than the physical assets, the intellectual property and patents from the BFGoodrich days were again under the control of one company.

Polycorp Ltd. provides and markets a complete line of natural and synthetic rubber lining constructions that offer corrosion, impact and abrasion protection over a wide temperature range. We have over ninety years of experience in developing and producing high quality linings, starting as BFGoodrich and now as Polycorp.

We will continue to lead our industry in product innovation and technical development while remaining the benchmark for product quality, customer service, and technical expertise before, during, and after purchase of our products.

DISCLAIMER

READ CAREFULLY

As a service to its customers Polycorp Ltd. provides technical and application information to assist in the understanding of specific rubber lining needs. This information should be used as a guide only and the customer should not, in any way, assume or imply any liability on the part of Polycorp Ltd. with the use of this information.

Polycorp Ltd.'s responsibility is limited to the terms and conditions of the Exclusive Terms and Conditions of Sale set forth in this section. It is further understood that the technical and application information provided by Polycorp Ltd. can be affected by many factors such as inaccurate service conditions, weather, application skills and synergistic effects as they relate to a project.

Polycorp Ltd. disclaims liability for damages that may result from the use of this information except as provided in the Exclusive Terms and Conditions of Sale set forth in this section.

EXCLUSIVE TERMS AND CONDITIONS OF SALE

Polycorp Ltd. protective lining products and accessories ("Product(s)") are offered under the following terms and conditions and only to those customers to whom Polycorp Ltd. has directly mailed this Product Manual ("Customer"). **Possession of this product manual by others does not constitute an offer to sell products to such parties.** Additional terms and conditions of sale may be shown on or attached to sales order confirmations issued by Polycorp Ltd. Any additional or different terms or conditions stated in any purchase order or other document issued by Customer in connection with its purchase of the Product(s) are expressly rejected by Polycorp Ltd. and will have no effect and will not, under any circumstances, be binding on Polycorp Ltd.

These Exclusive Terms and Conditions of Sale ("Terms and Conditions of Sale") together with terms shown on or attached to Polycorp Ltd.'s sales order confirmations shall constitute the entire and exclusive contract (this "Agreement") between Polycorp Ltd. and Customer. This Agreement is intended to be a final expression of Polycorp Ltd.'s and Customer's understanding and agreement with respect to its terms and shall supersede all prior negotiations, promises, agreements and representations not set forth herein or on any sales order confirmations issued by Polycorp Ltd. Polycorp Ltd.'s acceptance of Customer's order is expressly conditioned on Customer's assent to the terms and conditions of this Agreement (including, without limitation, the Terms and Conditions of Sale). Any oral or written order by Customer, whether quoted, shipped or received by Polycorp Ltd., shall be construed as a written acceptance by Customer of Polycorp Ltd.'s offer to sell in accordance with this Agreement, and any such order shall be filled in accordance with the terms as provided in this Agreement. No other terms and conditions shall apply and no modifications or amendments to this Agreement shall be of any force and effect unless specifically set forth in a writing that expressly references these Terms and Conditions of Sale and is signed by an authorized employee of Polycorp. Ltd. Additionally, no modification shall be effected by an acknowledgment or acceptance by Polycorp Ltd. of any oral or written purchase order from Customer containing any different terms and conditions, and any such inconsistent terms and conditions shall be deemed to be superseded by this Agreement.

If for any reason Customer fails to accept this Agreement in writing, any conduct that demonstrates the existence of a contract (including, without limitation, the delivery of Product(s) in accordance with this Agreement prior to written acceptance hereof and acceptance of such items by Customer) shall constitute an agreement by Customer and

Polycorp Ltd. to all of the Terms and Conditions of Sale or other terms and conditions shown on or attached to Polycorp Ltd.'s sales order confirmations.

PAYMENT AND SHIPPING TERMS

All terms are net 30 days from the date of shipment as indicated on Polycorp Ltd.'s invoice, F.O.B. shipping point, **provided**, however, that freight shall be prepaid and allowed on each order of at least 2,000 pounds of Products to be shipped to a single destination within Canada or the continental United States. The minimum order for all standard grades of unvulcanized stock is one (1) full roll.

Title and risk of loss shall pass to Customer upon delivery to the common carrier. All shipments will be made to those locations specified in Customer's purchase order or telephone order. Delivery is subject to availability and lead times required by Polycorp Ltd.'s production schedule.

PRICES

All prices quoted are subject to change by Polycorp Ltd. without notice. Prices quoted herein do not include any taxes or duties (including, without limitation, the sales taxes on the Product(s) or freight) or any handling, rigging, uncrating, storage, or other charges incidental to shipment, delivery, storage, installation, or use of the Product(s). **All prices are subject to adjustment to compensate for any increase in raw material costs or for any taxes or levies effective through the date of shipment of any Products sold hereunder.**

CREDIT TERMS

Polycorp Ltd. may establish and change the credit and payment terms extended to Customer when in Polycorp Ltd.'s sole opinion Customer's financial or previous payment record warrants such action, and Customer's order of Products hereunder constitutes an agreement to honor the credit and payment terms so established or changed. Customer will provide promptly upon request such financial information as may be reasonably required by Polycorp Ltd. to complete its credit review of Customer.

DEFAULT

If Customer does not pay any amount when due or does not meet any other obligation hereunder, then (in addition to any other remedies available at law or in equity) Polycorp Ltd. may

accelerate any balance due and require immediate payment thereof, may repossess the Product(s), and may resell the Product(s), in each case, to the extent permitted by applicable law. The net proceeds of any such resale, after Polycorp Ltd.'s cost of repossessing, removing, transporting, reconditioning, refabricating, storing, and reselling the Product(s), and all other associated costs, will be applied to the unpaid balance owed by Customer. Customer will remain liable for any deficiency which remains after such resale, and Polycorp Ltd. will return to Customer all net proceeds in excess of Customer's unpaid balance. With respect to any delinquent payment(s) or accelerated balance(s), Customer will pay a finance charge at the rate of eighteen percent (18%) annually, or at the maximum applicable lawful rate of interest permitted by the laws of the state or province to which the Products are shipped, if lower, computed from the date each delinquent payment of accelerated balance shall have become due. Furthermore, in any action initiated to enforce the terms and conditions of this Agreement following Customer's default, Polycorp Ltd. shall recover as part of its damages all cost, expenses, and attorney fees incurred in connection with any actions taken on account of such default.

WARRANTY, DISCLAIMERS, AND LIMITATIONS ON LIABILITY

All warranties applicable to the Products are set forth in the Warranty Statement included in this section below. No other warranties are offered by Polycorp Ltd. with respect to the Products and Polycorp Ltd. has not authorized any employee or agent to offer any warranties except those expressly set forth herein.

MISCELLANEOUS

Polycorp Ltd. may change the construction, design, or configuration of the Products without notice to Customer as long as the general function of the Products is not thereby altered.

This Agreement (including, without limitation, the Terms and Conditions of Sale) are to be interpreted under the laws of the province of Ontario, and the federal laws of Canada applicable therein, without regard to principles of choice of law.

Course of dealing, course of performance, course of conduct, prior dealings, usage of trade, community standards, and customary practice or interpretation in matters involving the Products or the design, sale, delivery, installation, use, or maintenance of the Products or of similar or dissimilar goods shall not serve as references in interpreting the terms and conditions of this Agreement.

Notwithstanding any other provisions, and in addition to all other conditions and exclusions set forth herein, Polycorp Ltd. will not be liable for any delay or default in performance caused by events beyond its control, including (by way of example and not by way of limitation) any acts of God, any acts of third parties, any acts of Customer or any of Customer's employees, agents, or representatives, acts of civil or military authorities, fires, floods, and other similar and dissimilar natural causes, riots, wars, sabotage, vandalism, embargoes, labor disputes, strikes, lockouts, lack or shortage of transportation, labor, materials, supplies, fuel, power, or other resources, delays in receiving any permits or licenses, delays caused by any laws, regulations, proclamations, ordinances, or any government action or inaction, delays caused by contractors and subcontractors, or any other cause or condition beyond Polycorp Ltd.'s control. In the event of any such delay or default, the time for performance of obligations of Polycorp Ltd. will be extended for a commercially reasonable period of time.

Polycorp Ltd. reserves the right to allocate its available supplies among its customers on such basis as Polycorp Ltd. may deem fair and practical under the circumstances without liability for any resulting failure of performance.

Customer's payment obligations hereunder are independent of any other obligations Customer or Polycorp Ltd. may have under the terms and conditions of this Agreement or any other contract or account with Polycorp Ltd. or any other business unit of Polycorp Ltd. Customer will not exercise any right of offset in connection with any balances due under the terms and conditions of this Agreement or under any other contract or account with Polycorp Ltd. or any other business unit of Polycorp Ltd.

All sales are subject to Polycorp Ltd.'s senior management review and express written approval of credit and finance matters and any terms, conditions, or descriptions inconsistent with the terms and conditions of this Agreement.

Any failure by Polycorp Ltd. at any time, or from time to time, to enforce or require the strict keeping and performance by Customer of any of the terms and conditions of this Agreement shall not constitute a waiver by Polycorp Ltd. of a breach of any such terms or conditions, nor shall it affect or impair such terms or conditions in any way, or the right of Polycorp Ltd. at any time to avail itself of such remedies as it may have for any such breach or breaches of such terms or conditions. A waiver of any of the terms or conditions hereof must be in writing and signed by Polycorp Ltd. Any such waiver shall not be deemed a continuing waiver, but shall apply solely to the instance to which the waiver is directed. If any of these terms or conditions or portion thereof are rendered unenforceable under the law, all remaining terms and

conditions of this Agreement not affected by such determination shall remain in full force and effect and shall be binding upon Polycorp Ltd. and Customer.

Except as otherwise provided in writing, nothing contained herein shall be construed to give any rights or benefits to anyone other than Polycorp Ltd. and Customer, and all duties and responsibilities undertaken pursuant hereto will be for the sole and exclusive benefit of Polycorp Ltd. and Customer and not for the benefit of any other party.

WARRANTY STATEMENT

Polycorp Ltd. warrants to the original Customer that Products sold by Polycorp Ltd. will, under normal use and service, be free from defects in materials and workmanship (the "Warranty"). The Warranty for any Product commences on the date of shipment as reflected on Polycorp Ltd.'s invoice and expires 12 months after such date.

In order for Customer to make a valid claim that any Product supplied by Polycorp Ltd. does not meet the Warranty, Customer must fully comply with the following Warranty claim procedures:

Customer shall have notified Polycorp Ltd. in writing prior to the Warranty expiration date and shall have received a written Returned Goods Authorization (RGA) from Polycorp Ltd. referencing the Product(s) covered by the Warranty; and Customer shall have returned such Product(s) to Polycorp Ltd. referencing Customer's RGA, freight collect via common carrier specified by Polycorp Ltd. (or freight prepaid if returned via any other carrier). In no event will Polycorp Ltd. make on-site repairs or replacements.

If Polycorp Ltd. determines that a returned Product is covered under the Warranty, then Polycorp Ltd. shall, at its option in its sole discretion, either (i) replace the returned Product at no additional cost to Customer or (ii) refund the original purchase price paid for such returned Product. **Customer acknowledges and agrees that its failure to (i) follow the Warranty claim procedures set forth above, including (without limitation) the process by which it reports any alleged defects in materials or workmanship and obtains its RGA from Polycorp Ltd., or (ii) comply with the other Warranty conditions set forth herein, shall constitute a release and waiver of all Warranty obligations of Polycorp Ltd. hereunder.**

The Warranty is subject to the condition that Customer notifies Polycorp Ltd. immediately in the event the Product at any time demonstrates any defect in materials or workmanship. The Warranty is subject to the further conditions that materials not intended for immediate

application shall be stored in humidity-controlled warehouses or storage areas at temperatures not to exceed 50° F. and in no event shall be stored for any period of time at temperatures exceeding 120° F. or where the material may be subject to partial cure. The Customer is responsible for proper installation and normal care and maintenance of the Product.

The Warranty does not include coverage for any defect or performance deficiency, which is the direct or indirect result, in whole or in part, of accidents, abuse, misuse, operation of Product(s) outside of their environmental, electrical or performance specifications, conditions, capabilities, or standards, vandalism or any other damage or alteration of the Product(s) by persons other than Polycorp Ltd. employees, combining incompatible products, fires, floods, and other similar and dissimilar natural causes, damage, alteration, or any impairment of the Product(s) resulting from causes or conditions not associated with ordinary storage, handling, installation, maintenance, service, or use, maintenance or service by any party other than Customer or a designated representative of Polycorp Ltd., or any acts, omissions, causes, or events beyond the control of Polycorp Ltd. It is solely Customer's responsibility to test and determine the suitability of any Product for any intended use, and although Polycorp Ltd. may have recommended a Product at Customer's request, Customer assumes all risk and liability whatsoever regarding such Product's suitability for Customer's purposes or any other intended use. Furthermore, the Warranty does not extend to dimensional changes or other defects directly or indirectly caused by storage, handling, or processing the Product(s) under environmental conditions exceeding those recommended by Polycorp Ltd. or generally accepted by the industry for the Product(s) or for any storage, handling, manufacturing, or fabrication process used by Customer involving the Product(s). The Warranty does not apply to Products that have not been paid in full. Polycorp Ltd. must be given a reasonable period of time to inspect any Product that is the subject of a Warranty claim, and Customer's failure to allow such inspection shall invalidate any warranty claim. **The Warranty is not transferable to any subsequent purchaser or users of the Product(s).**

The Warranty is (i) the sole and exclusive warranty provided for the Product(s), (ii) extends only to the original Customer (and not to any subsequent purchasers or users), (iii) is expressly in lieu of any other warranties, express or implied, including without limitation any warranty of merchantability, fitness for particular purpose or otherwise, even if such purpose is known to Polycorp Ltd., and (iv) in lieu of any other obligations or liability on the part of Polycorp Ltd. Polycorp Ltd. neither assumes, nor has authorized anyone to assume for it, any other warranty or liability in connection with its Product(s). If implied warranties arise or exist under any applicable law and cannot be waived or disclaimed, then those warranties will last only as long as the Warranty.

LIMITATIONS OF LIABILITY

It is expressly agreed that Customer's sole remedies relating to the products are set forth herein. Polycorp Ltd. will have no liability under any circumstances for any consequential, incidental or special damages by reason of any act of omission arising out of or in connection with the Products, or the sale, delivery, installation, maintenance, operation, performance, or use of the Products, including (by way of example and not by way of limitation) damages, expenses, or losses incurred by reason of loss of use, lost revenues, lost profits, damage to associated equipment or to facilities, costs of capital, costs of substitute products or facilities, costs of replacement products, costs associated with down time, and any similar and dissimilar damages, expenses, or losses whether any such liability is based on contract, tort, or other legal or equitable principles, and in no event shall Polycorp Ltd.'s liability exceed the purchase price of the Product(s) identified or involved in any dispute. The sole purpose of the stipulated sole remedy set forth in this section shall be to provide Customer with free replacement or refund for defective Products in the manner provided herein. This sole remedy will not be deemed to have failed of its essential purpose so long as Polycorp Ltd. is willing and able to replace defective Products in the manner prescribed herein or, in its sole option, to provide a refund of the original purchase price paid by the Customer for such Product.

Section 3: General Characteristics of Lining Materials

The following are general characteristics of common materials used for protective linings. These should be used as broad guidelines only. **Always refer to the chemical resistance table contained in Section 4 for recommendations for specific chemicals. Contact your Polycorp representative for more detail.**

Polycorp recommends that customers use the Material Recommendation Request Form in Appendix III to gather the specifics of a particular application. This provides Polycorp Engineers with the ideal amount of information to make optimum lining recommendations.

SOFT NATURAL RUBBER (NR)

Good resistance to most inorganic chemicals with the exception of strong oxidizing agents. They exhibit outstanding abrasion resistance and will expand and contract with thermal variations of the metal substrate.

ADVANTAGES

- Lowest cost of all elastomers
- Ease of application
- Ease of cure
- Ease of repair
- Excellent low temperature properties
- Good general chemical resistance within temperature limitation
- Superior to excellent abrasion and tear resistance

CONSIDERATIONS

- Not oil resistant
- Not flame resistant

TYPES

- Hardness range from 30 to 70 Shore A
- FDA compliant
- Chemical cure - for quick atmospheric cure and repairs

USES

- Chemical storage tanks
- Tank trailers, railroad tank cars
- Tumblers, vibrators, cyclones, fans, pumps, pipe and fittings, etc

DO NOT USE

- In tumblers or vibrators where oily parts may be processed
- For plating tanks

STANDARD PRODUCTS:

1032, 1060, 1061, 1064,1068,1097,1099, 2000, 2001, 2002, 2004, 2019, 2020, 2027, 2033, 2033P, 2041, 2042, 3049, 60714, 64025, T1000, T1001, T1003, T1004S, T1200, T1300, T8000

HARD NATURAL RUBBER (SEMI AND EBONITE)

Better chemical and heat resistance than soft natural rubber. Wide application in organic and inorganic acids and chlorine gas. Specific grades have excellent permeation resistance and heat resistance.

ADVANTAGES

- Moderate cost
- Ease of application and repair
- Ease of cure
- Excellent chemical and permeation resistance
- Heat resistance up to 200°F (93°C)

CONSIDERATIONS

- Not oil resistant
- Not flame resistant
- Subject to damage by cold weather exposure or sudden extreme temperature changes

TYPES

- Semi-hard
- General purpose Ebonite
- FDA compliant and electroplating tank Ebonite (no graphite)
- Chlorine and hot brine resistant Ebonite (graphite)

USES

- Chemical process tanks, agitators, mixers, pumps, fans, water treatment columns
- Plating tanks (nickel, copper, cadmium)
- Pipe and fittings
- Pickling tanks

DO NOT USE:

- For chrome plating tanks
- For nitric or hydrofluoric acid
- Where abrasion is severe
- Where oil is present

STANDARD PRODUCTS:

1003, 1004, 1006, 1017, 1035, 1036, 1038, 1040, 1042, 1048, 1053, 2017, 3014

TRIFLEX™

Three ply natural rubber lining (soft-hard-soft) that has excellent chemical and moderate abrasion resistance. The semi-hard rubber center layer provides a permeable barrier and the soft cushion allows maximum adhesion to steel.

ADVANTAGES

- Moderate cost
- Ease of application
- Ease of cure
- Ease of repair
- Good flexibility reducing danger of cracking in cold or temperature changes
- Excellent chemical and permeation resistances

CONSIDERATIONS

- Not oil resistant
- Not flame resistant

USES

- Phosphoric acid process equipment and hydrochloric acid storage
- Acid pickling tanks where brick sheathing is used

DO NOT USE

- Where oil or solvents are present
- For tumblers or vibrators

STANDARD PRODUCTS:

1000, 1001, 1008, 1019HT, 1020HT, 1066, 1077HT, 3015, 3016

CHLOROBUTYL /BROMOBUTYL (CIIR/BIIR)

Good resistance to acids and caustic solutions up to 260°F (127°C). Recommended for applications that require ozone, sunlight and aging resistance. Excellent low temperature properties.

ADVANTAGES

- Heat resistance up to 260°F (127°C)
- Good resistance to ozone, sunlight and aging
- Good chemical and permeation resistance

CONSIDERATIONS

- Not oil resistant
- Not flame resistant

USES

- For hydrofluoric acid, super phosphoric acid and sodium hypochlorite storage and process
- Mixed acid wastes
- For sodium hypochlorite storage and transportation

DO NOT USE

- For plating tanks
- Where oil or solvents are present

STANDARD PRODUCTS:

1024, 1051, 1054, 1055, 1056HT, 1058, 2006, 2007, 2040, 2055, 2056, 4631, 6511, 6512, 17001, T6005, T6105

CHLOROPRENE (CR, Neoprene®)

A synthetic elastomer with some physical properties similar to natural rubber. Superior to natural rubber in resistance to heat, ozone, sunlight, weather, flame and oil.

ADVANTAGES

- Oil resistant
- Heat resistant up to 200°F (93°C)
- Flame resistant - will not support combustion
- Good chemical resistance
- Excellent resistance to ozone, sunlight and weather
- Excellent abrasion resistance

CONSIDERATIONS

- A preheated table required for application

TYPES

- General purpose
- High abrasion resistance

USES

- Caustic storage and transportation tanks
- Chemical process and storage tanks
- Mining equipment, such as tumbling barrels and vibrators
- Agitators, pumps, fans, pipe and fittings, other equipment

DO NOT USE

- For plating tanks
- Where solvents are present (halogenated solvents, ketones and lacquer solvents)
- In kerosene or mineral spirits

STANDARD PRODUCTS:

2010, 2011, 2012, 2013, 2034, 5621, 5821, T5009, T5109

NITRILE (NBR)

Good resistance to greases, oils, petroleum hydrocarbons and other non-polar solvents. Good heat aging resistance up to 239°F (115°C).

ADVANTAGES

- Good resistance to oil, fuel and hydraulic fluids
- Excellent resistance to water
- Good abrasion resistance and tensile strength
- Good low temperature properties
- Heat resistance

CONSIDERATIONS

- A preheated table required for application
- Poor resistance to sunlight and ozone
- Poor weathering qualities
- Poor resistance to highly polar solvents: acetone, MEK

TYPES

- General purpose

USES

- Fuel and oil handling hoses, tanks

DO NOT USE

- Highly polar solvents such as acetone, MEK, ether
- Exposure to sun, weather and ozone

STANDARD PRODUCTS:

2048

STYRENE-BUTADIENE RUBBER (SBR)

Good abrasion resistance, excellent impact strength, very good resilience and a high tensile strength. The operating temperature of SBR lining is up to 160˚F (71°C).

ADVANTAGES

- Excellent sliding abrasion resistance
- Excellent tear and wear resistance
- Good resistance to dilute acids, alkalis and alcohols

CONSIDERATIONS

- Not resistant to oil, gasoline, hydrocarbon or oxidizing agents
- Not flame resistant
- Poor resistance to ozone, sunlight and weather

TYPES

- General purpose

USES

- Pulley lagging and sliding abrasion application
- Mining equipment

DO NOT USE

- Where oil, gasoline and hydrocarbons are present

STANDARD PRODUCTS:

9159, 9160, 9169, 55159, 55160

MOR (MODERATE OIL RESISTANCE) RUBBER

Blended rubber lining for general purpose use for abrasion and moderate oil resistance.

ADVANTAGES

- Excellent abrasion resistance
- Resistance to trace quantities of oil, fuel and hydraulic oil
- Operating temperature range from -40°F (-40°C) to 160°F (71°F)
- Ease of application and repair

CONSIDERATIONS

- Not flame resistant
- Poor resistance to ozone, sunlight and weather

TYPES

- General purpose

USES

- Flotation process in mining industry
- General mining applications

STANDARD PRODUCTS:

3049

Section 4: Chemical Resistance Table

This chemical resistance table is to be used only as a guide to assist in the selection of the most satisfactory combination of natural and synthetic rubber linings for resistance to various chemical solutions. The table offers several rubber lining selections based on chemical concentration and temperature. The temperatures identified in the chart are considered to be normal operating temperatures in which the rubber lining will function properly. Temperature is a big factor in determining the service life realized from a rubber lining. Generally, the higher the temperature, the shorter the service life, while the lower the temperature, the longer the service life.

Polycorp Protective Linings offer a full line of natural and synthetic rubber linings to meet a growing list of service needs. The chemical resistance chart provides for common recommendations, however, we can meet the special needs for FDA, color, chemical cure linings, and special tie gum requirements.

The specific ratings found in this chart are based on past field experience, the advice of various polymer suppliers, and specific laboratory test results. **This information is offered only as a guide, and because of variables in actual service conditions, the accuracy of the ratings cannot be guaranteed**. Only the user evaluating the rubber lining in actual service conditions can determine actual service life.

We have included a ***"Material Recommendation Request"*** form in Appendix III. It is important to provide the technical group with as much detailed data concerning the service conditions in order to determine the appropriate rubber lining recommendation.

Chemical Resistance Table

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Acetaldehyde	40	150	66	1053	-
Acetic Acid-Glacial	100	80	27	1006 1035	1038 1038
Acetic Acid	10	140	60	1006 1035	1038 1038
Acetic Anhydride	100	100	38	1006 1035	1038 1038
Acetone	100	100	38	1051	-
Activated Silica	100	100	38	1060	2019
Alkyl Sulfonate	Any	150	65	1006 1035	1038 1038
Alum	Sat.	175 180	79 82	1000 2010	1001 2013
Aluminum Acetate	Sat.	150	65	1006 1035	1038 1038
Aluminum Bromide	Sat.	150	65	1006 1035	1038 1038
Aluminum Chloride	Sat.	180	82	1055	2040
Aluminum Fluoride	Sat.	100	38	1055 1051	2040 -
Aluminum Hydroxide	Sat. Sat.	150 180	65 82	1008 1055 2010	1001 2040 2013
Aluminum Nitrate	Sat.	150 180	65 82	1006 1035 1055	1038 1038 2040
Aluminum Phosphate	Sat.	150 180	65 82	1006 1035 1055	1038 1038 2040
Aluminum Sulfate	5 Sat.	125 180	52 82	1099 1055	2042 2040
Ammonium Alum	Sat.	180	82	1008	1001

Section 4: Chemical Resistance Table

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Ammonium Carbonate	Sat.	160	71	1006 1035	1038 1038
Aluminum Chloride	Sat.	180	82	1055	2040
Ammonium Hydroxide	Sat.	150	65	1055	2040
Ammonium Nitrate	Sat.	150	65	1055	2040
Ammonium Persulfate	Sat.	140	60	1055	2040
Ammonium Phosphate	Sat.	140	60	1055	2040
Ammonium Sulfate	Sat.	150 190	65 88	1055 1051	2040 -
Amyl Iodine	Any	Amb.		Testing Req.	
Amyl Alcohol	100	125	52	1055	2040
Arsenic Acid	Sat.	150	65	1000 1006	1001 1038
Barium Chloride	Sat.	180	82	1055	2040
Barium Sulfate	5 Sat.	125 175	52 80	1099 1055	2042 2040
Barium Sulfide	5 Sat.	125 175	52 80	1099 1055	2042 2040
Battery Acid (H_2SO_4)	50	150	65	1055	2040
Beer	100	125	52	1054	1058
Beet Sugar Liquid	Any	160	71	1055	2040
Beryllium Sulfate	Sat.	125 175	52 80	1000 1008	1001 1001
Bleach Liquor (NaOCl)	15	140	60	1051 1024	- -
Boric Acid	10 Sat.	125 175	52 80	1099 1008 1055	2042 1001 2040

Section 4: Chemical Resistance Table

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Brine (Calcium or Sodium Chloride)	Sat.	160 180	71 82	1000 1008 1055 2010	1001 1001 2040 2013
Butyl Alcohol	-	Amb.		1006 2010 1055	1038 2013 2040
Cadmium Chloride	Sat.	170	77	1008 1035	1001 1038
Calcium Chloride	Sat.	140 170 180	60 77 82	1000 1055 2010	1001 2040 2013
Calcium Hydroxide	Sat.	140 170	60 77	2020 1000 1055	2019 1001 2040
Calcium Hypochlorite	10	125	52	1006 1035 1055	1038 1038 2040
Cane Sugar Liquor	-	150	65	1006 1035	1038 1038
Carbonic Acid	Sat.	125 170	52 77	2020 1008 1055	2019 1001 2040
Caustic Soda	50	140 175	60 80	1020 1055	2019 2040
Caustic Potash	Sat.	140 180	60 82	1020 1055	2019 2040
Chlorinated Salt Brine	Sat.	140	60	1006 1035 1048	1038 1038 1038
Chlorine	-	175	80	1053	-
Chlorine Water	-	175	80	1053	-

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Chrome Alum	Sat.	140 160	60 71	1006 1035 1055	1038 1038 2040
Chrome Plating Solution				Rubber Lining Not Recommended	
Chrome Salts	Sat.	125	52	1000 1006 1035	1001 1038 1038
Chromic Acid				Rubber Lining Not Recommended	
Citric Acid	Sat.	140	60	1006 1035 1055	1038 1038 2040
Copper Chloride	Sat.	160 180	71 82	1006 1035 1055	1038 1038 2040
Copper Cyanide (in solution with alkali cyanides)	Sat.	140 160	60 71	1000 1099 1055	1001 2041 2040
Copper Plating (Acid)	-	150	65	1000	1001
Copper Plating (Bright-Wes-X)	-	150	65	1008	1001
Copper Electroplating	-	150	65	1008	1001
Copper Sulfate	Sat.	160 180	71 82	1000 1006 1035 1055	1001 1038 1038 2040
Cupric Chloride	Sat.	140 160 180	60 71 82	1008 1006 1035 1055	1001 1038 1038 2040

Section 4: Chemical Resistance Table

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Deionized Water	-	175	80	1006 1035 1048 1042	1038 1038 1038 -
Denatured Alcohol	100	125	52	1006 1035	1038 1038
Dextrose	Sat.	140	60	1006 1035	1038 1038
Diammonium Phosphate	Sat.	Amb. 150	Amb. 65	1000 1006 1035	1001 1038 1038
Distilled Water	-	175	80	1035 1048 1055	1038 1038 2040
Epsom Salts	Any	175	80	1055	2040
Ethanol	100	125	52	1035 1055	1038 2040
Ethyl Alcohol	100	125	52	1035 1055	1038 2040
Ethylene Glycol	50	150 175	65 80	1006 1035 1055	1038 1038 2040
Fatty Acid				Testing Recommended	
Ferric Chloride	Sat.	175	80	1055	2040
Ferric Sulfate	Sat.	175 180	80 82	1008 1035 1055	1001 1038 2040
Ferrous Chloride	Sat.	180	82	1055	2040
Ferrous Sulfate	Sat.	180	82	1055	2040
Fluoroboric Acid	40	150	65	1008 1055	1001 2040

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Fluorophosphoric Acid Mono	25	Amb.	Amb.	2010 1051	2013 -
Fluorosilicic Acid	20	160 180	71 82	1055 1051	2040 -
Fluorophosphoric Acid di	25	Amb.	Amb.	1051	-
Fluorophosphoric Acid Hexa	25	Amb.	Amb.	1051	-
Formaldehyde	40	100	38	1051	-
Formic Acid	Sat.	125	52	1051	-
Fumaric Acid	Any	Amb.	Amb.	1035	1038
Furfural (Furfuraldehyde)	100	70	21	1051	-
Gelatin	Sat.	140	60	1055	2040
Glauber's Salt	5 Sat.	150 125	65 52	1035 1006 2010	1038 1038 2013
Glycerine	100	125	52	1035	1038
Glycerol	100	125	52	1035 1055	1038 2040
Gold Chloride	Sat.	180	82	1055	2040
Grain Alcohol	100	125	52	1035 1055	1038 2040
Gypsum	Any	180	82	1055	2040
Hexahydrobenzene				Rubber Lining Not Recommended	
Hexyl Alcohol				Testing Suggested	
Hydrated Lime & H_2O	Sat.	175	80	1055	2040
Hydrobromic Acid	-	140	60	1055	2040

Section 4: Chemical Resistance Table

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Hydrochloric Acid	3-4	160	71	1060 1035 1048	2019 1038 1038
	10-15	175	80	1008	1001
	Sat.	140	60	1099 2000	2042 2042
		160	71	1000	1001
Hydrocyanic Acid	25	150	65	1051	-
Hydrofluoric Acid	<50%	90	32	2000 1055	2042 2040
	70	90	32	1051 6511	- -
Hydrofluorosilic Acid	50	180	82	1055 1051	2040 -
Hydrogen Sulfate (Sulfuric Acid)	30	140	60	1000 1055	1001 2040
	50	100	52	1051	-
Hydrogen Sulfide (wet)	1	Amb.	Amb.	1051	-
Hydrosilicofluoric Acid	50	180	82	1055	2040
Hypochlorous Acid	10	150	65	1035	1038
Iron Chloride	Sat.	180	82	1055	2040
Iron Sulfate	Sat.	180	82	1008 1055	1001 2040
Isobutanol	100	125	52	1035 1051	1038 -
Isobutyl Alcohol	100	Amb.	Amb.	1006 1035	1038 1038
		125	52	1051	-
Isopropanol	100	Amb.	Amb.	1006 1035 1051	1038 1038 -

Section 4: Chemical Resistance Table

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Isopropyl Alcohol	100	Amb.	Amb.	1006 1035 1051	1038 1038 -
Lead Acetate	Sat.	120	49	1000 1035	1001 1038
Lead Nitrate	Sat.	Amb. 150	Amb. 65	1000 1035	1001 1038
Lead Sulfate	Any	Amb. 175	Amb. 80	1099 1000 1055	2042 1001 2040
Lime Bleach	10	125	52	1035 1051	1038 -
Lime Hydrated	Sat.	140 180	60 82	2020 1055 1051	2019 2040 -
Lye Solution	Sat. 35 Sat.	Amb. 150 180	Amb. 65 82	1099 1000 1055	2042 1001 2040
Magnesium Chloride	Sat.	140 180	60 82	2020 1055	2019 2040
Magnesium Hydroxide	Sat.	140 180	60 82	2020 1055 1051	2019 2040 -
Magnesium Nitrate	Sat.	125 175	52 80	1099 2020 1055	2042 2019 2040
Magnesium Sulfate	Sat.	140 180	60 82	2020 1055	2019 2040
Maleic Acid	25	Amb.	Amb.	1000 1035	1001 1038
Malic Acid	Sat.	125	52	1000 1008	1001 1001
Manganese Chloride	Sat.	180	82	1055	2040

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Manganese Sulfate	Sat.	180	82	1055	2040
Mercuric Chloride	Sat	140 185	60 85	1000 1055	1001 2040
Mercuric Cyanide	Sat.	140 160	60 71	1000 1055	1001 2040
Methanal (also formaldehyde)	40	100 125	38 52	1000 1055	1001 2040
Methanol	100	Amb. 125	Amb. 52	1035 1055	1038 2040
Methane Carboxylic Acid (also acetic acid)	10	140	60	1055	2040
Methyl Alcohol	100	Amb. 125	Amb. 52	1035 1055	1038 2040
Methyl Benzene				Rubber Lining Not Recommended	
Methyl Chloride				Rubber Lining Not Recommended	
Monochlorobenzene				Rubber Lining Not Recommended	
Monochloromethane				Rubber Lining Not Recommended	
Muriatic Acid (also hydrochloric acid)	3-4 10-15 Sat. 	160 175 140 160	71 80 60 71	1060 1048 1008 1099 2000 1000	2019 1038 1001 2042 2042 1001
Naptha				Rubber Lining Not Recommended	

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Natural Gas				Rubber Lining Not Recommended	
Nickel Acetate	Sat.	180	82	1055	2040
Nickel Chloride	Sat.	180	82	1055	2040
Nickel Nitrate	Sat.	140 180	60 82	1099 1055	2042 2040
Nickel Sulfate	Sat.	140 180	60 82	1099 1055	2042 2040
Niter	Sat.	140 180	60 82	2020 1055	2019 2040
Niter Cake	Sat.	125 180	52 82	1099 1055	2042 2040
Nitric Acid				Rubber Lining Not Recommended	
Nitrogen	100	150	65	1055	2040
Oil of Vitriol (see Sulfuric Acid)					
Oleum				Rubber Lining Not Recommended	
Orthoboric Acid	10 Sat.	125 175	52 80	1099 1008 1055 1051	2042 1001 2040 -
Oxalic Acid	10	Amb.	Amb.	1055	2040
Phosphoric Acid	85	185	85	1054 1055 1051 1020	1058 2040 - -
Phospholeum	105	120	49	1055	2040
Pickling Acid (H_2SO_4)	25-30	180	82	1008	1001

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Plating Solutions:					
Brass	-	150	65	1008 1035 1051	1001 1038 -
Cadmium	-			Rubber Lining Not Recommended	
Chrome	-			Rubber Lining Not Recommended	
Copper Cyanide	-	150	65	1000 1006 1035 1055	1001 1038 1038 2040
Copper Acid	-	150	65	1000	1001
Copper Bright	-	150	65	1008	1001
Copper Electroplating	-	150	65	1053	-
Gold	-	150	65	1053	-
Indium	-	150	65	1053	-
Iron	-	150	65	1053	-
Lead	-	150	65	1053 1051	- -
Nickel, Gray	-	150	65	1035	1038
Nickel Bright	-	150	65	1035	1038
Tin	-	150	65	1000 1035 1051	1001 1038 -
Zinc	-	150	65	1000 1035 1051	1001 1038 -

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Potable Water	-	140	60	1048	1038
Potash	Sat.	125 175 180	52 80 82	1099 1035 1055	2042 1038 2040
Potassium Acid Sulfate	Sat.	125 150	52 65	1099 1000 1035	2042 1001 1038
Potassium Alum	Sat.	140 175 180	60 80 82	1000 1008 1055	1001 1001 2040
Potassium Carbonate	Sat.	125 140 180	52 60 82	1099 2020 1055	2042 2019 2040
Potassium Bicarbonate	Sat.	125 140 180	52 60 82	1099 2020 1055	2042 2019 2040
Potassium Carbonate	Sat.	125 140 180	52 60 82	1099 2020 1055	2042 2019 2040
Potassium Chloride	Sat.	125 140 180	52 60 82	1099 1035 1055	2042 1038 2040
Potassium Cuprocyanide	Any	125 150	52 65	1099 1000 1055	2042 2041 2040
Potassium Cyanide	Sat.	125 140 180	52 60 82	1099 1035 1055	2042 1038 2040
Potassium Hydroxide	Sat.	180	82	1055	2040
Potassium Hypochlorite	13	140	60	1051	-
Potassium Nitrate	Sat.	125 140 180	52 60 82	1099 1035 1055	2042 1038 2040

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Potassium Sulfate	Sat.	175 180	80 82	1035 1055	1038 2040
Potassium Sulfite	Sat.	125 170	52 77	1099 1035	2042 1038
Propanol	100	120	49	1055	2040
Propyl Alcohol	100	125	52	1055	2040
Saline Water	2-3 5-10	160 175	71 80	1035 1008 1055 2010	1038 1001 2040 2013
Salt Brine	Sat.	160 180	71 82	1000 1035 1008 1055	1001 1038 1001 2040
Salt Peter (potassium chloride)	Sat.	125 140 180	52 60 82	1099 1035 1055	2042 1038 2040
Salt Water	-	125 160 175	52 71 80	2020 1035 1008 1055 2010	2019 1038 1001 2040 2013
Silver Nitrate	Sat.	125 175	52 80	1099 1055	2042 2040
Slaked Lime	Any	170 180	77 82	1008 1055	1001 2040
Soda Alum	5 Sat.	125 150 180	52 66 82	1099 1008 1055	2042 1001 2040
Soda Ash	Any	140 175	60 80	1000 1035 1008 1055	1001 1038 1001 2040

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Sodium Acid Carbonate	Any	140 175	60 80	1000 1035 1008 1055	1001 1038 1001 2040
Sodium Acid Sulfite	Sat.	150	66	1035	1038
Sodium Aluminate	Sat.	140 170 185	60 77 85	2020 1008 1035 1055	2019 1001 1038 2040
Sodium Aluminum Sulfate	Sat.	125 150	52 66	1099 1000 1055	2042 1001 2040
Sodium Antimonate	Any	150	66	1000 1055	1001 2040
Sodium Bicarbonate	Sat.	125 140 175 200	52 60 80 93	1099 1008 1055 1051	2042 1001 2040 -
Sodium Bifluoride	Sat.	140	60	1008	1001
Sodium Bisulfite	Sat.	150	66	1035	1038
Sodium Borate	10 Sat.	125 180	52 82	1099 1008 1055	2042 1001 2040
Sodium Carbonate	Sat.	125 140 175	52 60 80	1099 1000 1035 1055	2042 1001 1038 2040
Sodium Chloride	Sat	125 140 175 200	52 60 80 93	1099 1008 1035 1055 1051	2042 1001 1038 2040 -

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Sodium Chlorite	Sat.	125 175 180	52 80 82	1099 1035 1055	2042 1038 2040
Sodium Fluoride	Sat.	125	52	1000	1001
Sodium Flurosilicate	10 20 50	Amb. 160 180	Amb. 71 82	1099 1055 1051	2042 2040 -
Sodium Glycolate	Any	150	66	1000 1035	1001 1038
Sodium Hexaflurosilicate	10 20 50	Amb. 160 180	Amb. 71 82	1099 1055 1051	2042 2040 -
Sodium Hydroxide	50	140 180	60 82	2020 1055	2019 2040
Sodium Hypochlorite	15	140	60	1051 1024	- -
Sodium Hypophosphite	Any	Amb. 150	Amb. 66	1099 1000	2042 1001
Sodium Perborate	Sat.	125 150 180	52 66 82	1099 1000 1008 1055	2042 1001 1001 2040
Sodium Phosphate	Sat.	125 175 180	52 80 82	1099 1048 1008 1055	2042 1038 1001 2040
Sodium Pryoborate	10 Sat.	125 175 180	52 80 82	1099 2020 1008 1055	2042 2019 1001 2040
Sodium Sulfate	Sat.	140 175 180	60 80 82	2020 1048 1008 1055	2019 1038 1001 2040

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Sodium Sulfite	Sat.	125 140	52 60	1099 2020 1000 1055	2042 2019 1001 2040
Sodium Thiosulfate	Sat.	150 180	66 82	1000 1048 1055	1001 1038 2040
Stannic Chloride	Sat.	150 180	66 82	1008 1048 1055	1001 1038 2040
Stannous Chloride		150 180	66 82	1008 1048 1055	1001 1038 2040
Sucrose Solution	Any	120	49	1055	2040
Sugar Solution	Any	120	49	1055	2040
Sulfur Dioxide	Any	150 185	66 85	1053 1051	- -
Sulfonic Acid	50 20	140 160	60 71	1048 1008	1038 1001
Sulfuric Acid	30 25 50	150 160 150	66 71 66	1008 1048 1055 1051	1001 1038 2040 -
Sulfurous Acid	10 75	150 100	66 38	1035 1051	1038 -
Tannic Acid	Sat.	13 150	54 66	1055 1051	2040 -
Tartaric Acid	Sat.	140	60	1035	1038
Thallium Hydroxide	Sat.	150	66	1000	1001
Tin Perchloride	Sat.	125 150 180	52 66 82	1099 1000 1035 1055	2042 1001 1038 2040

Chemical	Concentration (%)	Temperature		Recommended Rubber Lining	Chemical Cure Repair Stock
		°F	°C		
Tin Salt	Sat.	125 150 180	52 66 82	1099 1000 1035 1055	2042 1001 1038 2040
Toluene				Rubber Lining Not Recommended	
Trichloroethylene				Rubber Lining Not Recommended	
Trisodium Phosphate	Sat.	125 140 175	52 60 80	1099 2020 1000 1055 1035	2042 2019 1001 2040 1038
Vinegar	-	100	38	1055 1035	2040 1038
Water	-	175	80	1048 1035	1038 1038
Water Demineralized	-	175	80	1048 1035	1038 1038
Xylene				Rubber Lining Not Recommended	
Zinc Acetate	Sat.	Amb. 125	Amb. 52	1099 1008 1055	2042 1001 2040
Zinc Chloride	Sat.	150 180	66 82	1008 1035 1055	1001 1038 2040
Zinc Cyanide	Sat.	150 180	66 82	1008 1035 1055	1001 1038 2040
Zinc Sulfate	Sat.	150 180	66 82	1008 1035 1055	1001 1038 2040

Section 5: Polycorp Product Guide

The product lines for Polycorp Protective Linings are comprised of two distinct groups:

- The **Polycorp T-series** linings are a value based range of products designed as a cost effective alternative for applications where cosmetic requirements are less stringent.
- The **Polycorp Polymeric** Linings are designed to meet the most exacting standards for quality and consistency. These are the material choices for demanding applications like rail, truck and tank linings.

The following tables are meant as a general guide only. Please contact your Polycorp representative for specific recommendations.

Cure Methods: ***A - Autoclave I - Internal Steam E - Exhaust (Atmospheric) Steam***
CC - Chemical Cure (Ambient or Exhaust steam assist)

***** FDA Compliant:*** ***All ingredients formulated the rubber lining conform to the requirements of FDA Title 21, CFR 177.2600 for food contact***

****** Chemical cure:*** ***Use C-600 activator for FDA compliant rubber lining***

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
1000	Tan/ yellow/ tan	40 - 60 A	**Triflex™** Natural rubber	A - I - E	Yes	Combined chemical and abrasion resistance
1001	Black	45 - 65 A	**Triflex™** Natural rubber	CC - E	Yes***	Combined chemical and abrasion resistance
1003	Black	80 - 100 A (35 - 55 D)	Semi-hard natural rubber with natural tie gum or sticky back	A - I - E	Yes	Excellent chemical and temperature resistance. Superior in water treatment equipment.
1004	Black	50 - 70 D	**Superflexite A** Semi-hard natural rubber with natural tie gum	A - I - E		Excellent chemical resistance at elevated temperatures
1006	Black	60 - 80 D	**Acidseal E** Semi-hard natural rubber with natural tie gum	A - I - E	Yes	General purpose lining for severe corrosion service at elevated temperature
1008	Black	55 - 65 A	**Triflex™** Soft -hard- soft	A - I - E	Yes	Excellent abrasion and chemical resistance with low water absorption. Excellent for FGD scrubber applications

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
1015	Tan/ grey/ black	40 - 60 A	**Triflex™** Semi-hard - hard - soft	A - I - E		Excellent chemical and permeation resistance
1017	Black	80 - 100 A (35 - 55 D)	Semi-hard natural rubber without tie gum	A - I - E		General purpose lining Excellent chemical and temperature resistance. Superior for water treatment
1019HT	Tan/ black/ tan	40 - 60 A	**Triflex™** Soft -hard- soft High temperature	A - I - E		Excellent chemical resistance at high temperature service (up to 220°F/104°C). Developed for phosphoric acid service
1020HT	Tan/ yellow/ tan	40 - 60 A	**Triflex™** Soft -hard- soft High temperature	A - I - E		Excellent chemical resistance at high temperature service (up to 220°F/104°C). Developed for phosphoric acid service
1024	Black	45 - 55 A	Pure chlorobutyl rubber with natural tie gum	A		Excellent chemical resistance at elevated temperature. Superior lining to handle strong oxidizing solution
1032	Black/ tan	45 - 55 A	Soft natural rubber with natural tie gum	A - I -E	Yes	Excellent chemical, abrasion and tear resistance
1035	Black/ tan	45 - 65 D	**Superflexite B** Field curing Semi-hard natural rubber with soft natural tie gum	A - I - E		Excellent chemical resistance at elevated temperatures
1036	Black	75 - 95 A (25 - 45 D)	Semi-hard Ebonite with soft natural rubber tie gum	A - I - E	Yes	Excellent chemical resistance at elevated temperatures
1038	Black/ white	75 - 95 A (25 - 45 D)	Semi-hard chemical cure natural rubber with natural rubber tie gum	CC - E	Yes***	Repair stock for black semi-hard lining. Good chemical resistance at elevated temperatures
1040	White/ tan	75 -95 A (25 - 45 D)	Semi-hard natural rubber with natural rubber tie gum	A - I - E	Yes	Excellent chemical and temperature resistance. Superior performance in water treatment equipment
1042	White	75 - 95 A (25 - 45 D)	Semi-hard Ebonite with natural tie gum	A - I - E	Yes	Excellent chemical Resistance at elevated temperatures

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
1048	Black/ tan	75 - 95 A (25 - 45 D)	Semi-hard natural rubber with or without tie gum	A - I - E	Yes	Excellent chemical resistance and temperature resistance. Superior performance in water treatment equipment
1051	Black/ tan	50 - 60 A	Chlorobutyl with natural rubber tie gum	A - I -E		Excellent chemical resistance at elevated temperatures. For handling strong sodium hypochlorite solutions up to 15% chlorine. Also suitable for 70% hydrofluoric acid service up to 125°F (52°C).
1053	Black/ tan	90 - 100 A (45 - 65 D)	Graphitic semi-hard natural rubber with soft natural tie gum	A - I - E		Outstanding resistance to wet chlorine, chlorinated brine and chlorine water solutions.
1054	White/ tan	35 - 45 A	Blended chlorobutyl and natural rubber with natural tie gum or sticky back	A - I - E	Yes	General chemical resistance at temperatures up to 200°F (93°C).
1055	Black/ tan	50 - 60 A	Blended chlorobutyl and natural rubber with natural tie gum	A - I - E	Yes	General chemical resistance at elevated temperatures. Excellent in super phosphoric acid.
1056HT	Black/ tan	55 - 65 A	chlorobutyl rubber with tan natural rubber tie gum	A - I - E	Yes	General chemical resistance in temperatures up to 220°F (104°C)
1058	White/ tan	30 - 50 A	Chemical cure chlorobutyl rubber	CC - E	Yes***	General purpose repair stock for chlorobutyl linings. Good chemical and heat resistance
1060	Black/ tan	55 - 65 A	**Armorite** Soft natural rubber with or without soft natural tie gum	A - I - E	Yes	Extremely high abrasion and tear resistance
1061	Black	50 - 60 A	Soft natural rubber without tie gum	A - I - E	Yes	Reinforced to provide excellent chemical, abrasion and tear resistance
1064	White	55 - 65 A	Soft natural rubber	A - I - E	Yes	Used in food services where a non-staining lining is required

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
1066	White	55 - 65 A	**Triflex™**	A - I - E	Yes	Excellent abrasion and chemical resistance with low water absorption
1069	Black	55 - 65 A	Soft natural rubber	A - I - E	Yes	Excellent chemical, abrasion and tear resistance. Excellent machining and grinding properties
1077HT	Black/ tan/ black	55 - 75 A	**Triflex™** Chlorobutyl faced Soft -hard- soft	A - I - E		Excellent chemical and abrasion with low water absorption. Excellent for FGD Scrubber module applications, phosphoric acid and deformer industry
1097	Tan	55 - 65 A	Natural rubber	A - I - E	Yes	Excellent chemical, abrasion and tear resistance. Excellent machining and grinding characteristics.
1099	Tan	30 - 40 A	Soft natural rubber (pure gum rubber)	A - I - E	Yes	Stained compound to eliminate impurities. Excellent chemical, abrasion and tear resistance
2000	Tan	30 - 40 A	**Acidseal MA** Soft Natural rubber (pure gum rubber)	A - I - E	Yes	Strained compound to eliminate impurities. Excellent chemical, abrasion and tear resistance
2001	Black	35 - 45 A	**Acidseal MA** Soft natural rubber (pure gum rubber)	A - I - E	Yes	Strained compound to eliminate impurities. Excellent chemical, abrasion and tear resistance
2002	Black	38 - 48 A	Soft natural rubber	A - I - E		Excellent chemical, abrasion and tear resistance
2004	White	30 - 40 A	Soft natural rubber (pure gum rubber)	A - I - E	Yes	Food grade service where a non-staining lining is required
2006	Black	45 - 55 A	Pure chlorobutyl rubber	A - I - E		Excellent chemical resistance at elevated temperatures. Superior lining to handle strong sodium hypochlorite solutions (up to 15% chlorine. Also suitable for 70% hydrofluoric acid.

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
2007	Black	45 - 55 A	Pure chlorobutyl rubber	A - I - E		Used for stripping butt joints on chlorobutyl linings 1051 and 2006
2010	Black	55 - 65 A	Neoprene rubber	A - I - E		General purpose with good abrasion, weathering, flame retarder and corrosion resistance. Good machining properties
2011	Black	55 - 65 A	Neoprene rubber	A - I - E		General purpose with good abrasion, weathering, flame retarder and corrosion resistance. Good machining properties
2012	Black	55 - 65 A	Neoprene rubber	A - I - E		General purpose with good abrasion, weathering, flame retarder and corrosion resistance. Good machining properties
2013	Black	55 - 65 A	Chemical cure Neoprene rubber	CC - E		Chemical cure repair stock for Neoprene lining
2017	Black	45 - 65 D	**Superflexite B** Semi-hard natural rubber	A - I - E		General purpose field curing lining with excellent chemical resistance at elevated temperatures
2019	Black	40 - 60 A	Chemical cure soft natural rubber	CC - E	Yes***	General purpose chemical cure repair stock. Excellent corrosion and abrasion resistance
2020	Black	42 - 52 A	Soft natural rubber	A - I - E		Excellent corrosion resistance with good physical properties and abrasion resistance
2027	Red	30 - 40 A	Soft natural rubber	A - I - E		Superior abrasion resistance for mining and pipe applications.
2033	Black	45 - 55 A	Soft natural rubber	A - I - E		Ozone, oxygen and weather with excellent abrasion resistance
2033P	Black	55 - 65 A	Soft natural rubber	A - I - E		Ozone, oxygen and weather with excellent abrasion resistance
2034	White	45 - 55 A	Neoprene rubber	A - I - E	Yes	General purpose with excellent abrasion, oil and corrosion resistance

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
2040	Black	50 - 70 A	Chemical cure chlorobutyl with natural rubber tie gum	CC - E	Yes***	General purpose chemical cure repair stock for chlorobutyl linings.
2041	White	30 - 50 A	Chemical cure soft natural rubber	CC - E	Yes***	Chemical cure repair stock for white natural rubber lining. Excellent non-staining combined with abrasion and corrosion resistance.
2042	Tan	35 - 55 A	Chemical cure soft natural rubber	CC - E	Yes***	Chemical cure repair stock for white natural rubber linings. Good abrasion and corrosion resistance.
2048	Black	55 - 65 A	Nitrile rubber	A - I - E		General purpose where petroleum aliphatic solvents and some oils are present.
2055	Black	50 - 60 A	Soft blended chlorobutyl rubber	A - I - E		General purpose chemical resistance at elevated temperature.
2056	Black	50 - 60 A	High temperature chlorobutyl rubber	A - I - E		General purpose chemical resistance at temperature up to 220°F (104°C).
2098	Tan	40 - 60 A	Chemical cure natural rubber	CC - E	Yes***	General purpose repair stock for tan natural rubber linings.
3014	Black	75 - 95 A (25 - 45 D)	Chemical cure semi-hard natural rubber	CC - E	Yes***	Chemical cure repair stock for semi-hard natural rubber linings. Good chemical resistance at elevated temperature.
3015	White/ black/ tan	55 - 65 A	**Triflex™**	A - I - E	Yes	General purpose with excellent chemical and temperature resistance. Superior performance in water treatment equipment
3016	White/ black/ tan	75 - 95 A (25 - 45 D)	**Triflex™** Semi-hard natural rubber face and natural tie gum	A - I - E	Yes	General purpose with excellent chemical and temperature resistance. Superior performance in water treatment equipment
3049	Black	50 - 60 A	**MOR** Natural rubber blend	A - I - E		Moderate oil resistance (MOR) for general abrasion application

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
4631	Black	50 - 60 A	Natural rubber and chlorobutyl blend	A - I	Yes	For vapor pad in ceiling of HCl tank cars. Reduces “chunking” tendency
5621	Black	50 - 60 A	Lead cure Neoprene rubber	A - I - E		Good abrasion, weathering, flame and corrosion resistance as well as machining properties.
5821	Black	50 - 60 A	Lead cure Neoprene rubber	A - I		Superior abrasion, weathering, flame and corrosion resistance properties as well as machining properties.
6511	Black	45 - 55 A	Bromobutyl rubber	A - I		Superior temperature resistance in phosphoric acids and caustic solutions up to 260°F (127°C)
6512	Black	45 - 55 A	Bromobutyl with natural rubber tie gum	A - I - E		Superior temperature resistance in phosphoric acids and caustic solutions up to 260°F (127°C)
9159	Black	50 - 60 A	SBR rubber	A - I - E		Good physical properties for sliding abrasion application
9160	Black	55 - 65 A	SBR rubber	A - I - E		Good physical properties for sliding abrasion application
9169	Black	55 - 65 A	SBR rubber	A - I - E		Good physical properties for sliding abrasion application
17001	Black	50 - 60 A	Blended chlorobutyl with or without natural tie gum	A - I - E		General purpose chemical resistance at elevated temperatures
55159	Black	50 - 60 A	SBR rubber	A - I - E		Good physical properties for sliding abrasion application
55160	Black	55 - 65	SBR rubber	A - I - E		Good physical properties for sliding abrasion application
55160	Black	55 - 65 A	SBR rubber	A - I - E		Good physical properties for sliding abrasion application
60714	Black	60 - 70 A	Natural rubber	A		Excellent abrasion resistance along with ozone and weather resistance

Product	Color	Hardness	Material	Cure*	FDA** Compliant	Application
64025	Tan	35 - 45 A	Natural rubber	A - I - E		Excellent chemical, abrasion and wear resistance.
T1000	Tan	35 - 45 A	**Epseal** Soft natural rubber	A - I - E		Excellent chemical, abrasion and wear resistance. Operating temperature -40°F to 150°F (-40°C to 66°C)
T1001	Black	35 - 45 A	**Epseal** Soft natural rubber	A - I - E		Excellent chemical and abrasion resistance. Specially formulated for steel mill pickle lines application
T1003	Black	50 - 60 A	**Epseal** Soft natural rubber	A - I - E		Excellent abrasion resistance. Normally used for overlays
T1004S	Black	55 - 65 A	**Epseal** Soft natural rubber	A - I - E		Excellent abrasion resistance along with oxygen and weather resistance
T1200	Red	35 – 45 A	Soft natural rubber	A - I - E		Industry leading abrasion resistance – both impact and sliding
T1300	Red	35 – 45 A	Soft natural rubber	A - I - E		Excellent abrasion and tear resistance
T5009	Black	55 - 65 A	**Epseal** Soft Neoprene rubber	A - I - E		Excellent aging and weathering resistance.
T5109	Black	55 - 65 A	**Epseal** Soft Neoprene rubber with natural tie gum	A - I - E		Good abrasion, weathering, flame retarded and corrosion resistance.
T6005	Black	50 - 60 A	**Epseal** Blended chlorobutyl rubber	A - I - E		Excellent chemical resistance at elevated temperatures. Good resistance to some oxidizing chemicals
T6105	Black	50 - 60 A	**Epseal** Blended chlorobutyl with natural tie gum	A - I - E		Excellent chemical resistance at elevated temperatures. Good resistance to some oxidizing chemicals
T8000	Tan	35 - 45 A	Natural rubber blend	A - I - E		Abrasion resistance application

Non-Standard Products:

The following may be available on a non-standard basis. Please contact Polycorp representative for price, availability and technical Data.

Product	Color	Hardness	Material
1002	Black/grey/tan	45 - 65 D	**Triflex™ K** Hard-hard-soft combination
1005	Black/tan	50 -60 D	**"Saniprene"** Hard natural rubber
1010	Black/grey/tan	55 - 65 A	**Triflex™** Soft-hard-soft combination
1011	Brown/black	50 - 70 D	Semi-hard natural rubber
1012	Black/tan	45 - 65 D	Graphite loaded flexible Ebonite Lining
1012S	Black/black/tan	45 - 65 D	**Triflex™** Graphite loaded flexible Ebonite
1013	Tan/black/tan	45 - 65 A	**Triflex™** Soft-hard-soft combination, FDA compliant
1014	White/tan/black	45 -55 A	**Triflex™** White chlorobutyl faced
1015	Black/grey/tan	40 - 50 D	**Triflex™** Semi-hard-hard-soft combination
1021	Tan or black	30 - 40 A	Soft natural rubber
1037	Brown/white	75 - 95 A	Chemical cure semi-hard natural rubber
1039	Black/tan	55 - 65 A	**Acidseal EP** with natural rubber tie gum
1041	Grey/tan	60 -80 D	Graphite reinforced natural rubber
1045	Black/tan	45 - 65 D	Graphite loaded flexible Ebonite Lining
1049	Black	50 - 70 D	**"Saniprene"** Hard natural rubber without tie gum
1050	Black/tan	55 -65 A	Blended chlorobutyl with soft natural rubber tie gum
1057	Black	50 -60 A	Butyl rubber lining
1063	Black/tan	55 - 65 A	Soft natural rubber with natural tie gum
1068	White	55 - 75 A	Chemical cure
1069	Black/black	55 - 65 A	Soft natural rubber with sticky back tie gum
1070	Black	60 - 80 A	Butyl rubber lining
2003	Black	55 - 65 A	**"Armorite Plain"** Soft natural rubber
2012S	Black/black	55 - 65 A	Neoprene with soft natural tie gum
2013	Black	50 - 70 A	Chemical cure Neoprene rubber
2016	Grey	60 - 80 D	Graphite reinforced natural rubber
2022	Black	45 - 55 A	Soft natural rubber lining, high heat resistance.

Product	Color	Hardness	Material
2024	Black/tan	53 - 73 D	Hard natural rubber and chlorobutyl blend
2028	Black	49 - 59 A	Soft natural rubber, excellent abrasion and tear resistance
2033S	Black	50 - 60 A	Soft natural rubber, excellent ozone weathering and abrasion resistance
2034	White	45 - 55 A	Neoprene, FDA compliant
2040S	Black/white	55 -75 A	Chlorobutyl rubber with Neoprene tie gum
2040X	Black	50 -70 A	Chlorobutyl rubber with soft natural tie gum
2050	Black	55 - 65 A	Soft blended chlorobutyl rubber
2060	Black/tan	50 - 70 A	**Triflex™** Graphite center layer with soft natural rubber face and tie gum
3011	Black/grey/black	50 - 60 A	Chlorobutyl face stock with semi-hard graphite center layer. Designed for wet or dry chorine gas and chlorine brine service
3017	White/white	25 - 45 D	Semi-hard natural rubber face and soft natural tie gum. Chemical cure.
3025	White/tan	25 - 45 D	Semi-hard natural rubber face and soft natural tie gum. Chemical cure.

Section 6: General Application Instructions

GENERAL GUIDELINES

The following is only for general guidelines. Please contact your Polycorp representative for specific applications.

Rubber will not bond to galvanized metal.

1. Metal Fabrication

1.1 All welding (hot work) on the tank, pipe, or other equipment to be lined shall be complete before the application of adhesives or rubber lining materials.

1.2 Metal fabrication and welding shall be in accordance with specific codes. All welds must be smooth with no porosity, holes, high spots, lumps or pockets.

2. Surface Preparation

2.1 Remove all loose corrosion products, weld spatter, mill scale, burrs and sharp edges from the surface to be lined using the appropriate hand or power tools in accordance with SSPC-SP2 (Hand Tool Cleaning) and SSPC-SP3 (Power Tool Cleaning).

2.2 Surfaces shall be inspected prior to the start of surface preparation to assure that they are dry and that visible deposits of oil and grease have been removed in accordance with SSPC- SP1(Solvent Cleaning). In addition, the inspector shall identify surface imperfections (such as weld spatter, porosity, pits, laminations, slivers or crevices) for repair as appropriate.

2.3 Before and during operations (e.g. abrasive blasting, power tools) ambient conditions shall be checked to determine the air and surface temperatures, relative humidity and dew point, to which the bare steel will be exposed. These operations shall not be permitted when the surface temperature is less than 5°F (3°C) above the dew point and/or the relative humidity is over 80%. The temperature should be 50°F (10°C) to 90°F (32°C).

3. Abrasive Blast Cleaning

3.1 The compressed air supply for abrasive blasting shall be inspected before and during operations for the presence of oil and/or water by performing a white blotter test. The test shall be performed downstream of separators. The blotter shall be free of visible contaminants of oil or water after being held in the air stream at a distance of 18” (457 mm) to 24” (610 mm) from the source for at least two minutes in accordance with SSPC Painting Manual Vol.1 Good Painting Practice – “Air Compressor and Air Cleanness”.

3.2 A production blast will be performed on all metal surfaces to be lined to remove corrosion products and staining. All metal surfaces shall present an appearance in accordance to SSPC-SP5 /NACE No.1.

3.3 Strict adherence to air temperature, 50°F (10°C) to 90°F (32°C), relative humidity and shell temperature (5°F (3°C) above the dew point) will be required. At the beginning and middle of every shift, the inspector will record, in the area of the tank they will be working, the steel temperature and the air temperature and calculate the dew point and relative humidity.

Relative Humidity	Maximum Time Span Between Blasting and Primer Application
Over 80%	No Application
70-80%	1 hour
60-70%	4 hours
50-60%	8 hours
49% or Below	24 hours

3.4 The entire surface of the tank to be lined is to be blasted clean to a profile of 2.0 mils (0.051mm) minimum.

3.5 All sandblasted areas are to be cleaned to remove all contaminating materials prior to applying primers.

3.6 All areas blasted are to be primed with one coat of primer as soon as possible after blasting and before any visible rust appears. Allow to dry a minimum of one hour.

3.7 Upon commencement of sandblasting, and continuing for the remainder of the project, no gasoline, kerosene or diesel operated engines will be permitted in or near the tank without venting such equipment to the exterior atmosphere to avoid the contamination of work area.

4. Cementing Instruction

4.1 All primers and cements contain solvent fumes which may be explosive under certain conditions. Therefore, safety precautions shall be taken during application.

- **Always review Material Safety Data Sheets for specific hazards and PPE requirements**
- **Refer to product specific technical data sheets for adhesive recommendations**
- **All work practices should conform to local, state, provincial and federal law**

4.2 All primers and cements shall be thoroughly stirred and mixed sufficiently per manufacturer's recommendations before use so solids will stay in suspension. When brushing cements, they shall be of such consistency to give a smooth, uniform coverage. Use only brushes with nylon or animal bristle.

4.3 Any rust spots that appear during or after the cementing application shall be removed to clean metal by using a suitable method (grinding or blasting). These areas shall then be re-primed and/or re-cemented.

4.4 In the event the lining cannot be applied for an extended period of time and the cement loses its tack, the cemented surface shall be freshened by applying another coat of cement and/or cement-solvent mixture.

4.5 To prevent condensation the substrate temperature shall be a minimum of 5°F (3°C) above the dew point. If cemented surfaces are exposed to sunlight and/or weather, primer will be reapplied prior to lining.

4.6 Drying time for primers and cements should be long enough for the solvent to evaporate. The rate of evaporation is influenced by temperature, humidity, thickness of wet film, etc., but normally 60 minutes is sufficient. Cemented parts should be kept free from all contamination during the drying and lay over period.

4.7 Cements should be stored in a clean, cool and well-ventilated area. Storage at high temperatures may have a detrimental effect on the adhesion properties. If the temperature is too high for too long the cement can gel (set up). To avoid solvent loss and consequent thickening of the cement, containers should be tightly sealed. When cements are transferred to smaller holding cans, the cans should be free from contamination and provisions should be made to seal containers when not in use.

5. Rubber Lining

Rubber linings shall be stored in areas where they are not exposed to direct sunlight (see Technical Data Sheet for shelf life of individual product under different storage conditions). There are four types of seam methods for rubber lining application (See Fig. 6-1 to Fig. 6-4):

- Closed skive (Down skive)
- Open skive
- Butt joint with cap strip
- Skive butt joint

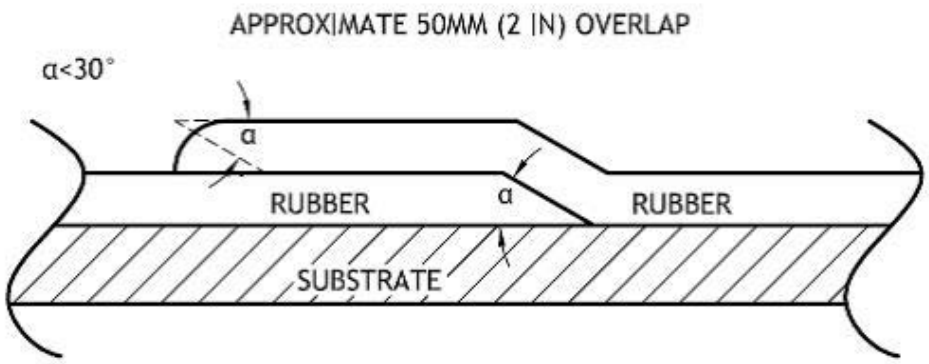


Fig. 6-1 Closed Skive

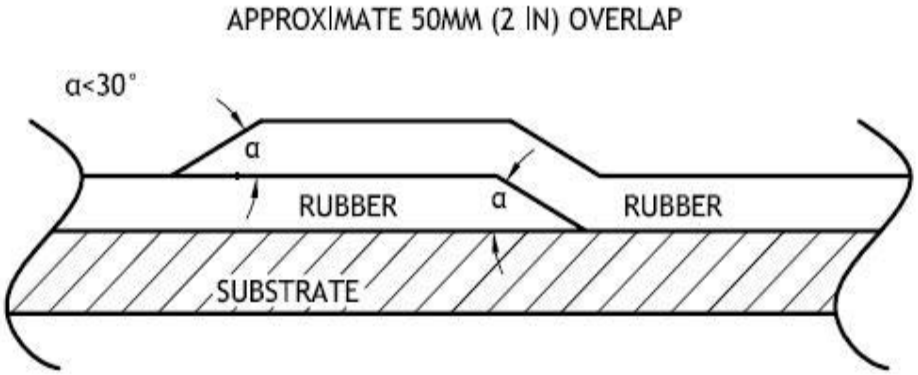


Fig. 6-2 Open Skive

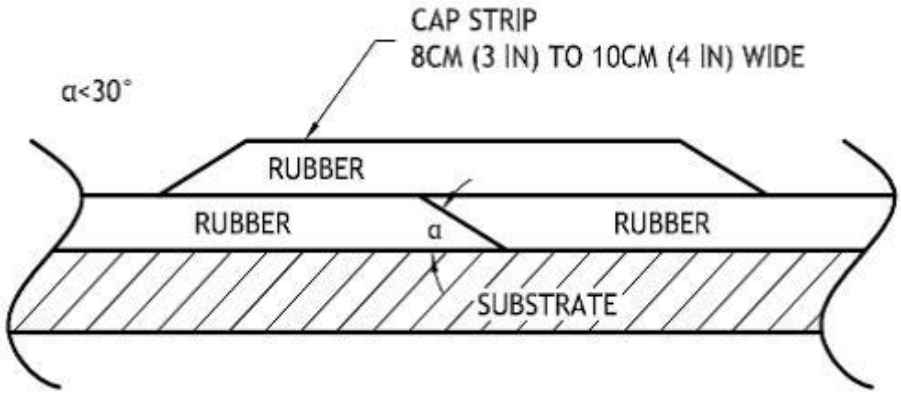


Fig. 6-3 Butt seam with strip

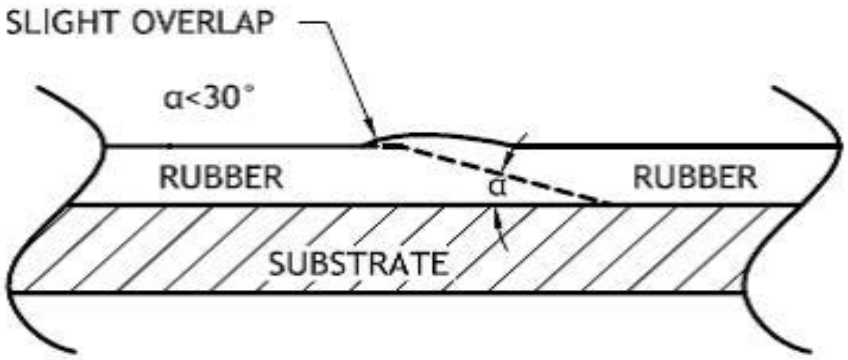


Fig. 6-4 Skive butt joint

5.1 Cutting the rubber

- Unroll the rubber sheet on a clean table. A heating table may be used for some rubber stocks.
- If preshrinking of the rubber is required, follow the instructions from the Product Technical Data Sheet
- Cut with plastic film still on rubber

5.2 Cementing the rubber

- Remove the plastic backing
- The plastic side goes to the steel
- Tie gum side of rubber should be cemented with appropriate cement
- For sticky back linings, the cement is only required on the cut skives
- Allow the cement to dry so no solvent is left

5.3 Liner Cloth

Place a lint-free liner cloth over the cemented side of the rubber to allow proper placement of the sheet

Using the liner cloth is to prevent premature sticking of the cemented rubber sheet

5.4 Sheet Application

- Position the lining on the cemented metal and, at the same time, gradually remove the liner cloth.
- After the sheet is partially tacked in place, it should be rolled with a steady, firm and overlapping stroke. The rolling should be started in the center of the panel and worked toward the edges. It is essential that the rubber lining be rolled tightly against the metal to remove any trapped air and assure complete contact between rubber and metal.

5.5 Joints in Rubber Lining

- Lining panels should be joined together by appropriate seam methods (See Technical Data Sheet for details).
- Special care must be taken to minimize stretching of the rubber linings.

5.6 Seam Placement

- The panels can be laid vertically or horizontally. Normally, the orientation is dictated by the geometry of the vessel.
- Avoid four layers of rubber when it is possible.
- Three layers of rubber are acceptable when the seams are staggered.
- Neatness and uniformity are best practice for rubber lining

5.7 Tanks should be protected from weather when located outside. In cold weather, heating facilities should be furnished to bring the temperature to 55°F (13°C) minimum inside the tank.

5.8 Manway flanges on autoclave and atmospheric cured tanks should be covered full face with lining stock and lapped 2” onto manway throat lining. On internal steam cured tanks, the manway and nipple outlet flanges can be covered as outlined in Fig.10-3, Fig.10-4 and Fig.10-5.

Note: visit www.poly-corp.com for Technical Data Sheet or contact your Polycorp representative for information on special cases

Section 7: Flange Lining Procedures

1. Flange Lining Method

There are many ways to line flanges. The following diagrams (Fig. 10-3, Fig. 10-4 and Fig. 10-5) provide possible options however end-user specifications, materials used and service conditions should all be considered to determine the appropriate method.

2. Curing the Flanges

2.1 For atmospheric cures, the flanges should be “bagged” by wrapping plastic sheeting around the nozzle to contain the steam.

- There must be a small hole in the plastic near the bottom to allow condensate to drain.
- There must be adequate steam to force steam out through the drain hole to assure proper cure of the flange rubber.

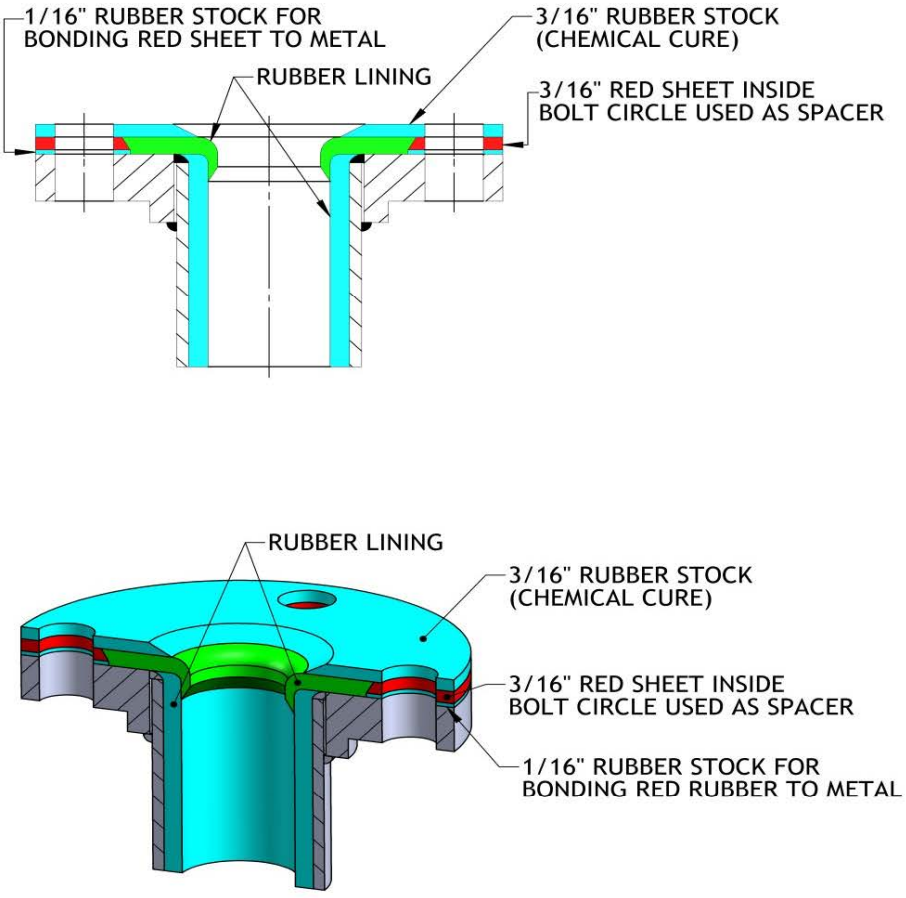


Fig. 10-3 Internal steam cure vessel - Flange detail for outlets
(This method is recommended on vacuum equipment)

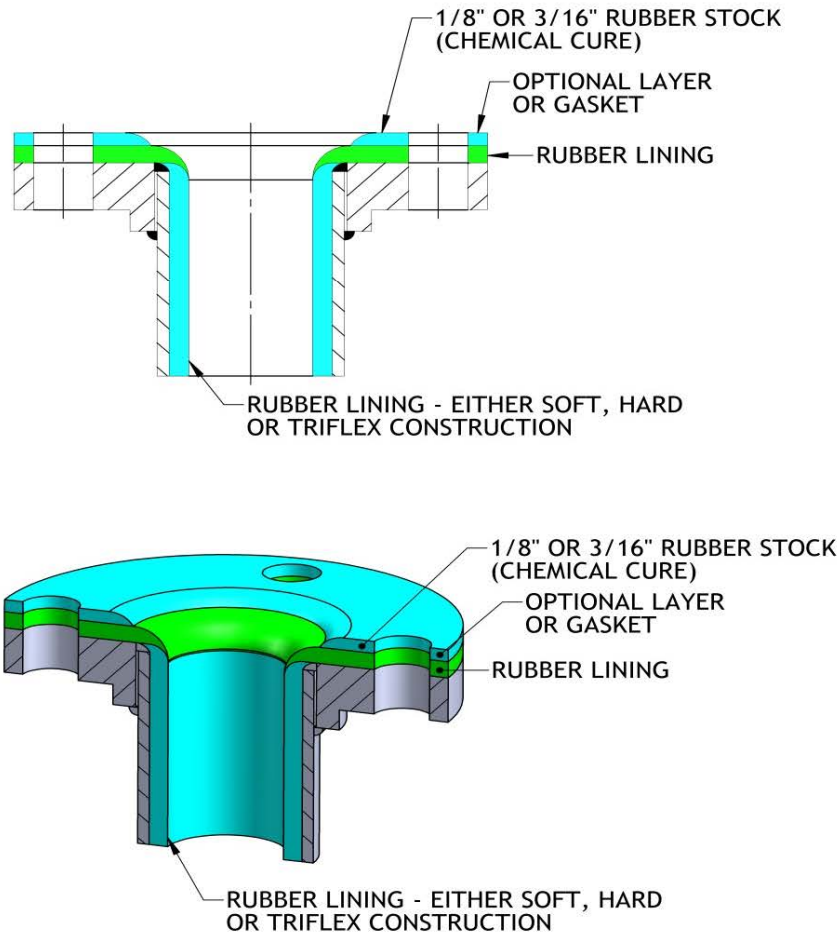


Fig. 10-4 Internal steam cure vessel - Flange detail for outlets

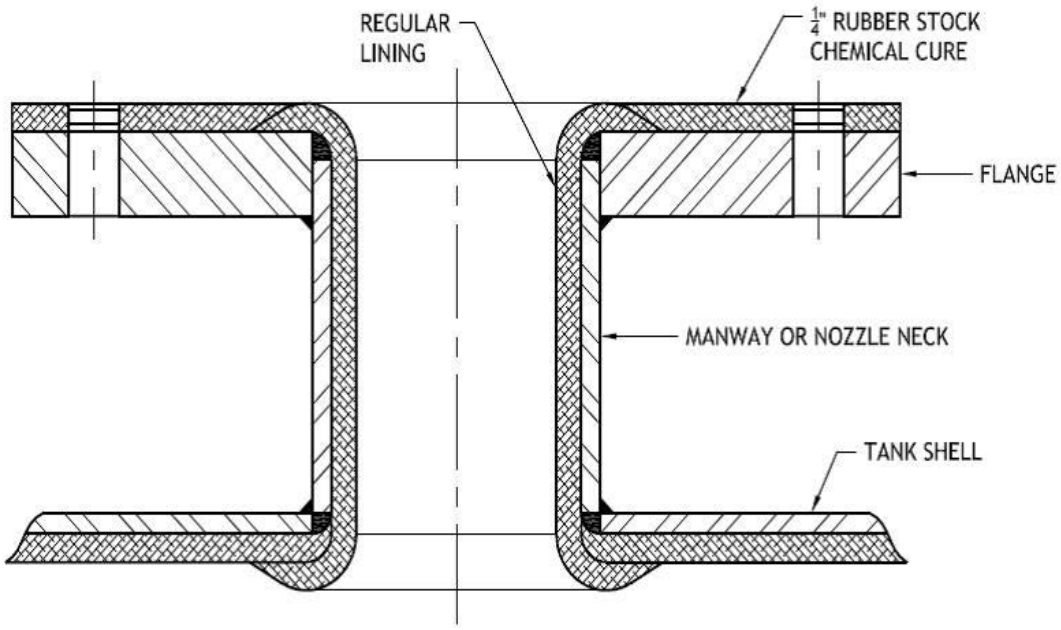


Fig 10-5 Internal steam cure vessel flange detail for outlets

2.2 For internal pressure curing, special blind flanges can be made to pressure cure the flange face without distorting the rubber. See the picture below.

- The thin steel strip welded to the blind flange should be wider than the thickness of the flange lining so live steam can cure the flange face.
- Bolting on these special blinds requires a rubber gasket and a washer for each bolt to contain the steam during the internal pressure cure.
- The flange face can be buffed flat after cure.

3. Gaskets

A gasket may be used between mating surfaces in-service.

4. Release Agents

Release agents should be applied to prevent the sticking of the flange face rubber to the mating surface. Options include:

- Various anti-seize compounds can be effective but are very messy.
- Talc pastes made by mixing with water have been used but may not be as effective over the long term.
- Silicone and water emulsions offer good release properties over a long period of time.
- For internal pressure cures, be sure to allow the water to evaporate before bolting on blind flanges. ***Silicone solutions are not to be used when***

hydrofluoric acid is present. Silicone is attacked by HF and could contaminate the acid.

5. Torque Specification

Procedure to torque bolts on rubber-lined flanges.

- Bring mating flanges into contact and install bolts/torqueing nuts “finger tight”.
- Align surfaces and adjust bolts to produce a uniform gap between the flange faces.
- Torque two opposing bolts together to ½ the full torque specified for the pipe size being installed.
- Repeat above step for the two bolts at 90 degrees to the first bolts torqued.
- Continue torqueing opposite pairs of bolts until all bolts have been tightened.
- Repeat procedure until all opposite pairs have been torqued to the full value specified for the pipe size installed.

Bolt Torqueing Guideline

Pipe Size (Inches)	Bolt Size (Inches)	No. Bolts	Half Torque (ft•lb)	Full Torque (ft•lb)
2	5/8	4	6	12
3	5/8	4	8	16
4	5/8	8	5.5	11
6	¾	8	7.5	15
8	¾	8	11	22
10	7/8	12	12	24
12	7/8	12	18	32
14	1	12	22	44
16	1	16	20	40
18	1–1/8	16	21.5	43
20	1-1/8	20	20	40
24	1-1/4	20	28	56
30	1-1/4	28	27	54

Section 8: Pipe Lining Procedures

1. Metal Specification

Pipe should be fabricated and welded in accordance with specific codes. Welds shall have a round and smooth surface suitable for applying rubber lining.

2. Metal Preparation

All metal surfaces to be lined should be blasted to a “white-metal” surface defined in SSPC-SP5/NACE No.1. The surface should be free of all oil, grease, dirt, mill scale, rust or other foreign matter.

3. Cementing

Apply primer immediately after blasting. Apply additional coats of cements as specified in Technical Data Sheets. Allow sufficient drying time between cement coats as per Section 6.

4. Lining Procedure for Standard Flanged Pipe

4.1 Form a tube with lining stock using longitudinal skived butt seams as illustrated in Fig. 8-1. To facilitate stitching of the skived seam, a metal strip is used inside the tube while it is being formed. The spliced tube’s outside circumference should be slightly less than the inside circumference of the pipe. The following formula is a suggested guideline for cutting width of tubes.

Overall Width of Tube = 3 x Pipe ID

** Pipe larger than 16” can be lined with two pieces of stock and joined with laps. Pipe that has a diameter large enough for personnel to enter should be lined in the same manner as tanks or ductwork.

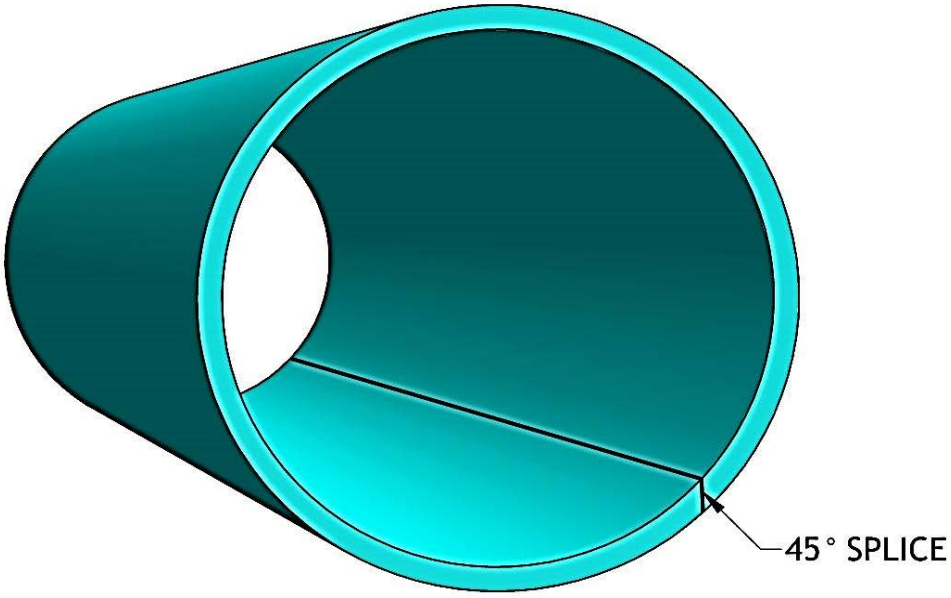


Fig. 8-1 Longitudinal skived butt splice

4.1 Apply twisted multifilament string lengthwise in pipe to permit proper air venting between pipe and lining. Do not use string made from synthetic yarns. Stringing should be done after cementing and the individual strings should be spaced equally around the inside circumference. Normally, four strings are used on pipe with diameters up to and including six inches. Larger size pipe normally uses additional strings.

4.2 Enclose the tube in a liner and attach a towrope. Pull tube into pipe with a slow constant pull.

4.3 Remove liner and expand tube against pipe wall by using air pressure. A mechanical extension and flange arrangement may be used for the pipe ends so that a minimum of 10 psig (69 KPa) internal pressure can be maintained in the expanded tube for at least five minutes. See pipe lining pictures.

4.4 Remove extension and flare excess stock over flange face and trim flush.

4.5 Apply a covering to full face of flange.
Remove extension of pipe lining and fold the edges over the flange face mating up to the flange rubber with a closed skive. See Fig. 8-2-1 and Fig. 8-2-2.

** When using hard rubber lining on flanges, it is important that customer understands that soft rubber gaskets are required over the face lining.

4.6 On pipe sizes larger than 6”, the flange stock may be lapped onto the pipe lining with a closed skive instead of the skive used on smaller size. This lapping technique makes a stronger joint and is the preferred method. Some customers may prefer not to have laps at flanges because of abrasion considerations or requirements on full line capacity. See Fig. 8-3-1 and Fig. 8-3-2.

4.7 Fig. 8-4 and Fig. 8-5 for suggested lining styles of lateral nozzles and side outlets.

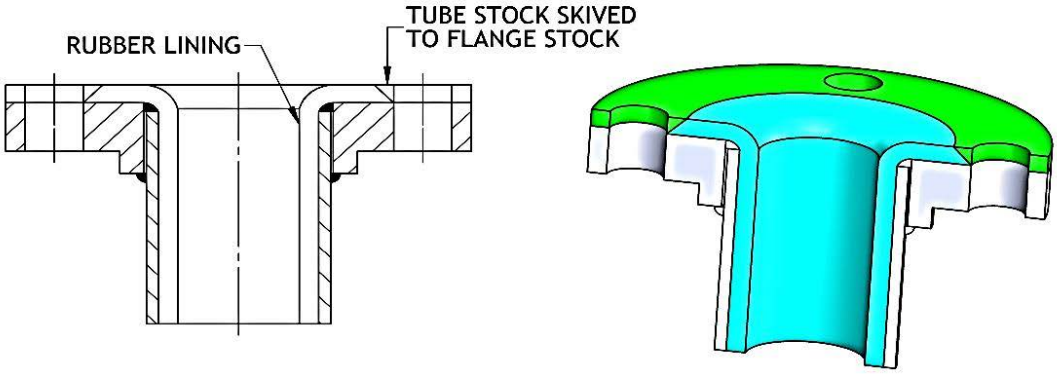


Fig. 8-2-1 Rubber lining to maintain thickness over the flange face
(Tube stock skived to flange stock)

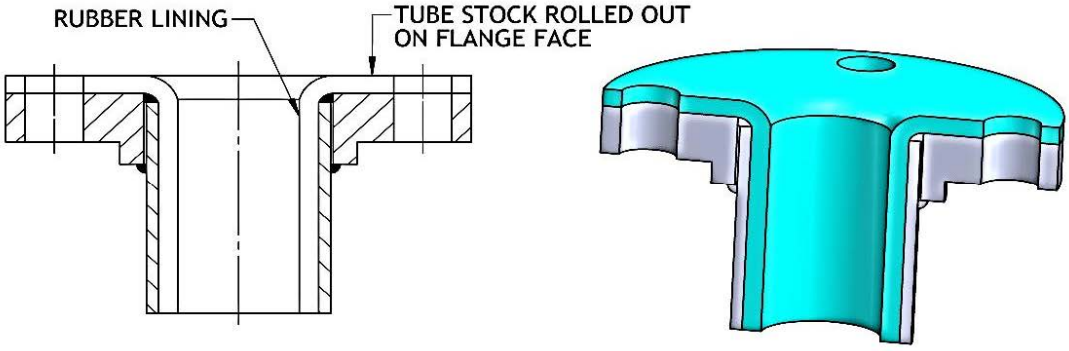


Fig. 8-2-2 Rubber lining to maintain thickness over the flange face
(Tube stock rolled out on flange face)

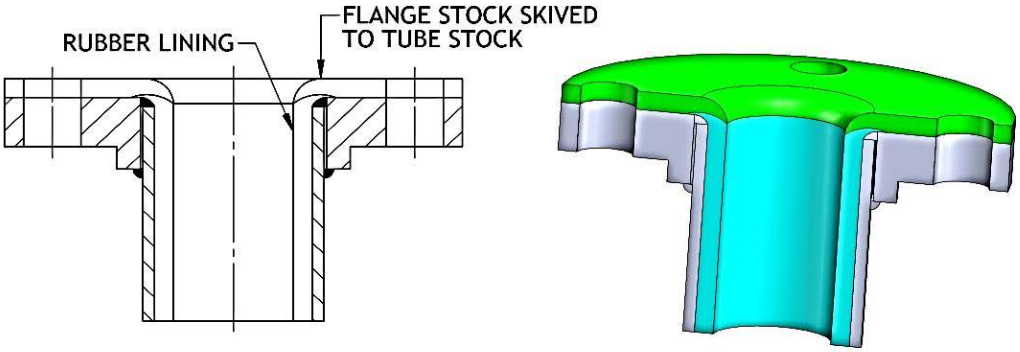


Fig. 8-3-1 Flange covering method
(Flange stock skived to tube stock)

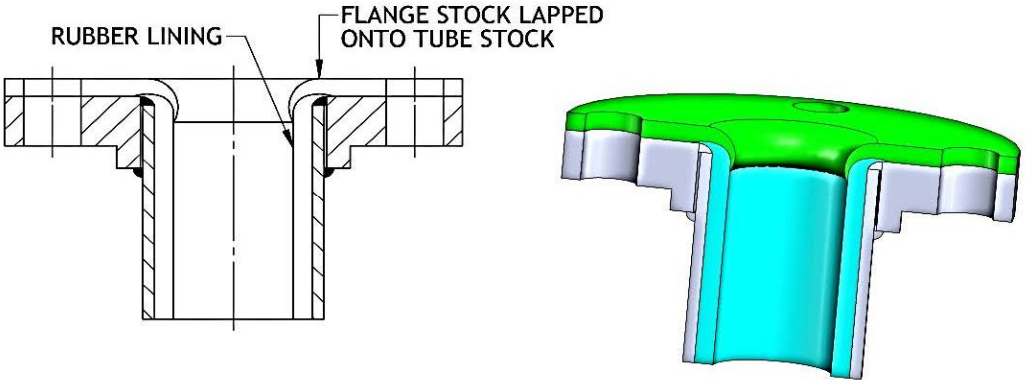


Fig. 8-3-2 Flange covering method
(Flange stock lapped onto tube stock)

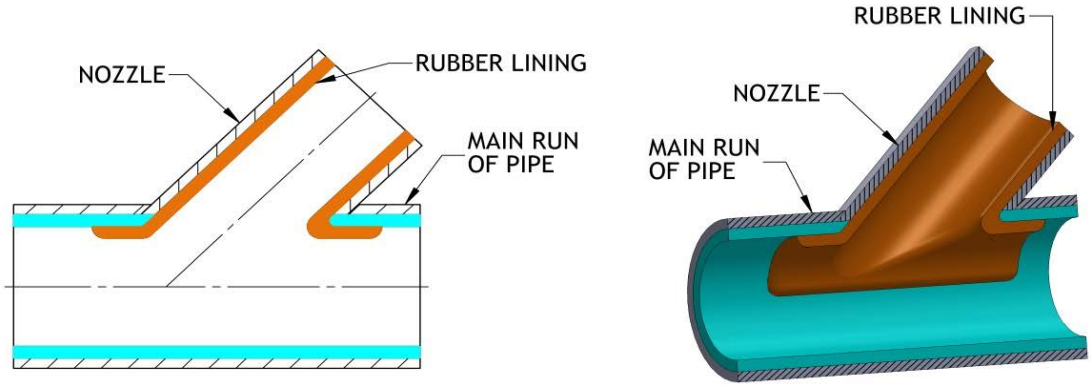


Fig. 8-4-1 Lateral nozzle details

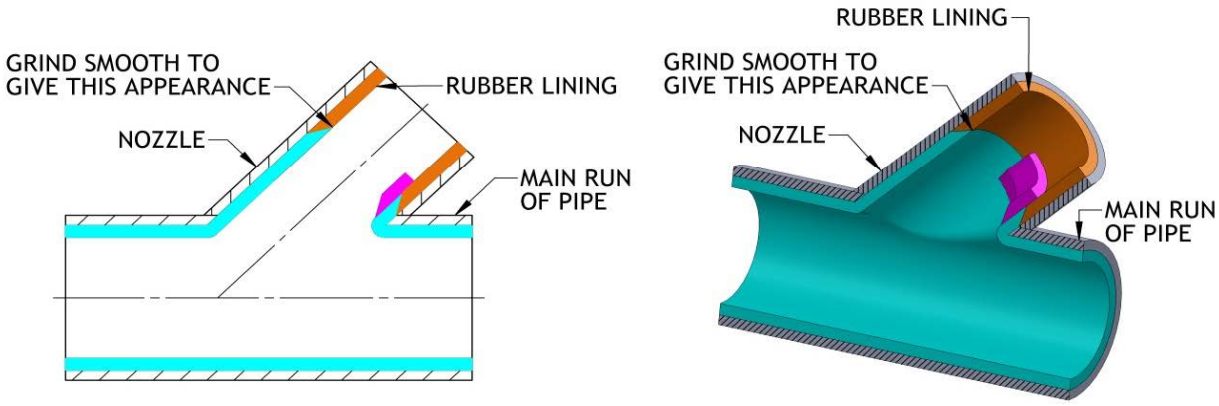


Fig. 8-4-2 Lateral nozzle details

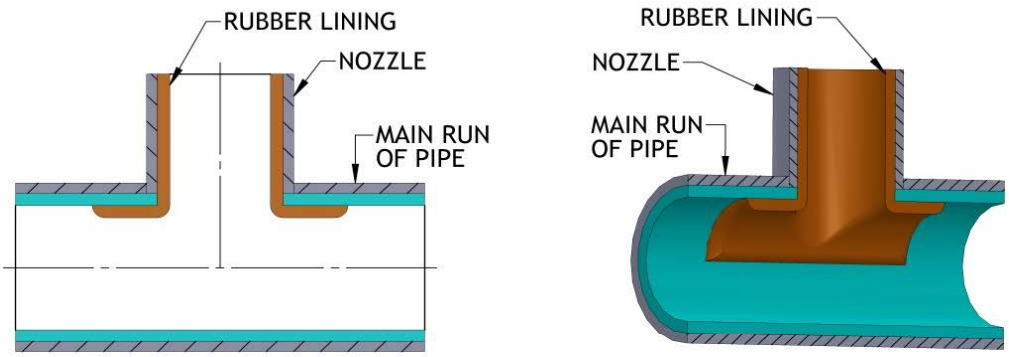


Fig. 8-5-1 90° nozzle details

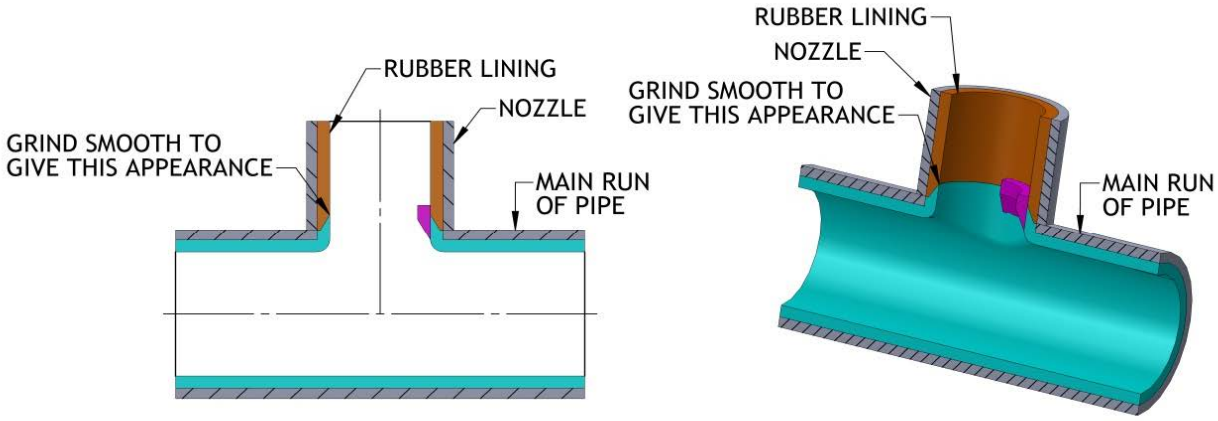


Fig. 8-5-2 90° nozzle details

Lining Procedure for Victaulic Pipe

5.1 Line inside of pipe in accordance with procedures used for standard flanged pipe.

5.2 When using 1/8” through 1/4” linings the tube lining should be extended over the end of the pipe and bent back into the recess on the outside of the pipe. Apply a round of tape over the OD of outside rubber. After cure, remove the tape and buff the OD flush with OD of metal. See Fig. 8-6-1 and Fig. 8-6-2 for rubber lining constructions including single grooved pipe and double grooved pipe for Victaulic pipe.

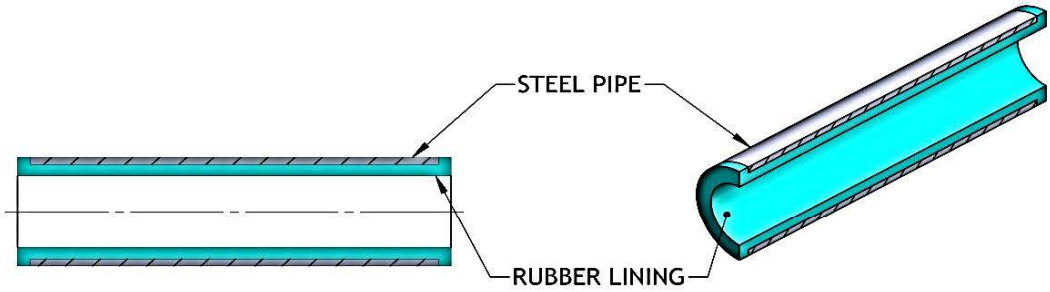


Fig. 8-6-1 Rubber lining construction for Victaulic pipe
(Single grooved pipe)

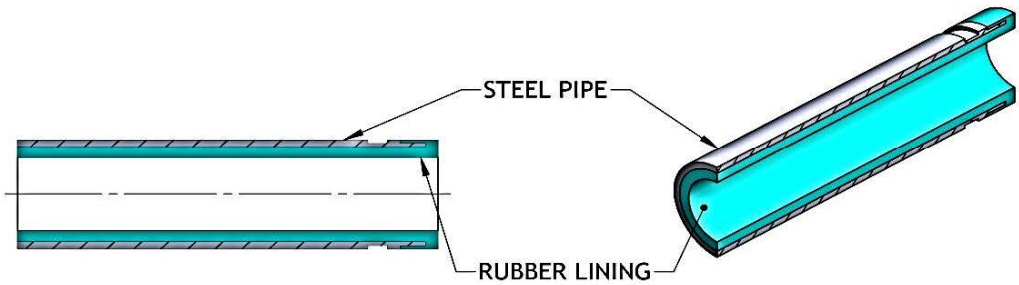


Fig. 8-6-2 Rubber lining construction for Victaulic pipe
(Double grooved pipe for corrosion application)

PIPE LINING PROCEDURE

1, Cutting a rectange rubber sheet

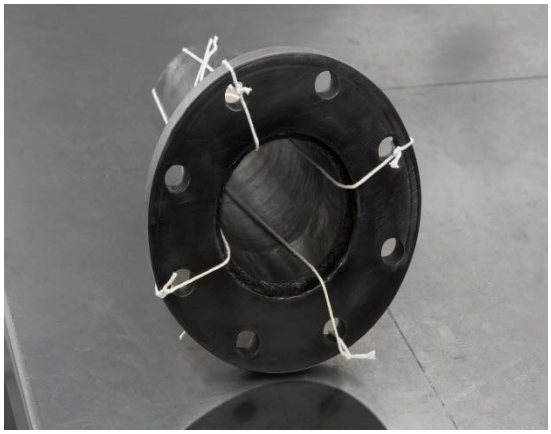
2, Applying cement (or solvent)

3, Forming a tube

4, Stitching of the skived seam

5, Applying solvent on the tube

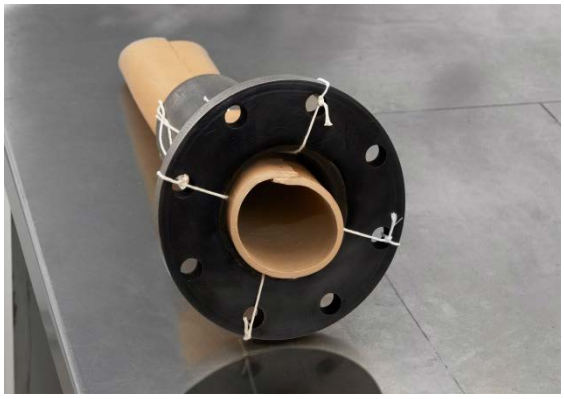
6, Wrapping the tube with Cloth Liner



7, Stringing pipe

8, Pulling Tube through pipe with Cloth Liner

9, Removing the Cloth Liner



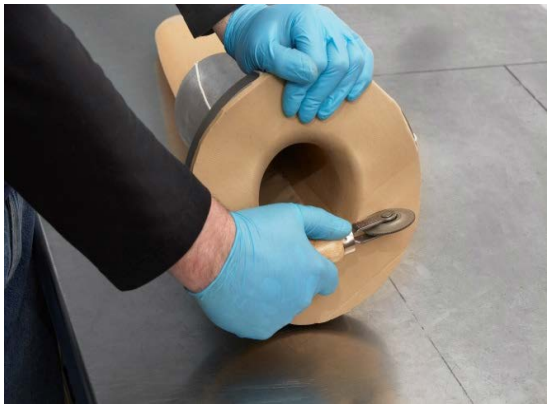
10, Expanding the tube against pipe wall

11, Flaring Tube over face of flange

12, Cutting out flange stock

13, Applying solvent to Flange cover

14, Placing Flange cover to Flange face



15, Stitching Flange unit

16, Cutting rubber out of bolt holes

Section 9: Non-Metallic Substrate Lining Procedures

1. Application of Rubber Lining to Concrete

The concrete should be solid, dense, nonporous (clean sand finish-not water finish) and free from dust and loose particles on the surface to be cemented. There should be no pits or voids under the surface. The concrete should be thoroughly dry.

1.1 Surface Preparation

- If the concrete is contaminated with oil, grease, acid, etc., scrub the surface with a commercial type of nonionic detergent solution
- After cleaning the surface, wash thoroughly with water and allow it dry completely
- Lightly sandblast to remove any latent and loose materials, dust and contaminants
- Where the surface has deteriorated, grind or cut through to good material and remove all dust

1.2 Adhesive Instruction

- Apply one coat of high build epoxy
- Allow it to cure as per manufacturer's recommendations
- Any remaining pits, pockets or rough areas should be filled with epoxy to provide a smooth flat surface for rubber application
- Lightly sandblast to roughen the surface of the epoxy
- Apply primer and cements as per manufacturer's recommendations for film thickness and dry times
- Inspect each coat of primer and cements for complete coverage
- Cemented surface should not be exposed to sunlight or UV light

1.3 Rubber Sheet Lining

- Follow the procedures from "Rubber Lining" of Section 6

1.4 Curing

- Follow the recommendations on the Technical Data Sheet for atmospheric cure time and temperature

2. Application of Rubber Lining to Fiberglass Reinforced Plastics (FRP)

This type of the rubber lining is only for brand new tank equipment

2.1 Surface Preparation of FRP

- The surface of FRP shall be blasted to a roughened surface
- Remove all blasted materials from the surface of the FRP

2.2 Adhesive Instruction

- Apply the primer and cements on the FRP surface as per manufacturer's recommendations
- Allow each coat of primer and cements to dry completely
- Inspect each coat of the primer and cements for complete coverage
- Cemented surface should not be exposed to sunlight or UV light

2.3 Rubber Sheet Lining

- Follow the procedures from "Rubber Lining" of Section 6

2.4 Curing

- Follow the recommendations on the Technical Data Sheet for cure time and temperature

Note: Contact your Polycorp representative for information on special cases

Section 10: Curing

CURING

The five basic methods used for curing rubber lining are autoclave, internal (pressure) steam, exhaust or atmospheric steam, chemical cure and hot water cure. The specific method used will depend on the nature and size of the vessel to be lined. Note that recommendations contained in this manual are suggested guidelines only. Actual cure times will depend on factors such as rubber thickness, vessel size and metal wall thickness, heat loss, ambient conditions and elevation.

All cures should have proper temperature recording charts and these should be properly identified with job number and date. If there are any questions regarding conformance of cure to published time and temperature recommendations, please contact your Polycorp representative.

1. Autoclave Cure

This refers to vulcanization where the rubber-lined vessel/part is placed inside a pressure vessel and subjected to controlled steam under pressure**. <u>An autoclave cure provides the best and most uniform cure and should be used whenever possible</u>**. Metal parts should be placed in the autoclave so that the best possible drainage of condensate from the rubber will be obtained. To obtain the most accurate and uniform cure, it is desirable to have the autoclave fully equipped with thermocouples and instrument controls on air pressure and steam. Sufficient boiler capacity should be available to raise the temperature from ambient to cure in a relatively short period of time. After finishing cure, it is recommended the rubber-lined vessel be cooled down by using water and/or air. Proper cool down of autoclaves will prevent post curing and preclude the possibility of cracking hard rubbers. The following cool-down procedures are suggested as recommended methods:

- Cool down soft natural and synthetic rubbers one hour with air and water.
- Cool down Triflex™ and hard rubber with air and water until autoclave temperature reaches 200°F (93°C). Continue a gradual cooling down of the autoclave with air and then with air and water. This cool down procedure can be modified, but a step-wise procedure will prevent cracking of the hard rubber.

During cool down it is important to maintain an air and water pressure equal to or greater than the steam pressure.

All autoclaves should be equipped with temperature and pressure recorders. The recording charts should be properly identified and dated.

Precautions must be taken against stratification of steam and air particularly in large vulcanizers. During start-up the bottom exit valve must be cracked open to allow a complete sweep of steam and cold air through the autoclave to avoid a cold bottom and subsequent undercured rubber.

In all cases, follow the Autoclave manufacturer's operation manual.

Follow the recommendations on the Technical Data Sheet for cure times and temperatures.

2. Internal Pressure Steam Cure

Internal steam pressure cures are used on vessels that are designed for pressure and are too large to be placed in an autoclave. The vessel should be positioned during cure so that complete condensate drainage is obtained. To accomplish this, tanks with a sump should be cured with a well pipe connected to a trap (see Fig. 10-1).

Tanks without a sump can be cured. A drain valve shall be open enough so that the continuous flow of steam can be observed (see Fig. 10-2). All nozzles should be bled with a 1/4" petcock. Drain valve should be left open long enough to be sure that all air is evacuated before building up pressure.

- Sufficient boiler capacity should be available to raise the temperature from ambient to curing in a relatively short period of time. Long uninsulated pipe runs from the steam source should be avoided. Low pressure steam plus un-insulated lines promote excessive condensate.
- Outside temperature has a significant influence on the time required to cure a vessel. In cold winter temperatures, if it is practical, the vessel should be insulated to effectively carry out the cure.
- Steel thickness is also a factor. Heavy thick steel needs additional time to compensate for the heat sink and warm-up period. This is where external temperature gauges are quite valuable in monitoring the time/temperature so one can judge and insure themselves that a complete cure is being obtained.

All flange faces should be lined with one of special constructions shown in Fig. 10-3, Fig. 10-4 and Fig. 10-5.

- Prior to introducing steam into the vessel, all outlets should be blanked off with a blind flange equipped with a petcock so as to insure the release of steam thereby guaranteeing the nozzle and flange are properly cured (see Fig. 10-6 for detailed assembly).
- Always insert Mylar or a like material between blind flange and rubber on the flange to insure removal of the blind flange after cure without damaging the rubber on the flange
- The blind flanges should not be bolted down too tight initially as they can be tightened as the cure progresses.

<u>To bolt the flange too tight initially forces the rubber to squeeze out as the temperature increases thereby leaving a very thin ply of rubber on the flange</u>

- The blind flanges may be tightened as the cure progresses. However, the rubber on the flange will have started to harden. So the blind flanges can be tightened down with less rubber squeezing out.
- The pressure should be brought up in the tank as quickly as possible.
- When the desired pressure has been reached, the petcocks can be slowly opened until there is a visible amount of steam flowing through the petcock. It will allow curing the nozzles and flanges properly.
- When the tank is being readied for cure, the air and steam line should be inserted separately so as to allow air to be inserted in the tank while the steam is still on.
- After curing completely, cool down internal steam cures by introducing air until temperature reaches 150°F (60°C). All cures should have proper temperature and pressure recording charts with identified job number and date.

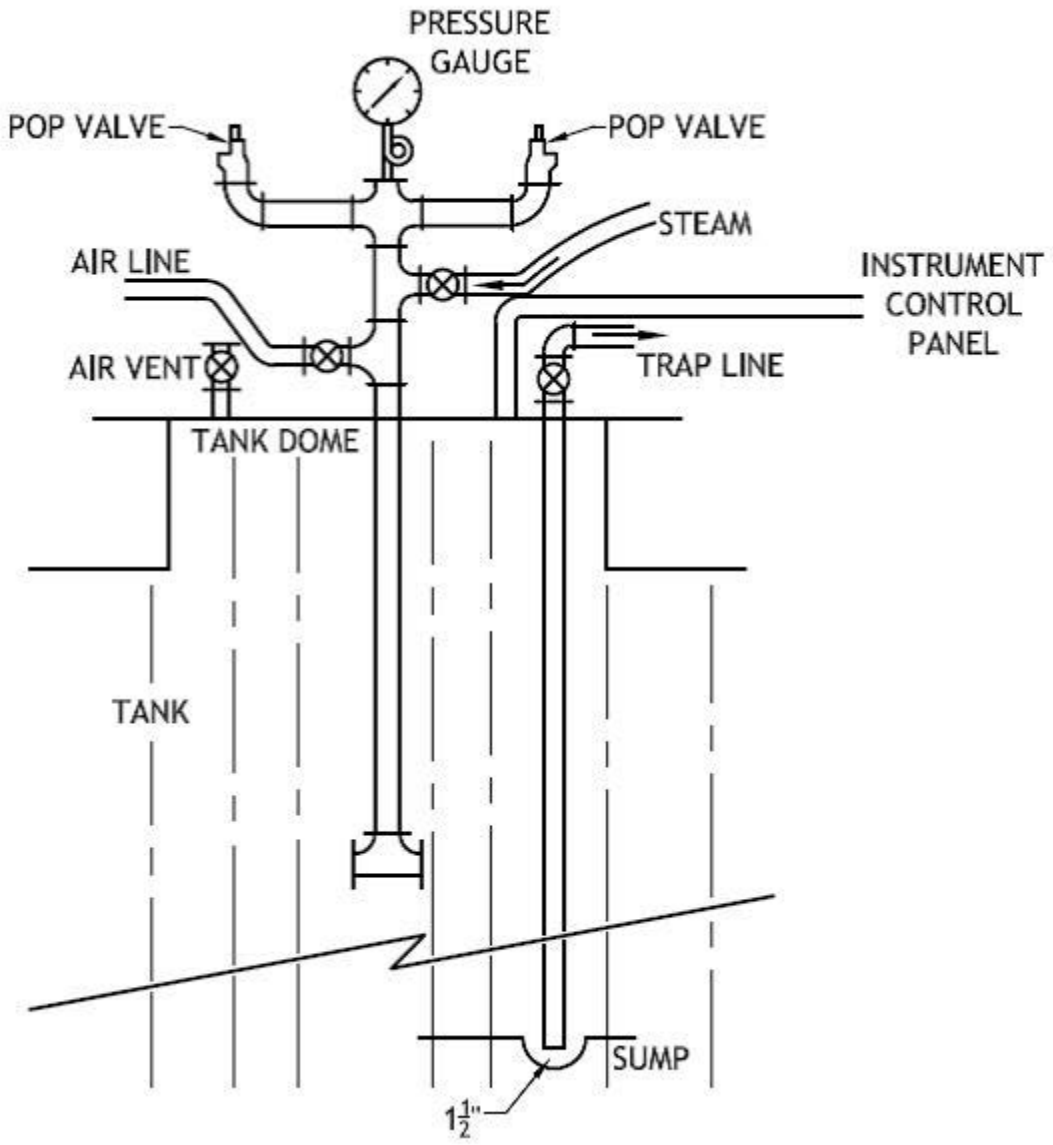


Fig. 10-1 Internal steam cure – tank with sump

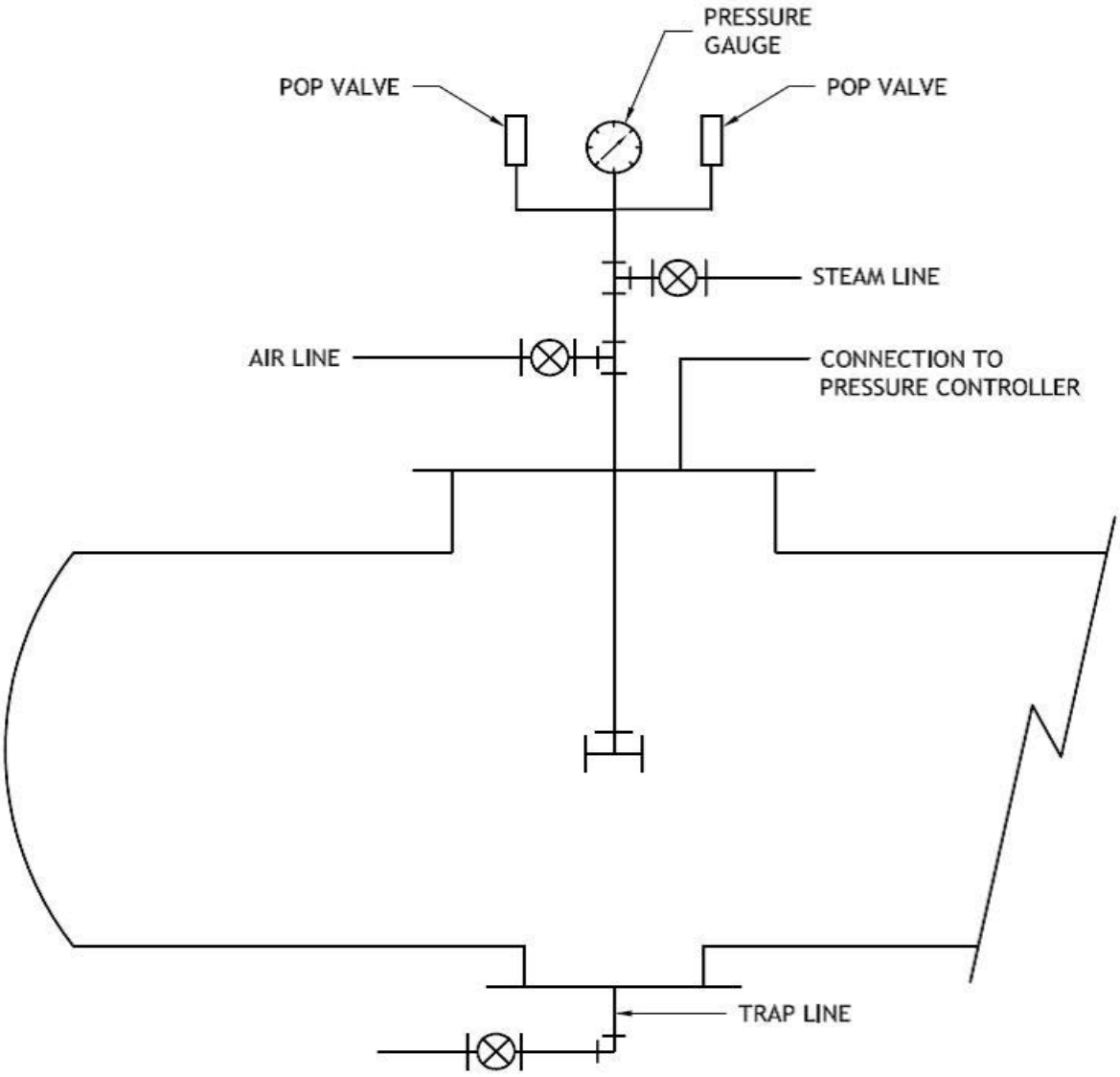


Fig. 10-2 Internal steam cure – tank without sump

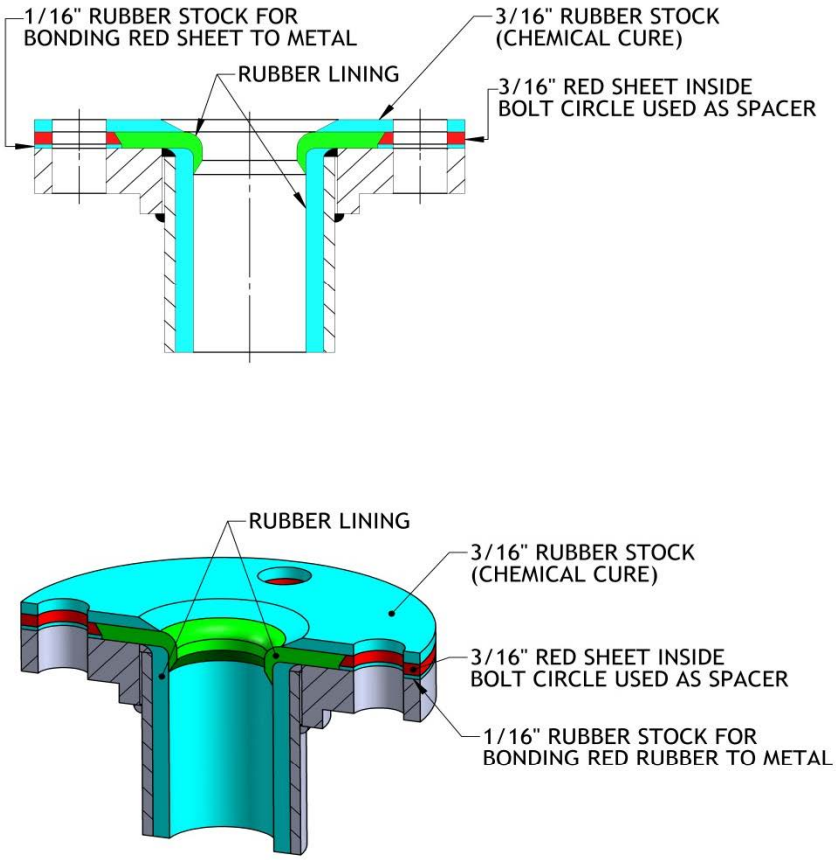


Fig. 10-3 Internal steam cure vessel - Flange detail for outlets
(This method is recommended on vacuum equipment)

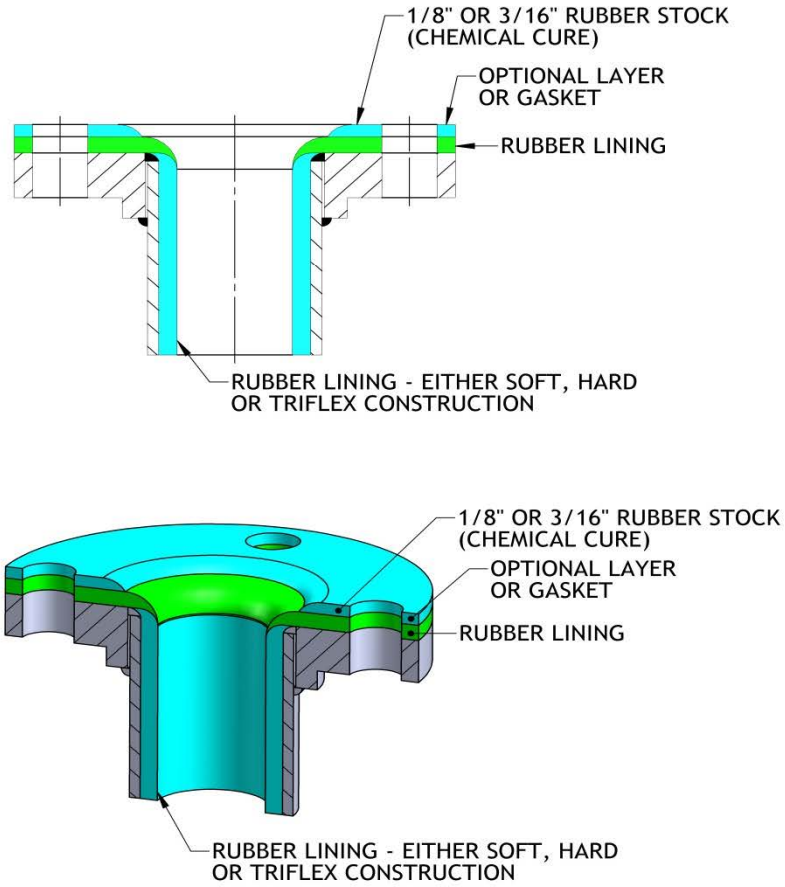


Fig. 10-4 Internal steam cure vessel - Flange detail for outlets

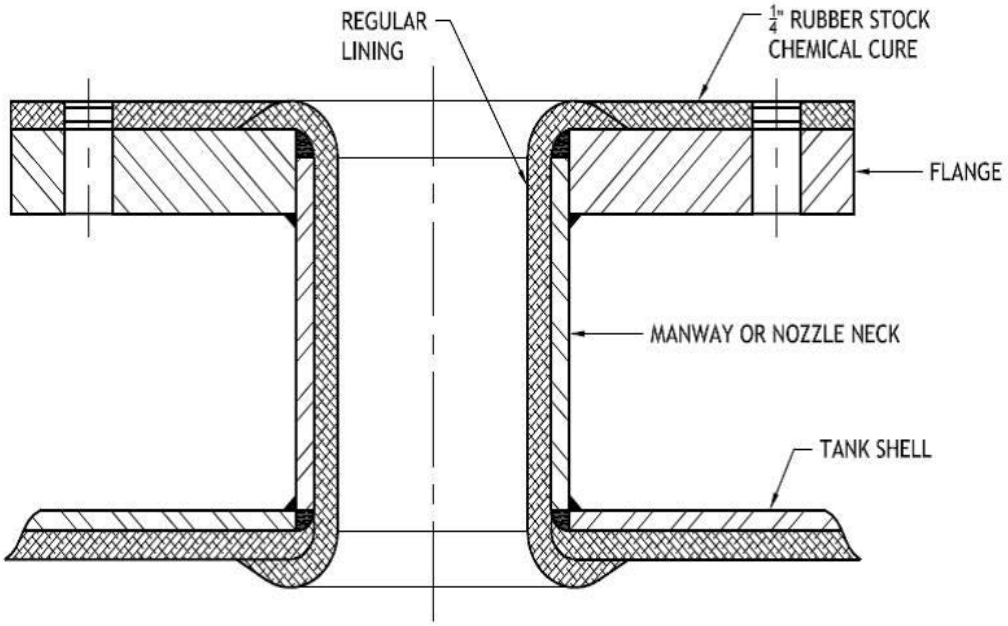


Fig. 10-5 Internal steam cure vessel flange detail for outlets

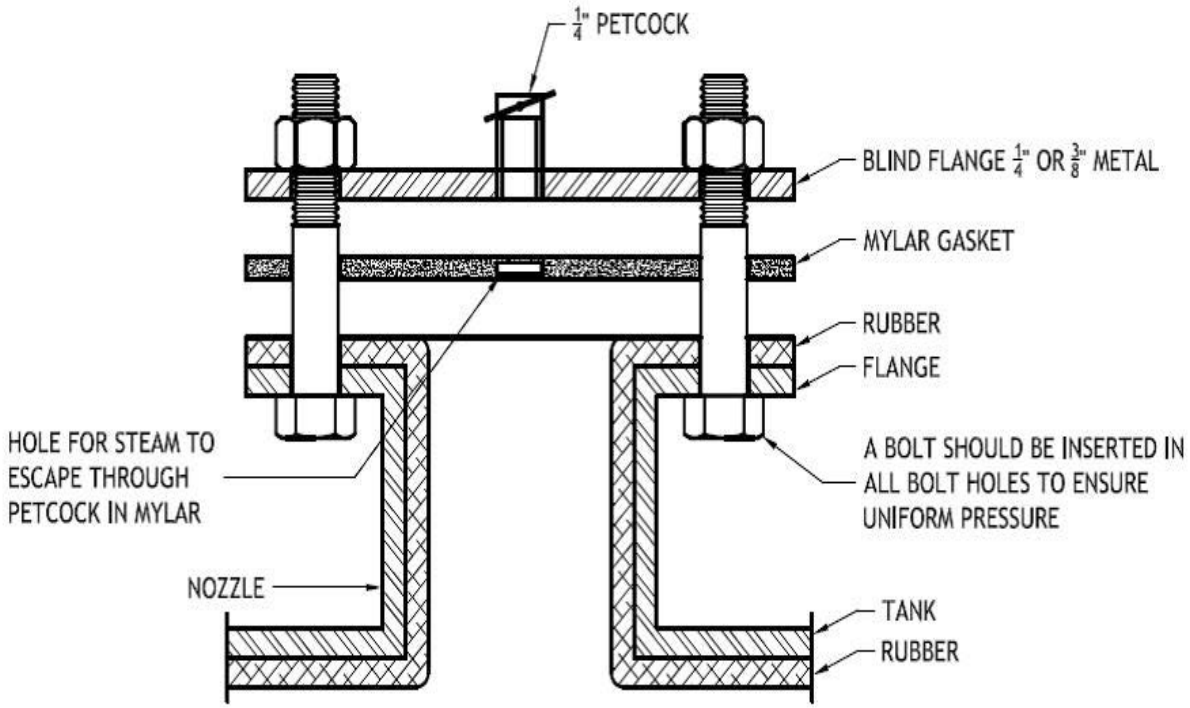


Fig. 10-6 Internal pressure steam cure – Flange assembly

3. Exhaust or Atmospheric Steam Cure

If it is practical, the vessel shall be adequately protected and insulated to prevent loss of the heat required to fully vulcanize the rubber. Exhaust or atmospheric steam is normally used for field vessels that have open tops and/or bottoms, vessels that do not withstand pressure or vessels that are too large to fit in an autoclave. In the case of open top tanks, the opening must be covered with fabric or combinations of fabric and plastic. The covering must be made tight so the steam will be contained. Steam should be introduced into tank by means of a steam line through an outlet from the bottom of the tank. It is absolutely essential that provisions be made to be able to remove all condensate from the vessel during cure. The bottom outlet on a closed top tank may be left open for drainage, but other outlets should be covered. See Fig. 10-7 for typical exhaust steam piping setup.

3.1 Tanks that have an enclosed top with bottom outlet should start timing the cure when the temperature of the bottom outlet is about 140°F (60°C) and the temperature of the rubber surface has reached the desired cure temperature (as measured in the coldest spot in the vessel).

3.2 Thermometers through outlets and internally located thermocouples at various points in the tank should be used to monitor the temperature. When temperature varies at different spots in the vessel, the coldest spot should govern how much the overall cure should be increased. No cool down period is required for this type of cure.

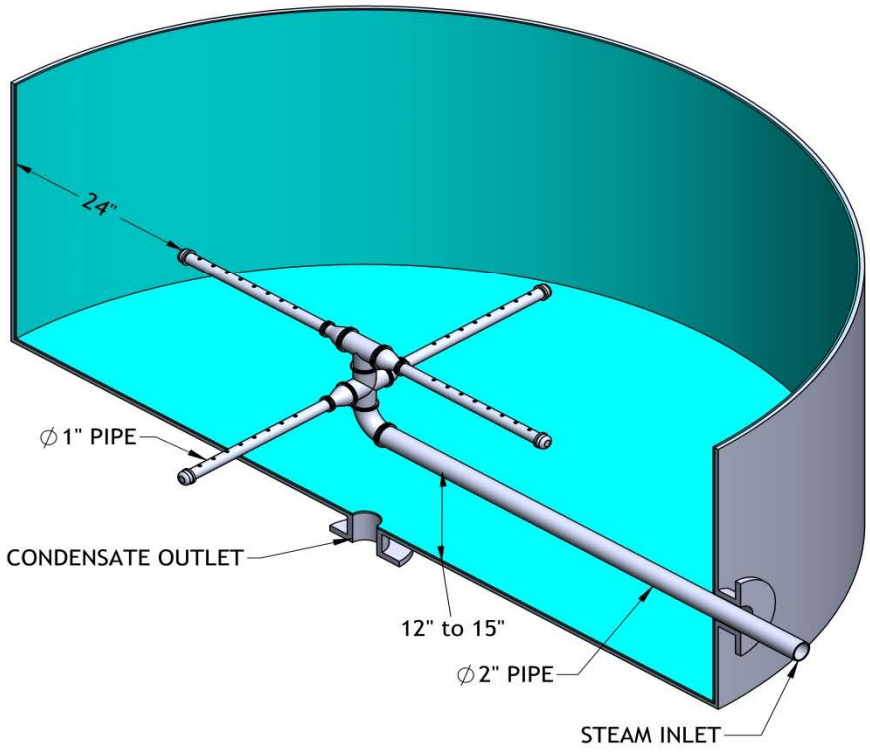


FIG. 10-7 TYPICAL EXHAUST STEAM PIPING SETUP

NOTE: *For large tanks or during cold weather, larger size piping to furnish more steam may be required (insulation may also be necessary) to maintain appropriate inside curing temperature that is in accordance with Polycorp's recommendation.*

3.3 Precautions

Specifications and information on the Technical Data Sheets is written based on

consistent lab conditions. Frequently the cure times are extended for the lining to receive the optimum cure. The following are all considerations in determining the correct cure cycle.

- Warm up vessel at a rate of 30 – 50°F/hour (16 – 28°C/hour). The time it takes to warm up the unit does not count toward the cure time.
- Curing is a function of time and temperature. Lower temperatures will lengthen the cure time. Tank insulation, temperature of the surrounding air, elevation and wind velocity over the tank can shorten or lengthen the cure.
- Thickness and surface area (structure) of the metal will act as a heat sink and increase the length of the cure.
- Cold spots can develop as a result of trapped air, condensate accumulation or ineffective steam circulation. Thermocouples must be strategically placed to monitor the coldest spots in the tank. Temperature readings must also be taken on the metal opposite the rubber lining to ensure the metal temperature is about minimum 150°F (66°C) to cure the rubber/cement interface.
- The amount of steam must be properly estimated for curing. To ensure proper cure of flange faces, steam must escape around openings. If the steam is stagnant, cold spots form. The steam supply must not only be adequate but must be directed in such a way to ensure it is flowing over all rubber lining surfaces, especially the bottom. Drains should be provided at the bottom of the vessel and elsewhere to ensure condensate will run off and not collect in any pockets. An open top tank or one sitting on a concrete pad can result in situations where the tank walls are cured but the floor is not.
- The entire cure and cool down must be monitored, especially if it is possible to pull a vacuum and collapse the vessel. Vacuum breakers may be necessary depending on the construction of the vessel.

3.4 Key Calculations for Steam Requirements for Atmospheric Cure

- Pounds of Steam per hour:
  Example - during 2-hour warm-up period and based on an enclosed vessel with 3/8” plate on bottom and 1/4" on sides and top

Pounds per hour of steam = 0.05V + 0.15A + 0.005W

Where: V = Volume in cubic feet
A = Area in square feet
W = Weight of rubber and steel in pounds

- Boiler Horsepower Required = Pounds of steam per hour ÷ 30
- Steam Flow Table: Table shows steam flow in pounds per minute through 1,000 feet of pipe

	Steam Pressure		
Pipe Size	**50#**	**75#**	**100#**
1”	4.27	6.32	8.15
2”	25.8	36.7	52.5
2 ½”	40.7	57.7	74.5
3”	71.5	101.0	130.0
3 ½”	89.0	146.5	185.0
4”	144.0	204.0	263.0

To the use the table, determine steam requirement in pounds per minute for 1,000 feet of pipe. For example, if 2,000 pound per hour are required (2000/60 = 33.3 lb/minute), a 2” pipe at 75 pounds of steam pressure is required.

To adjust for varying lengths of pipe, multiply flow rate from the table by the appropriate factor below:

Length of Pipe (Feet)	Factor
100	3.16
200	2.24
300	1.83
400	1.58
500	1.41
600	1.29
700	1.20
800	1.12
900	1.05

Example: If steam source is 100’ away, a 2” pipe is used and gauge pressure is 50# then steam delivery/minute = 3.16 x 25.8 = 81.53 pounds.

5. Chemical Curing

There are cases where using heat to cure the rubber is not possible. Steam may not be available or the equipment to produce the steam is inadequate. Chemical curing rubber is an acceptable solution for these situations. It is typically used in field repair situations.

Chemical activators are used to cure these specialized compounds. They are almost always used by coating the activator on the rubber lining sheet and then adding another coat on the lining after the first has dried. In some cases you may want to coat the rubber sheet prior to lay-up. Specific instructions are contained on the respective Technical Data Sheets. Activator should not be applied to the side of the rubber being applied to the substrate as this may interfere with bonding.

The chemical activator will only result in a rapid cure of the lining surface. Full cure of these types of linings may take an extended period of time.

6. Hot Water Curing

On field lined tanks, one way to obtain some pressure during cure is to use water for hydrostatic pressure. In preparation for water cure, the outlets and/or manways must be prepared using chemical cured or pre-cured rubber. The tank structure must be designed so that it is able to withstand the hydrostatic pressure of the water and curing temperatures up to 210 ºF (99°C). Also, the tanks need to have sufficient foundation to support the water filled vessel, either a sand base for non-installed, or the proper tank setting itself.

On open top tanks, the preparation procedures are the same, except the tank is lined all the way to the top and the water is filled to the top.

Prior to filling the tank with water, steam sparger piping should be installed near the bottom of the vessel. The steam shall be directed not to impinge on the rubber surface and it is recommended that the steam be introduced in an angled, downward direction. Steam should be introduced to the filling tank as soon as the lowest sprayer nozzles are immersed. Once the temperature has reached 180ºF (82°C), the cure can be considered as starting. It is best for the water temperature to be 180ºF - 205ºF (82°C - 96°C). No water source is acceptable that may contain oil.

Thermocouples should be used to monitor the temperature within the vessel from top to bottom. Also, metal temperature probes may be utilized on the outside for temperature information if the tank is not insulated.

After the cure is completed, if the water temperature is slow to come down, it is permissible to add cold water.

Section 11: Repair of Rubber Lined Equipment

General Repair Information

Regardless of all the precautions taken in the original cure and maintenance of rubber lined equipment, some rubber linings will eventually need repairs. When repairs are necessary, they can vary from small blisters or cracks to major areas in numerous panels of rubber.

The methods of repair are generally dictated by the type of the original lining, extent of repair, intended service and the facilities available. For these reasons there are no standard methods of repair especially when considering field repairs. The only repairs that can be presumed to be equal to the original lining are those that are made with the same stock used in the original lining and given a full re-cure of the repair. On occasions it is not possible to re-cure the vessel in the original manner, other alternate methods have to be used.

In this repair section there are step-by-step procedures for different repairs, but there may be occasions where slight deviations have to be made. In general the following standards have to be met regardless of the type of repairs that are made.

- The damaged metal and rubber must be properly prepared by buffing or grinding. The surface of the rubber adjacent to the repair area should be buffed to clean rubber back for a minimum of 4 inches.
- Before cementing, the entire work area must be clean. All buffing dust, grindings, moisture and acid fumes, etc. should be removed not only from the direct area, but also from any adjacent area where it might be carried or blown in.
- The cements must be applied in the proper sequence on the metal and/or buffed rubber and allowed to dry between each coat.
- The mating surfaces shall have a minimum of 30° skive and must be of correct size for fill-in and/or overlap.
- The mating surfaces of the repair stocks must be swabbed with toluene or cement, and allowed to dry.
- The repair compounds must be carefully rolled and stitched down and all trapped air removed.

1. Repair for Surface Defects of the Rubber Lining

When a flaw in the rubber lining does not have to be cut out, such as a thin area or surface damage to the lining, a patch is sufficient if agreed upon between the applicator and owner. The patch can be as small as 2” (5 cm) or large enough to cover several flaws. See Fig.11-1 for details.

1.1 Use rubber stocks, primers and cements indicated on Technical Data Sheet for repair.

1.2 Remove all loose or defective rubber, cutting back to areas of good adhesion.

1.3 Buff or roughen rubber to be lined.

1.4 Refresh the buffed rubber surface with clean solvent.

1.5 Cement the buffed rubber surfaces. This may require more than one coat.

1.6 Apply cements to a patch of uncured rubber stock. This patch should be cut with skived edges and be large enough to fit the buffed and cemented of the original lining.

1.7 Roll down the patch carefully and remove any trapped air.

1.8 Cure the patch in the same manner as originally cured. In the case of large vessels that were cured originally with atmospheric steam, a single repair may be cured by building a box around the patch, or otherwise confining the steam to the area of the patch.

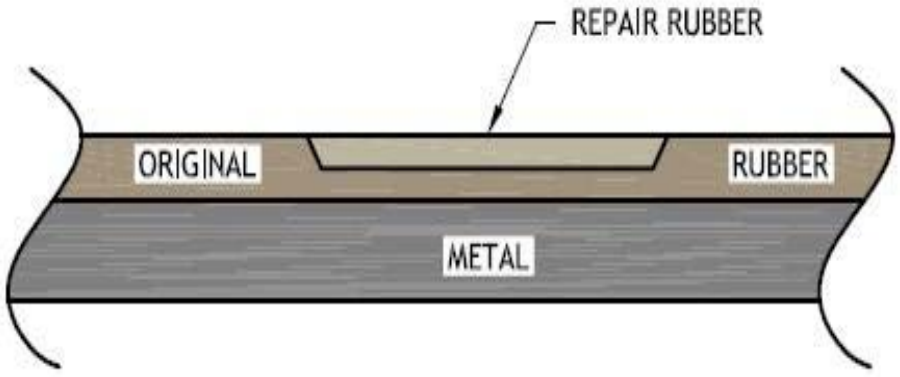


Fig. 11-1 Repair for surface defects of rubber lining

2. Cover Patch + Fill-in (Inlay) Repair of the Rubber Lining

2.1 Use rubber stocks, primers and cements indicated on Technical Data Sheet for repair. See Fig. 11-2 for details.

2.2 Remove the defective rubber to good adhesion to metal. In the case of a pinhole leak, this operation is omitted.

2.3 Buff or grind exposed metal until clean and bright. If metal damage has occurred the rubber must be removed back to good adhesion or 8” beyond damaged metal. Repair metal. During metal cutting and welding, the metal between the weld and original rubber must be kept cool so as not to overheat rubber or the bond. After the welding is complete the weld spatter must be removed and the weld ground smooth.

2.4 Buff edges of exposed rubber to a minimum of 30° bevel.

2.5 Buff surface of original lining back 4” from cut edge. The rubber surface must be free from dust, moisture and acid fumes. Moisture will reduce and often destroy adhesion of the cement, making a successful repair impossible. Any traces of contamination on the rubber being repaired should be neutralized.

2.6 Cement the metal using the following steps:

- One coat of primer
- One coat of intermediate
- Two coats of tack

2.7 Cement the buffed rubber with two coats of tack.

2.8 Use pattern and cut a piece of the original uncured lining to conform with the edges that have been skived to a 30° bevel. Cement the surface of the rubber patch with tack and allow it to dry.

2.9 Inlay the uncured lining stock over the metal and skive onto the beveled edges of the buffed rubber. This is usually done by using a slightly larger piece of stock than necessary and trimming flush with original lining after thoroughly rolling into place.

2.10 Apply a cover patch of uncured lining over the inlay. This cover patch should be cut with skived edges and be large enough to fit the buffed and cemented surface of the original lining.

2.11 Roll the stock in a straight line working from center to edges allowing the air to escape ahead of the roller.

2.12 Cure entire unit in the same manner as originally cured. In the case of large vessels that were cured originally with atmospheric steam, a single repair may be cured by building a box around the patch, or otherwise confining the steam to the area of the patch.

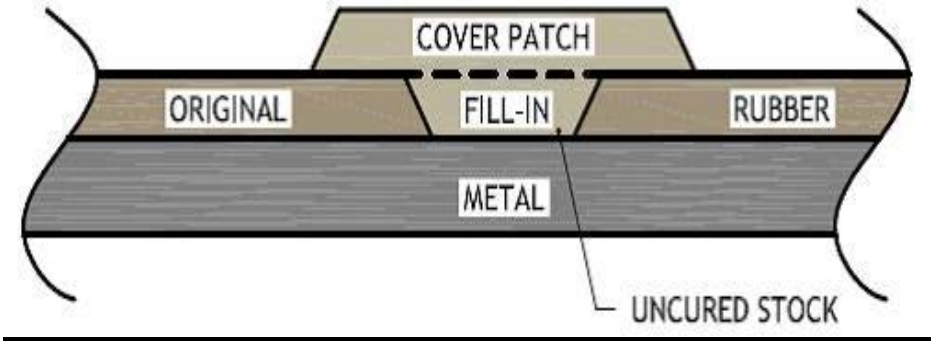


Fig. 11-2 Cover patch with fill-in (inlay) repair

3. Repairs for Large Areas of the Rubber Lining

It is permissible to use a single thickness of uncured stock over the area to be repaired. The patch should extend out 4” onto the old rubber. See Fig. 11-3 for details.

It is permissible to use single thickness of chemical cure stock over area to be repaired. This patch should extend out 4” on old rubber. Use the same cement and activator procedures as outlined in the chemical cure section.

- Use rubber stock, primer and cements indicated on Technical Data Sheet for repair.
- Use same repair procedure per Section 2 “Cover + Fill-in Repair”.
- Cure per recommendations from Technical Data Sheet.

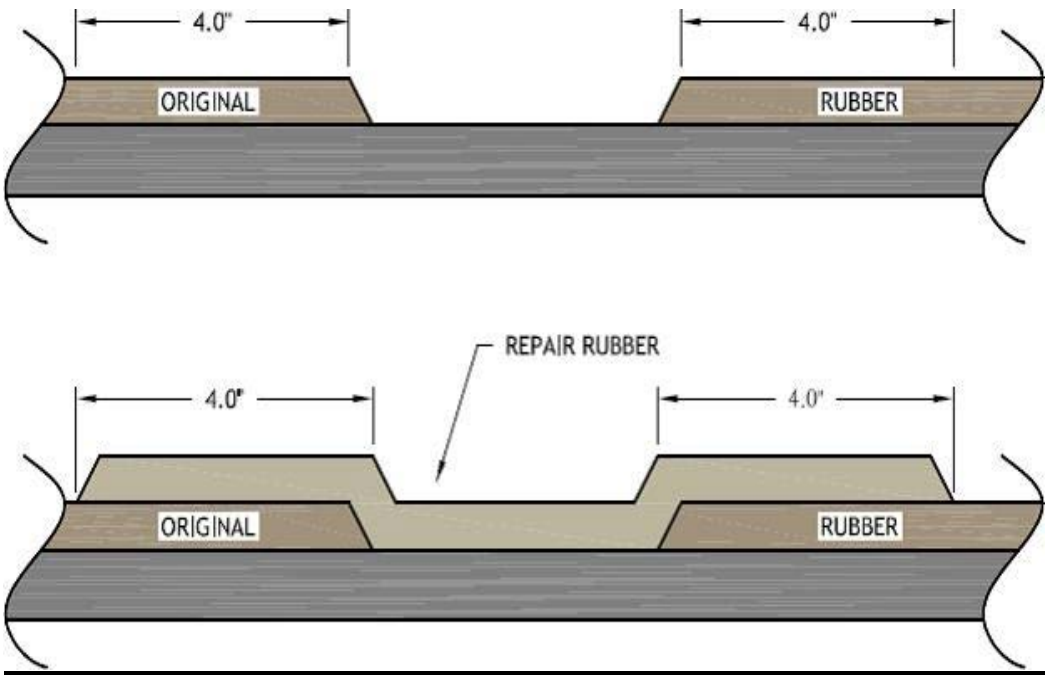


Fig. 11-3 Large area repair

4. Repair for Hard, Semi Hard and Triflex™ Rubber Lining

4.1 Use rubber stock, primers and cements indicated on Technical Data Sheet for repair.

4.2 Remove the defective rubber to good adhesion.

4.3 Buff or grind exposed metal until clean and bright.

4.4 Buff surface or original lining back 4” from cut edge. The rubber must be free from dust, moisture and acid fumes.

4.5 Cement metal and buffed rubber as follows:

- One coat of primer
- One coat of intermediate
- Two coats of tack

4.6 Inlay uncured rubber over the metal and skive onto a minimum of 30° beveled edges of the buffed rubber. This is usually done by using a slightly larger piece of stock than necessary and trimming flush with original lining after it is rolled and stitched into place.

4.7 Apply cement to the top surface of the inlay patch with tack.

4.8 Apply a cover patch (1/8” thick) of uncured rubber on to the top of the inlay rubber.

4.9 Cement the mating surfaces of the patch material with tack. The cover patch should be cut large enough to extend out 4” on the buffed and cemented area of original lining.

4.10 Thoroughly roll and stitch repair stocks to original lining.

4.11 Cure repair with atmospheric steam.

5. Chemical Cure Repair

5.1 Remove the defective rubber to good adhesion.

5.2 Buff or grind exposed metal until clean and bright.

5.3 Buff surface of original lining back 4” from cut edge. The rubber must be free from dust, moisture and acid fumes. Moisture will materially reduce and often destroy adhesion of the cement, making a successful repair impossible.

5.4 Cement the metal as follows:

- One coat of primer
- One coat of intermediate
- Two coats of tack

5.5 Cement the buffed rubber with two coats of tack. Allow each coat of cement to dry thoroughly. In small repairs where the rubber is cut or gouged, but not loose from the metal, the buffed out areas should have two coats of tack.

5.6 Cut a piece of chemical cure repair rubber to conform to the edges skived to a 30° bevel. Cement the surface of the rubber with tack and allow it to dry.

5.7 Inlay the chemical cure repair material over the metal and skive onto the beveled edges of the buffed rubber. This is usually done by using a slightly larger piece of stock than necessary and trimming flush with original lining after thoroughly rolling into place.

5.8 After the inlay is in place the top surface should receive an additional coat of tack.

5.9 Apply a cover patch of chemical cure rubber over the inlay. The cover patch should be cut large enough to fit the buffed and cemented surface on the original lining.

5.10 Brush the entire exposed surface of the cover patch with three separate coats of C-700 or C-600 activator. Dry 30 minutes between coats. Take care that activator C-700 or C-600 does not run off the surface. If repair is on a vertical surface or overhead, apply at least one coat of C-700 or C-600 to surface of repair stock before it is positioned. After completion of the final coat of C-700 or C-600, there should be a time lapse of at least 8 hours before repair is put into service.

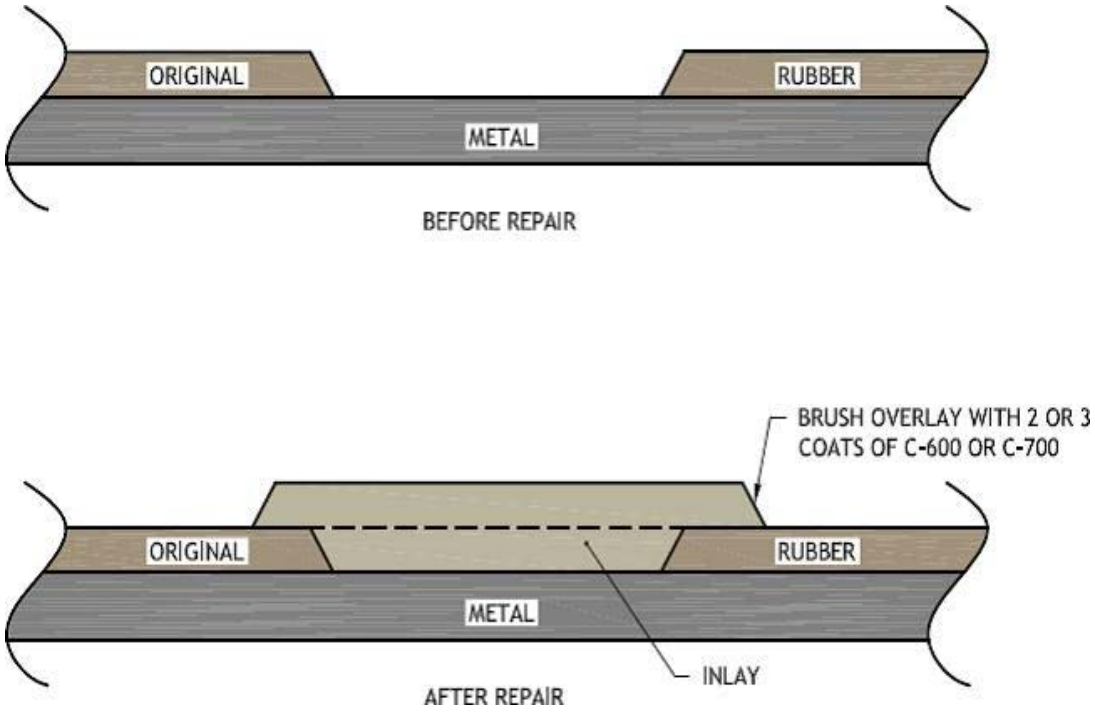


Fig. 11-4 Chemical cure repair

For assistance of repairs, please contact your Polycorp representative.

1. Inspection of Rubber Lining Before and After Curing

1.1 Inspection before curing

Upon completion of lining operations, the vessel, should be given a visual inspection with special attention to the following areas:

a) The lining should be checked against the blueprints to see that all areas conform to the details of the specification.

b) The lining should be examined for visual imperfections such as blisters, poor adhesion, loose joints, etc.

c) The lining should be examined for continuity and freedom from pinholes by passing a spark tester over the surface of the lining. The rubber surface must be free of moisture and foreign matter before the test is started. Spark leaks are apparent when the spark of the electrode becomes bright and is conducted directly to the defective area in a concentrated pattern. There will also be a diminishing of the corona discharge and an increase in the frequency of crackling noises as the spark is conducted to the defect point. See section 13 for further information on spark testing.

1.2 Inspection after curing

After completion of the curing operation, the rubber lining should be given a visual inspection with special attention to the following areas:

a) The lining should be examined for visual imperfections such as blisters, poor adhesion and loose joints, etc.

b) The lining should be examined for continuity and freedom from pinholes by passing a spark tester over the surface of the lining.

c) The lining should be checked with a Durometer in accordance with ASTM D-2240 to determine the surface hardness. Durometer readings should be made after the cured rubber has cooled and normalized to the temperature.

d) All dimensions, etc., specified on the blueprint should be given a final check before shipment.

2. Inspection of In-Service Rubber Lined Vessels

Periodic inspections of in-service rubber lined vessels should be completed. After vessels have been cleaned and allowed to dry, visual inspection and spark testing should be conducted.

Inspection guidelines:

a) The total surface of the lining should be spark tested.

b) The surface of the lining should be inspected for visual defects. These defects can be related to mechanical damages, blisters, adhesion failures or loose seams.

c) The rubber lining should be inspected for chemical attack. Special attention should be given to any swelling or softening that may be caused by organics or oils.

d) The rubber lining should be inspected for wear patterns that may have been caused by abrasion.

e) The defects that are found should be repaired by a qualified applicator.

INSPECTION REPORT

INSTALLED RUBBER LINING (PAGE 1 OF 4)

Applicator: _____ Location: _____

Contact: _____ Phone No: _____

Customer: _____ Type of Lining: _____

Roll No: _____ When Applied: _____

How long has lining been in service?

_____

Description of tank or equipment lined.

_____

_____

Complete service conditions, including concentrations and temperatures.

_____

_____

Description of the problem:

Adhesion: Is adhesion poor throughout all panels and laps? _____

Is poor adhesion isolated to specific panels? _____

Is blistering and disbondment present? _____

Is adhesion poor at metal interface? _____

Is primer disbonded from metal? _____

Other notations and comments _____

_____

INSPECTION REPORT

INSTALLED RUBBER LINING (PAGE 2 OF 4)

Blistering: Are blisters filled with water? _____

Are blisters dry and/or separated between coats of cements? _____

Are blisters between plies of the lining? _____ If so, describe

_____

Are blisters filled with expanded air after cure? _____

Are the blisters at heat sink? _____

Are the blisters at metal interface in weld areas? _____

Other notations and comments. _____

Cracking: What is the nature of the cracks? Location: _____

Depth: _____ Direction: _____ Width of Cracks: _____

Are cracks running parallel to laps and/or in corners or on brackets? _____

Was the tank allowed to stand empty? _____

Was the tank subject to thermal shock? _____

Other notations and comments: _____

_____

Swelling/Softening of Lining:

Are organic solvents present? _____

Is there an aromatic (sweet) odor present? _____

Is there a petroleum odor present? _____

Are defoamers being used in the process? _____

Is the problem in the vapor areas? _____ or liquid areas? _____

Other notations and comments _____

INSPECTION REPORT

INSTALLED RUBBER LINING (PAGE 3 OF 4)

Abrasion: If abrasion is a problem, describe in detail the wear areas and patterns

_____

_____

Surface sloughing and spalling:

Is the surface of the lining flaking? _____ Crumbling? _____ Softening? _____

Describe the surface _____

_____

Other notations and comments _____

_____

Mechanical abuse:

Is there cutting and tearing of the lining at point of impact? _____

Is the lining porous and/or degrading? _____

Is there loss of adhesion? _____

Is there cavitation cutting and spalling in high impact sections of the equipment?

_____

Other notations and comments _____

_____

INSPECTION REPORT

INSTALLED RUBBER LINING (PAGE 4 OF 4)

Flange failures:

Is the lining bulging and cracking at the knuckle radius of the flange?

_____

Has the lining on the flanges been over compressed? _____

What torque figures do they use? _____

What is the flange construction?

Lined full face? _____

Lined to bolt holes? _____

Gaskets? _____

Other notations and comments: _____

_____

Collect necessary samples of lining being inspected and store in sealed plastic bags for evaluation and testing.

_____ _____

Signed Date

Copies of all reports to:

Polycorp Ltd.
33 York Street
Elora, Ontario, Canada N0B 1S0

Section 13: Spark Testing

Spark Testing of Rubber Lined Vessels

Before and after the rubber lining is cured, it must be tested with a spark tester. The purpose of the test is to determine the presence of pinhole leaks, punctures, cuts, etc., that expose passages to the base metal. Refer to Practice ASTM D5162 or NACE Standard Practice SP0188 for general practices. Please note that a spark test is not complete without a full and thorough visual inspection of the entire lining completed at the same time as the spark test itself. Spark testing is not an absolute test, meaning that it is not 100% fail safe. Technique, visual inspection, equipment maintenance and rubber lining application experience are all essential in reducing errors, misinterpreting results and completing the spark test with meaningful results.

1. Test Equipment

1.1 High frequency AC spark testers are capable of producing sufficient voltages (a voltage range of 15,000 – 45,000) to insure the proper calibration for rubber lining inspection. There are several brand name pieces of equipment available on the markets which are all suitable. DC spark testers are also suitable for use however maximum voltage is restricted to 30,000 by the manufacturer. These units are also bulky and can be difficult to maneuver. These units should only be considered where AC units are not practical for use.

1.2 Probes with T shaped, L shaped or brush electrodes should be suitable for the size, geometry and type of lining being inspected. The T shaped spring loaded probe provides the most complete and accurate results and should be used where possible.

1.3 Steel calibration coupon 12” x 12” with a known leak. The coupon shall be lined with the same material and thickness of that material to be tested. The coupon shall be cured using the same method as the material to be tested.

2. Leak Verification

2.1 The material on the coupon shall have a leak to the metal substrate made by puncturing the material with a 22 gauge hypodermic needle or comparable piercing equipment or tool. Multiple punctures should be considered at differing angles.

2.2 Using the same probe that will be used for testing, pass over the surface of the test coupon in a constant uninterrupted manner until the fabricated leak paths are detected. Tester should be verified if equipment (probe) is changed and before and after testing.

2.3 Keeping the electrode in light contact with the lining surface, move the probe over the test area in one slow stroke at a rate of approximately 12 inches/second. Overlap passes to ensure 100% coverage. The stroke rate (inches per second) should be recorded.

3. Verification of Output Voltage by Using a Mechanical Type of Peak Reading Voltmeter

3.1 Adjust voltmeter to the voltage required for the type of lining being tested.

3.2 Polycorp recommends the use of 45,000 volts for Polycorp soft natural rubber linings (such as those used in HCl equipment) and a minimum of 15,000 volts for all other materials. In general 30,000 volts is considered safe for linings however, consideration to Neoprene and graphite filled linings should be made and reduced. 15,000 to 30,000 volt tests should be completed to ensure linings are not damaged. It is the responsibility of the person performing the spark test to complete sample test coupons on linings prior to the actual test to ensure damage does not occur.

3.3 Using the same power source, cable length and probe make a proper spark tester to meter connection. Refer to manufacturers specifications where necessary.

3.4 Output voltage is verified when a continuous spark is obtained across the gap on the voltmeter and should be recorded.

4. Test Procedure

4.1 No moisture should be present at the time of testing and all surfaces must be free of grit, dirt or foreign matter. Moisture can skew the results and “false positive” readings can occur.

4.2 Low lighting will assist in identifying a leak but exercise caution to ensure 100% coverage of the test area. A blue corona, continuous in nature, around the probe is normal and does not indicate a leak.

4.3 Using the same stroke rate and technique for leak verification (section 2) move the electrode over the entire test area. If evidence (a bright blue spark in conjunction with a change in pitch of the spark noise and/or indicated by an audio signal on some testers) suggests a lining defect. Move the electrode over the area in alternate

directions to verify and locate the defect. To prevent a dialectical breakdown of the lining, in particular for soft natural rubber, do not hold the electrode in one position for any longer than a few seconds. Multiple passes over a suspect area will not cause any lining damage.

4.4 Because a spark tester will only detect and/or verify a leak in the lining material, an enhanced visual inspection (with the aid of proper lighting) of the leak should be performed to detect other conditions (enlarged opening, cracking, discoloration etc.)

5. Information about Spark Testing

5.1 Spark testers may lose spark intensity after 15 to 30 minutes of use in which case they should be turned off and allowed to cool. Before proceeding with the test the unit must be verified on a test coupon per section 2.

5.2 AC voltage definition should be established. Spark test manufacturers refer to peak voltage and AC voltmeters use RMS, which means effective volts.

RMS Volts = 0.707 Peak Volts

5.3 A continuous dark blue or purple spark indicates a leak free lining. If a leak is present, a white or light blue spark will form and the sound of the arc/spark will change slightly. Specks of dust, depressions and other foreign matter will change the color of a spark. Dampness will result in brightened sparks.

5.4 When establishing spark length based on lining thickness it is critical that the spark length is twice the thickness of the lining. i.e. a ¼" thick lining requires a ½" length spark to reach through the lining. Reduced thickness linings (such as 3/16" or 1/8") can be tested with shorter spark lengths but must continue to be at least twice the lining thickness. Longer spark lengths are OK.

6. Caution:

The spark test will not find any leak where the path to the steel is longer than the spark length. A visual inspection of overlaps and the lining panels is critical to assure a leak free lining.

7. Contact Polycorp for more information about spark testers, test methods and obtained results.

Section 14: Care Maintenance and Storage of Rubber Lined Vessels

1. Maintenance and Care of Rubber Lined Equipment

1.1 To maximize the benefit from rubber lined equipment, the following maintenance and care items are recommended.

- Inspect rubber lined vessels on a regular basis. Minor repairs should be made promptly by qualified personnel.
- Protect rubber lining from exposure to sunlight and the elements, preferably by storing indoors in a cool, dark environment.
- Protect lining from exposure to direct flame and hot metal. All rubber linings will support combustion with the exception of Neoprene.
- Do not weld rubber lined equipment. Welding will damage the rubber.
- Protect hard and semi-hard linings from severe mechanical or thermal shock.
- Avoid physical damage to the rubber lining. Do not allow metal, tools or other objects to be dropped on the rubber lined surface.
- Do not alternate from one service to another without rubber supplier's approval.
- Wash out tanks only when necessary.
- Keep tanks filled if possible with regular commodity when storing. If this cannot be done recommendations should be received from the supplier.

1.2 Avoid subjecting rubber lining to solvent-type chemicals such as:

- Petroleum distillates such as gasoline, kerosene and oils.
- Coal tar derivatives such as benzol and toluol.
- Chlorinated hydrocarbons such as monochlorbenzol and carbon tetrachloride.

1.3 Caution erection crews against damage to exposed rubber. Rubber linings are not structural materials and can be damaged by cables, slings, sharp instruments, impact and heat.

1.4 Avoid excessive bolting pressure on rubber covered flanges. 25% compression of soft rubber gaskets is generally satisfactory.

1.5 Maintain adequate air circulation around outside of vessels that are operating at higher than ambient temperatures. Insulation on outside of tanks will not allow dissipation of heat.

2. Storage of Rubber Lined Vessels

The following are general storage guidelines only. Please contact your Polycorp representative for more specific recommendations.

2.1 Rubber lined vessels should be stored, between delivery and use, away from sunlight, ozone, heat and seasonal weathering.

2.2 Vessels lined with flexible linings may be stored outdoors, providing the vessels are protected with suitable protective poly covers or tarpaulins and are not subjected to extreme or sudden temperature changes. Do not store tanks close to ozone producing sources.

2.3 Rubber lined tanks should also be protected by painting the surface with a silicone emulsion which helps to protect rubber products against the effects of ozone, sunlight, weather and oxidation. Rubber lined vessels can also be protected by maintaining a constant nitrogen purge in the vessel.

2.4 Hard and semi-hard rubber lined equipment must be protected and stored preferably indoors and should not be subject to cold climatic conditions. Hard rubber becomes brittle when exposed to cold temperatures and there is a danger that thermal stresses may introduce cracking. Tanks that can be stored inside should have outlets, etc., covered and stored away from steam pipes or other high temperature sources.

2.5 Rubber lined vessels that need to be stored for longer periods may be protected by filling with regular commodity or at least partially filling with a 5% to10% solution of sulfuric acid, sodium carbonate or salt mixture. This will help to keep the lining flexible and keep the air/ozone from deteriorating the lining surface. The liquid contained within the tank should not be permitted to freeze.

2.6 Rubber lined vessels that have been stored should be closely inspected before being put into service.

GENERAL SAFETY PRECAUTIONS

Rubber lining activity must comply with all local, state, provincial and/or federal regulations. Always consult the appropriate authorities for specific requirements.

Always refer to product Material Safety Data Sheets (MSDS's) for specific hazard information and appropriate Personal Protective Equipment (PPE).

Solvents and cements used in application of rubber linings may be flammable or combustible and may have specific health hazards. Refer to appropriate MSDS's for precautions.

Rubber lining of tanks or vessels may involve entry into confined spaces. Always follow appropriate procedures that are in compliance with local, state, provincial and/or federal regulations.

WARNING

Rubber is a combustible material. Once ignited, rubber lining may burn rapidly and give off toxic fumes. To avoid serious injury or property damage, caution should be exercised to avoid contact between the rubber and any flames, sparks or other sources of ignition. Follow MSDS recommendations, industry safety standards and good fire prevention techniques at all times.