WASTE MANAGEMENT

CWM CHEMICAL SERVICES, LLC
1550 Balmer Road
Model City, NY 14107
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May 29, 2013

Mr. Dennis Weiss, P.E.
New York State Department of
Environmental Conservation
Region 9
270 Michigan Avenue
Buffalo, New York 14203-2999

Re: Revised Tank System Design and Assessment Report for AWTS Arsenic Removal Tanks T-3010 A/B/C/D

Dear Mr. Weiss:

On April 8, 2013, CWM Chemical Services, LLC (CWM) submitted a design assessment report for a proposed Aqueous Wastewater Treatment System (AWTS) arsenic removal system, prepared by EnSol, Inc., as required by 6 NYCRR 373-2.10(c)(1). In response to elevated levels of arsenic in the site generated leachate, a new system of cartridge filters and adsorption tanks has been designed for addition to the AWTS treatment train to reduce the levels of arsenic in the treated effluent.

The arsenic removal system includes a series of four 4-foot diameter by 5-foot high, 470 gallon, coated carbon steel tanks (T-3010 A/B/C/D), four pre-filters, arsenic removal media, and miscellaneous equipment and attachments. The arsenic removal system will be installed in the Water Treatment Building located east of the AWTS Building. The arsenic removal system will be installed at the current location of the Multi-Media Filtration System consisting of tanks T-3004 and T-3005. Tanks T-3004 and T-3005 are currently in the process of being closed.

NYSDEC provided comments for this submittal in a letter dated April 19, 2013. Attached please find CWM's responses to each of the NYSDEC comments. Also attached is an updated design assessment report for your review and approval which addresses the NYSDEC comments and replaces the April 8, 2013 report in its entirety.

CWM is submitting the tanks T-3010 A/B/C/D arsenic removal system revised design assessment report to obtain NYSDEC technical approval of this tank system. After this approval is received, CWM intends to submit a permit modification request to add these tanks to the 6NYCRR Part 373 Permit #9-2934-00022/00097.

Please call Mr. Jonathan Rizzo at (716) 286-0354 or myself at (716) 286-0246 if you have any questions or comments.

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

May 29, 2013
Mr. Dennis Weiss, P.E.
NYSDEC
Re: Revised Tank System Design and Assessment Report for AWTS Arsenic Removal Tanks T-3010 A/B/C/D

Sincerely,
CWM CHEMICAL SERVICES, LLC

Jill A. Banaszak
Technical Manager
Model City Facility

JPR/JAB/jpr

cc:

B. Rostami	- NYSDEC/Region 9
On-site Monitors	- NYSDEC/Model City, NY
M. Cruden	- NYSDEC/Albany, NY
M. Mortefolio	- NYSDEC/Albany, NY
A. Park	- USEPA/Region II
J. Devald	- NCHD/Lockport, NY
M. Mahar	- CWM/Model City, NY
J. Rizzo	- CWM/Model City, NY
T. Fogarty	- CWM/Model City, NY
S. Rydzyk	- CWM/Model City, NY
EMD Subject File	
Q & A	

CWM Chemical Services, LLC.
AWTS-Arsenic Removal System
Design Assessment Report
May 2013

Response to NYSDEC Comments dated April 19, 2013

General Comment:

NYSDEC Comment:

"Based on the review of the above definitions, the Department has determined that the cartridge filters are a component of the new tanks T3020 A/B/C/D tank system. The specific function of this component is to filter micro particles so that the Siemens Filter tank is able to function properly.

It (cartridge filters) still requires secondary containment, will need to be inspected for leaks, etc. The tank system is part of a Wastewater Treatment Unit aka the AWTS. Therefore, the report must be revised to indicate these units as components of the Arsenic Removal Tanks T3010 A/B/C/D."

CWM Response:
Section 1.2 of the Design Assessment Report has been revised to incorporate the cartridge filters as components to the Arsenic Removal Tanks. The cartridge filters are designed to be located within the secondary containment of the Water Treatment Building and will be inspected daily in accordance with CWM site inspections. Upon technical approval of the Design Assessment Report, CWM will submit a Permit Modification Request which will include revisions to Attachment F (Preparedness and Prevention) to include inspection of the Tanks T-3010 A/B/C/D and components.

Specific Comments:

NYSDEC Comment:

1. <u>*Section 2.6, Page 2-2*</u> - ***Process Description, Piping and Pumping System***

   "This section indicates that a combination of Flexible Hoses and HDPE piping will be used to connect the proposed tanks to one another and to the existing tank system. Although manufacturer's information on a variety of Flexible Hoses and HDPE piping is provided in Appendix C of the report, it is not clear what design information is applicable to the particular piping being proposed for this tank system. Therefore, the following design information must be provided for the particular Flexible Hoses and HDPE piping and other ancillary equipment (e.g., valves, connectors, etc.) to be used:

   - *An engineering evaluation of the proposed system's maximum operating pressure in comparison to the manufacturer's maximum pressure rating for the Flexible Hoses, HDPE piping and other ancillary equipment, as required by 6 NYCRR 373-2.10(c)(1)(i); and*

Response to NYSDEC Comments dated April 19, 2013

- *Design information and drawings with respect to the hose/piping supports, as required by 6 NYCRR 373-2.10(c)(5)."*

CWM Response:
An evaluation of the flexible hoses, HDPE piping and other ancillary equipment has been completed by CWM's engineering design consultant. Section 2.6 of the Design Assessment Report has been revised to incorporate this evaluation. Additionally, typical design details for the hose and piping supports have been added to report drawings.

NYSDEC Comment:

2. *Section 2.6, Page 2-3* - ***Process Description, Piping and Pumping System***

"It is stated on this page that the pressure on the cartridge filters will be relieved using a "Chicago Fitting" on the unit's piping to facilitate filter removal. Additional information must be provided as to how the liquid hazardous waste that is likely to be released during this de-pressurization will be managed and contained. Release to the secondary containment is not an appropriate method of containing intentional releases from a tank system, since the regulatory purpose of secondary containment is intended to be limited to unintentional tank system releases (e.g., releases from leaks, overflows and ruptures).

It also states that the removed cartridges will be removed for cleaning or replacement. Additional information must be provided regarding the cleaning of these cartridges with respect to containment of spent cleaning solutions and residues. For reasons stated above, secondary containment cannot be used for containing these solutions/residues. Also, with respect to cartridges to be discarded, additional information on their disposal should be provided which indicates compliance with hazardous waste regulations in light of the fact that they will be contaminated with listed hazardous wastes.

With respect to the adsorption tanks, it is stated here that the pressure will be relieved using a "Chicago Fitting" on the HDPE piping and the tank drained through a fitting at the tank's base to facilitate replacement. Additional information must be provided as to how the liquid hazardous waste that will be released during de-pressurization and draining will be managed and contained. Again, for reasons stated above, secondary containment is not appropriate such containment.

Response to NYSDEC Comments dated April 19, 2013

It is stated here that the adsorption tank's manufacturer (i.e., Siemens) will be responsible for the proper management of the tank(s) with the spent arsenic contaminated media. It is also stated that the Siemens adsorption tanks are approved as transportable hazardous waste containers by the US Department of Transportation and that Siemens is an approved carrier for transportation of hazardous waste. However, it should also state that each such containerized waste shipment will be properly manifested as hazardous waste.

With regard to both the periodic change-out of cartridge filters and the periodic replacement of adsorption tanks, CWM should develop a detailed step-by-step procedure for each, including the additional information requested above, and provide them for Department review. These procedures should be appropriately submitted for Department approval as additions to the AWTS Operations Manual."

CWM Response:
Section 2.6 of the Design Assessment Report has been revised to include a description as to how the cartridge filters and adsorption tanks will be de-pressurized and drained.

As stated in the report, pressure within the cartridge filters will be relieved by connecting a temporary drain hose to a Chicago fitting in the stainless steel piping between the two filters and draining the liquid within the cartridges to a portable container (i.e. 5 gallon container) and transferring the liquid to the AWTS for processing. The filter housing will then be opened and the spent cartridges removed and either cleaned or properly disposed of, including waste tracking, by CWM as hazardous waste (macroencapsulation) in accordance with applicable regulations and Site Wide Permit requirements. Cleaning of the cartridge filters will be accomplished by placing the cartridges in a container, transporting them to the adjacent A/T Building, and rinsing the cartridges above the Filter Press Sump located adjacent to tank T-910. The Filter Press Sump is permitted as a tank and as such has secondary containment, which is inspected daily. The rinse water and small particulates will be pumped to the alkalization tanks for processing.

De-pressurization of the adsorption tanks will be accomplished by connecting a temporary drain hose to a Chicago fitting in the HDPE pipe between the filters and adsorption tanks and draining the liquid to a portable container and transferring the liquid to the AWTS for processing. Once the pressure is relieved from the adsorption tanks, the tank will be removed from the Water Treatment Building and transported to the either the A/T Building or AWTS Front Unloading Containment Area. The adsorption tanks will be fully drained using the 2 inch drain valve at the bottom of the tank which will be connected to a vacuum truck located within the containment area. The liquid would be processed through the AWTS.

Response to NYSDEC Comments dated April 19, 2013

As an alternative, A/T personnel may transfer the liquids from the adsorption tanks and piping to the effluent holding tanks T-58 or T-125 through the outlet piping using the Chicago fitting connection and compressed air.

The Design Assessment Report has also been revised to state that each containerized waste shipment by Siemens (i.e., the tanks with spent media) will be properly manifested as hazardous waste.

CWM will revise the AWTS Operations & Maintenance (O&M) Manual to include the arsenic treatment system. The revision will include a discussion of the process operations and a detailed step-by-step procedure for periodic change-out of the cartridge filters and the periodic replacement of the adsorption tanks, including the information described above. The revision to the AWTS O&M Manual will be included in the Permit Modification Request upon approval of the Design Assessment Report.

NYSDEC Comment:

3. *Section 2.7, Page 2-3* - ***Overpressure Protection***

   This section states that the maximum working pressure of the adsorption tanks is 100 psi at 150 degrees Fahrenheit, and that they are not expected to operate above 50 psi at 110 degrees. This section should indicate the maximum operating pressure for the entire new system in relationship to maximum pressure rating provided by the manufacturer of each system component (e.g., HDPE piping, flexible hoses, tanks, valves, etc.). This section should also describe how operational pressures will be regulated by pumps and other devices within the system.

   The new tank system is proposed to operate at above ambient pressure, and as such, is a closed system with no overfill prevention controls. Therefore, to control over-pressurization of this closed system, this section states that the system will be equipped with two (2) pressure gauges that will be monitored through periodic inspections by CWM personnel. The Department considers this system of over-pressure protection to be inadequate in that it will not prevent an over-pressurization and potential rupture of tank system components (i.e., piping, hoses, tanks, etc.) caused by a malfunction of normal pressure regulation equipment at most times when the system is running unattended. Therefore, the system must include a high pressure sensor and alarm as well as an automatic cutoff linked to the alarm and appropriate feed pumps, to insure adequate overpressure protection. The sensor should be set at a pressure above that incurred during normal operation, but below the manufacturer's recommended pressure for system components. In

addition, tanks should be outfitted with pressure relief valves set to act as a backup in case of a failure in the electronic overpressure protection system.

CWM Response:
Section 2.6 of the Design Assessment Report has been revised to incorporate the maximum working pressures of the system components. As noted in Section 2.6, an evaluation of the proposed system's maximum operating pressure within the tanks in comparison to the maximum pressure rating for the ancillary equipment and components of the system was performed. As stated, the anticipated maximum operating pressure at any point in the system will not exceed the pressure rating of any individual component of the system. Considering the inlet pressure of the new arsenic removal system will be approximated by the outlet pressure from the carbon adsorber tanks T-3007/T-3008, the system pressure cannot exceed a maximum of 75 psi, due to the presence of pressure relief rupture disks located in the T-3007/T-3008 piping. As shown on Drawing C-210 in Appendix A of the Design Assessment Report, there is a rupture disk on each of the carbon tank outlet pipes that is rated at a burst pressure of 75 psig. The pressure relief devices that are intended to prevent over pressurization of the carbon tanks will also act to prevent over pressurization of the arsenic removal system tanks, as the feed pipe pressure (developed by the carbon feed pumps P-3003 A/B) will not exceed that of the rupture disk. As a result, the new arsenic removal system operating pressure is not expected to exceed 75 psi, well below the maximum system design pressure. Product information for the 3-inch SAF-T-GRAF rupture disk is included in Appendix C of the Design Assessment Report.

Additionally, in the event of a leak caused by rupture of the pressure relief device, the W/T Building is equipped with floor leak detection sensors that will alarm AWTS personnel of this condition and automatically shut off the carbon adsorber tanks' feed pumps P-3003 A/B. Additional high pressure sensors and alarms are not necessary.

NYSDEC Comment:

4. *<u>Section 2.9, Page 2-4</u>* - ***Secondary Containment and Leak Detection***

   This section indicates that the existing secondary containment provides over 100 percent (100%) containment for the capacity of the two (2) carbon absorber tanks (a combined 15,200 gallons), and implies that it is, therefore, more than adequate for the tanks in the new system which have a combined capacity of approximately 1965 gallons. However, 6 NYCRR 373-2.10(d)(4)(i)('a') also requires the secondary containment to have a capacity greater than all interconnected tanks, and it is unclear from the information provided in the report as to whether any of the tanks in the new system are interconnected with the carbon absorber tanks. If they are

Response to NYSDEC Comments dated April 19, 2013

interconnected in a manner that would cause both carbon absorber tanks and one (1) or more of the new tanks to empty into the secondary containment in the event of a pipe or tank leak or rupture, the total volume might exceed the capacity of the present secondary containment. Therefore, the report should include an evaluation of the piping connections between the carbon absorber tanks and the new tank system to determine if such interconnections exist (Note: A manual valve in the piping system between tanks is not considered by the Department as adequate protection against an interconnection since it is susceptible to operator error). If it is determined that such an interconnection does not exist, the report should contain a drawing detail of the actual piping between existing and new tanks and a description explaining why the tanks are not interconnected in the manner described above. If it is determined that such an interconnection does exist, the report should either explain why the existing secondary containment still has adequate capacity for all interconnected tanks and components, or indicate the installation of appropriate equipment/devices to interrupt the interconnection, or provide plans for increasing the secondary containment capacity for all interconnected tanks.

From the Department's review of Sheet 1 in the report, it appears that the new tank system will be in close proximity to the building's new overhead doors and wall. Based on the fact that the new system will be operated under pressure, it would seem that a leak in a pipe, hose or tank could spray on to the door or wall. It is uncertain based on the information provided in the report whether such a release would run down the door or wall and into the secondary containment or outside of the building. A sectional detail of the door, wall and steel secondary containment should be provided to illustrate that such a leak would be contained, or if the existing design will not prevent such a leak from migrating outside the building, design modifications should be provided to insure containment.

CWM Response:
After evaluating the piping connections between the carbon adsorbers and the new arsenic treatment tank system, CWM has determined that there is an interconnection between the tank systems, but in the event of a pipe or tank leak, it would be unlikely for the volume released to exceed the total containment volume of the secondary containment since a substantial amount of each tanks volume, carbon and arsenic adsorbers, contain solid media. The permitted secondary containment volume is based upon all the tanks containing 100 percent liquid. Nonetheless, in order to eliminate the interconnection, the piping drawing (Sheet 1 of Appendix A) has been revised to include a vertical pipe loop, above the highest point of the carbon tanks, and an anti-siphon/anti-vacuum device installed at that high point in the pipe to prevent a siphoning effect in the event of a tank or pipe leak. Section 2.9 of the Design Assessment Report has been revised to discuss the measures to mitigate tank interconnection

Response to NYSDEC Comments dated April 19, 2013

As an added measure to prevent the possibility of a leak from the connection of the flexible hose to the rigid pipe or tank, located near the north wall of the W/T Building, from potentially contacting the proposed overhead doors or building sidewall, these connection points have be re-located a minimum of 3-feet inward from the north wall, as shown on Sheet 1 in Appendix A. With respect to the possibility of the tanks leaking and spraying onto the building walls or new overhead doors, no additional design revisions have been made. The adsorber tanks have been designed, constructed, tested, and certified by Siemens in accordance with ASME code and applicable tank standards. The tanks will be inspected and hydrostatically tested prior to each use to verify the integrity of each tank.

NYSDEC Comment:

5. *Section 3.1, Page 3-1* - ***Design and Record Information***

It is stated here that the Design Engineer did not perform compatibility studies of the tank system materials and the material (i.e., hazardous waste) to be managed by the system, however, that a review of the system materials indicated adequate compatibility with the waste. While the Department would agree that a detailed compatibility study is not necessary in this case, simply stating that the review of the materials indicated adequate compatibility is considered by the Department to be insufficient to demonstrate compatibility. At a minimum, the report should contain a comparison of manufacturers chemical resistance information for each construction material (e.g., tank interior coatings, stainless steel, HDPE piping, flexible hose and other such ancillary equipment) and the known chemical composition of the wastewater to be managed in the new tank system, to adequately demonstrate compatibility as required by 6 NYCRR 373-2.10(c)(1).

CWM Response:

The Design Assessment Report has been revised to include manufacturers chemical resistance information for each of the construction materials intended to be used for this tank installation in Appendix C. In addition, the report has been revised to include typical chemical analyses of the wastewater to be managed by the tank system in Appendix D. Section 3.1 of the report has been revised to include a discussion of the evaluation performed by the Design Consultant and their findings that no issues or areas of concern were found and it was determined that the materials of construction were compatible with the wastewater to be handled by the system.

NYSDEC Comment:

6. *Section 3.2, Page 3-1* - ***Summary and Conclusions***

Response to NYSDEC Comments dated April 19, 2013

This section states that Siemens, the adsorption tank manufacturer, will pre-certify the structural integrity and tightness. However, additional information must be provided with regard to verifying the installed system's integrity prior to use. An appropriate procedure for tightness testing of the new tanks and their ancillary equipment or other components must be provided that will confirm the installed system's integrity at its maximum operating pressure plus an amount of additional pressure to provide for an appropriate factor of safety, as required by 6 NYCRR 373-2.10(c)(4).

The report states that the initial installation of the new system will be inspected by an independent, qualified, installation Inspector or registered New York Professional Engineer prior to placing the system in use, as required by 6 NYCRR 373-2.10(c)(2). During regular tank change out installations, the report states that CWM personnel will inspect the system components prior to startup to insure they are installed properly and will visually inspect the system components to insure they are free of leaks. The Department has determined to treat such tank or other component change outs as "in-kind" replacements.

Although the Department has made this determination, during such change outs the compliance with the substantive requirements of 6 NYCRR 373-2.10(c)(2) and 6 NYCRR 373-2.10(c)(7) (i.e., installation certification by a qualified Inspector or Professional Engineer, and documentation of such) and compliance with 6 NYCRR 373-2.10(c)(4) (i.e., post-installation tightness testing) must be met. A qualified Inspector may be someone who is familiar with the equipment such as a Manufacturer's Qualified Installer.

Additionally, the change-out procedure for the adsorption tanks required by Comment No. 2 above, must indicate that the tightness testing required above for the initial installation will be repeated after each tank replacement per 6 NYCRR 373-2.10(c)(4), and that the system will be re-inspected by a qualified Inspector or Professional Engineer after each such replacement per 6 NYCRR 373-2.10(c)(2) and 6 NYCRR 373-2.10(c)(7).

CWM Response:
Section 3.2 of the Design Assessment Report has been revised to include additional procedures for tightness testing of the new tanks and their ancillary equipment or other components that will confirm the installed system's integrity.

Response to NYSDEC Comments dated April 19, 2013

The Design Assessment Report has also been revised to include that all in-kind replacement tanks provided by Siemens, subsequent to initial system installation as a result of tank change out activities, will be pre-certified by Siemens as to their structural integrity, adequate condition, and system tightness. All other system components and ancillary equipment will remain in place from the initial installation and will not be changed out on a regular basis. During regular tank change out installations CWM personnel will inspect the system components prior to startup to insure they are installed properly. In addition, in accordance with 6 NYCRR 373-2.10(C)(4) (i.e., post installation tightness testing) all tanks, along with the associated flexible hoses and their connections, involved in the change out will be re-tested for tightness following the procedure used during initial tank installation. To comply with the substantive requirements of 6 NYCRR 373-2.10(c)(2) and 6 NYCRR 373-2.10(c)(7) (i.e., installation certification by a qualified Inspector or Professional Engineer, and documentation of such), CWM Engineering or AWTS Supervisory personnel will be trained by Siemens as Manufacturer's Qualified Installers for the tanks. Documentation of each tank change out and associated tightness testing and installation inspections by the designated CWM Manufacturer's Qualified Installer will be maintained on site for Department review.

NYSDEC Comment:

7. *Figures*

   In addition to the overhead depiction of the new system on Sheet 1, additional vertical depictions of all four (4) sides of the new system should be provided to indicate tank support structures and piping locations.

CWM Response:

The Design Assessment Report has been revised to include additional vertical depictions of the tank system including tank support structures and piping locations. Drawing Sheet 2 has been added to Appendix A to provide additional detail. Revisions to Sheet 1 in Appendix A have been made to indicate the location of various pipe supports to be installed, including the addition of Note 2.

Tank System Design and Assessment Report for AWTS Arsenic Removal Tanks T-3010 A/B/C/D

CWM Chemical Services, LLC
Model City, New York

April 2013
(Revised May 2013)

Prepared by

EnSol, Inc.
Environmental Solutions

EnSol, Inc.
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Transmitted Via Hand Delivery

May 24, 2013

Mr. Stephen Rydzyk
Engineer
CWM Chemical Services, LLC
1550 Balmer Road, P.O. Box 200
Model City, New York 14107

Re: Tank System Design and Assessment Report for Tanks T-3010A/B/C/D (Revised)
Model City, New York
EnSol Project #: 13-7009-2

Dear Mr. Rydzyk:

Enclosed please find two copies of the revised Final Report titled, *Tank System Design and Assessment Report for AWTS Arsenic Removal Tanks* dated April 2013 (Revised May 2013), as prepared by EnSol, Inc. (EnSol). This report is provided to present applicable design and construction information for the proposed Arsenic Removal System, as described herein, to allow for the removal of elevated levels of arsenic from the treated effluent of the AWTS. The revised report incorporates revisions to the original report to address review comments by the NYSDEC as presented in their letter to CWM dated April 19, 2013.

The report includes an assessment and review of the structural integrity of the proposed tank system and compatibility of the materials of construction with the materials expected to be handled. This assessment is intended to satisfy the State and Federal Regulations listed under 6 NYCRR Part 373-2.10(c), and 40 CFR 264.192, respectively, with regards to design and installation of new tank systems or components.

The intent of this report is to provide sufficient information to the New York State Department of Environmental Conservation (NYSDEC) for review of the proposed system design and usage, and for subsequent approval to construct and operate the tank system.

If you have any questions or require additional information, please contact me at (716) 285-3920, ext. 212.

Sincerely,

ENSOL, INC.

Brian D. Shiah

Brian D. Shiah, P.E.
President

Enclosures

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Tank System Design and Assessment Report for AWTS Arsenic Removal Tanks T-3010 A/B/C/D

CWM Chemical Services, LLC
Model City, New York

April 2013
(Revised May 2013)

Prepared by
EnSol, Inc.
661 Main Street
Niagara Falls, New York 14301

Table of Contents

Figures

Appendices

- Flange Gaskets (Durlon)
- Roller Cut Sheet (OMC)
- Rupture Disks (BS & B)

D. Carbon Effluent Analytical Laboratory Test Results

1. Introduction

1.1 General Site Information

CWM Chemical Services, LLC (CWM) owns and operates a commercial hazardous waste treatment, storage, and disposal facility (TSDF) in Model City, Niagara County, New York. This TSDF began operating in 1972 as ChemTrol Pollution Services, Inc. Due to corporate acquisitions and name changes, CWM, a subsidiary of Waste Management, Inc., is the present owner and operator of the facility. Waste Management, Inc. is based in Houston, Texas.

The facility is located on Balmer Road in Model City, New York, approximately 1.9 miles east of New York State Route 18 (Creek Road), and occupies land in the towns of Lewiston and Porter. A Regional Location Map and Facility Location Detail are presented in Figures 1 and 2, respectively. All existing waste management units on the site are located within the Town of Porter. The contiguous property along Balmer Road is also the location of offices for the Administrative, Sales and Marketing, Data Processing, Accounting, Environmental, and Engineering Departments.

The CWM Model City facility is permitted as a TSDF under the Resource Conservation and Recovery Act (RCRA). Numerous units at the site are used to store, treat, and dispose of a variety of liquid and solid organic and inorganic hazardous wastes. Storage, treatment, and disposal capabilities include an Aqueous Wastewater Treatment System (AWTS) utilizing chemical, physical, and biological treatment processes from which treated wastewater is discharged to the Niagara River in accordance with the facility's State Pollutant Discharge Elimination System (SPDES) Permit; secure landfilling of approved waste solids and semisolids, including polychlorinated biphenyls (PCBs); waste stabilization; container and tank storage; transformer decommissioning; and PCB treatment and storage. Figure 3 presents a Facility Layout Plan.

1.2 Project Purpose and Objective

The purpose of this report is to present applicable design and construction information for the proposed AWTS Arsenic Removal Tank System, and to document the results of an assessment conducted by EnSol, Inc. (EnSol) for this system. In response to elevated levels of arsenic in the site generated leachate a new system of cartridge filters and adsorption tanks has been designed for addition to the AWTS treatment train to reduce the levels of arsenic in the treated effluent. A pilot study was performed by Siemens Industry, Inc. (Siemens) to determine the effectiveness of this treatment system from which the appropriate sized cartridge filters and tanks were subsequently selected. As defined in 6 NYCRR 370.2 the cartridge filters are considered a component of the new tank system. The specific function of this component is to filter micro particles so that the Siemens adsorption tanks are able to function properly. It is intended that this report be used by CWM to aid in obtaining an approval from the New York State Department of Environmental Conservation (NYSDEC) as per 6 NYCRR 373-2.10(c) to install the new tank system including tanks, ancillary equipment and components, and to operate the tank system for the purpose stated above.

The objective of the assessment is to satisfy the applicable State and Federal Regulations for the installation of new tank systems as required by CWM's Sitewide Part 373 Permit #9-2934-020022/00097. As required by 6 NYCRR 373-2.10(c)(1), the owner or operator of a new tank system must obtain and submit to the NYSDEC a written assessment attesting that the tank system has sufficient structural integrity and is acceptable for storing hazardous waste.

The following information is included in this report for the proposed tank system: location, configuration, design parameters, operating procedures, materials of construction, provisions for secondary containment and leak detection, and the results of EnSol's assessment.

1.3 Tank Inspection/Assessment Requirements and Guidelines

An assessment of the subject tank system is required by State and Federal Regulations listed under 6 NYCRR 373-2.10(c) and 40 CFR 264.192, respectively, pertaining to Hazardous Waste Management Facilities. These regulations identify the assessment requirements to be met and associated activities to be performed related to the design and installation of new tank systems or components. The assessment procedure also requires an evaluation of the system design, as it pertains to the containment and detection of releases, in accordance with State and Federal Regulations listed under 6 NYCRR 373-2.10(d) and 40 CFR 264.193, respectively. Additional site-specific permit requirements may also be developed by the regulatory agencies, such as the CWM Tank and Sump Assessment Schedule included in CWM's Sitewide Permit.

In addition to general regulations and/or site-specific permit requirements, there are several recommended or applicable guidance documents pertaining to tank inspections, assessments, and design. EnSol personnel have used the primary guidance documents referenced below to conduct previous site inspections, assessments, and designs for tank systems, and to aid in the design and assessment contained herein.

i. *Guide for Inspection of Refinery Equipment, Chapter XIII, Atmospheric and Low Pressure Storage Tanks*, American Petroleum Institute (API) publication, 4th edition, 1991.

ii. *Tank Inspection, Repair, Alteration, and Reconstruction*, API Standard 653, 3rd Edition, December 2001.

iii. *Requirements for Tank and Container Storage*, NYSDEC, Technical and Administrative Guidance Memorandum No. 3019, April 23, 1991.

iv. *Concrete Secondary Containment for Tank and Container Storage*, NYSDEC, Technical and Administrative Guidance Memorandum No. 3021, March 11, 1991.

v. *Chemical Plant and Petroleum Refinery Piping*, American Society of Mechanical Engineers (ASME) Standard B31.3-1990

2. Tank Location and Description

2.1 Location

The adsorption tanks and cartridge filters are to be located within the Water Treatment (W/T) building where the current Multi-Media Filtration System (i.e. sand filters) is located. The out of service sand filter tanks are being closed and removed from the building along with all their piping and appurtenances. A new set of overhead doors will be installed on the north side of the building and a new platform support system will be erected within the building to accommodate the tanks and cartridge filters. The location of the Water Treatment Building is shown on the Figure 3, and a proposed internal layout of the building is shown on Sheet 1 of the design drawings by EnSol included in Appendix A.

2.2 Dimensions and Capacity

The four adsorption tanks will each be single chamber, cylindrical pressure vessels rated at 100 psi, with a dished bottom and roof, with exterior dimensions of 4 feet - 0 inches diameter x 5 feet - 0 inches high with an over all height of 8 feet. The design capacity of each tank is 470 gallons. This is the total volume of both the arsenic removal media and water. The tanks are the property of Siemens and will be leased for use in this system. The four pre-filters will be cartridge filters measuring 37 inches high with a diameter of 13 inches. The filter cartridge vessels are manufactured by Harmsco and have a pressure rating of 150 psi.

2.3 Structural Support and Foundation

Each tank is supported by four legs mounted to a skid frame which is used to lift the tanks by fork truck. The tanks will be placed on, and supported by, a structural steel platform and roller tray which will facilitate the changing of the tanks. Within the W/T building, a 12 feet wide x 14 feet 6 inch long structured platform will be erected in the location currently occupied by the sand filter tanks. The new platform will consist of two (2) 12 feet by 50 inch roller trays aligned with the new overhead doors which will be installed on the north side of the building. Each roller tray will hold a pair of adsorption tanks and, integral with the support platform, will be supported by the underlying reinforced concrete floor and raised concrete pad. A review of the existing W/T Building concrete floor, combined with the structural steel support frame design and anticipated loads was performed and the floor was found to be adequate to support the proposed system. An access platform will be located between the roller trays for connecting and disconnecting the tanks. The access platform will be at the same height as the roller trays. The roller trays and access platform will be set at the same height as the existing entry way platform at the northwest corner of the building. The roller trays will be equipped with stabilization bars to lock the tanks into place and prevent them from shifting or rolling on the rollers during operations. Refer to the drawings in Appendix A and tank manufacturer information in Appendix B for additional details.

2.4 Materials of Construction

The adsorption tanks are 470 gallon steel tanks manufactured by Siemens and are constructed of 3/16-inch thick welded carbon steel. The tanks have a design operating pressure rating of 100 psi at 150 degrees Fahrenheit. Refer to Appendix B for additional design and construction specifications and manufacturers information. The filters are upflow cartridge filters manufactured by Harmsco, which are stainless steel filter vessels with a pressure rating of 150 psi.

2.5 Miscellaneous Attachments

As shown on the drawings in Appendix A and product literature in Appendix B, the adsorption tanks have one 4-inch diameter fluid inlet and one 4-inch diameter fluid outlet on the side of the tank. The tanks are also equipped with one 2-inch diameter media inlet and one 2-inch diameter media outlet, a 3/4" drain, and a 12 inch by 16 inch elliptical manway at the top the tank. Nozzle diameters range from 2-inches to 4-inches. The tank also includes two pressure gauge assemblies.

The filter assemblies are equipped with one 2-inch inlet and one 2-inch outlet nozzle at the bottom of the assembly. A 1-inch drain is also located at the bottom of each filter. The top of the filter housing is removable for changing the filter cartridges.

2.6 Process Description, Piping, and Pumping System

An Ion Exchange Application Memo (November 2012) was prepared by Siemens to present the preliminary treatability testing results on CWM wastewater. The finding of this testing was subsequently used to determine system requirements. Refer to Appendix B for details.

The proposed use of the adsorption tanks and cartridge filters will be for the removal of arsenic from the AWTS effluent prior to discharge to the site's treated effluent tanks, tanks T-58 and T-125. The study performed by Siemens determined the number and size of cartridge filters and adsorption tanks needed to meet the CWM treatment goals. The cartridge filters will be used to remove fine solids and prevent blinding of the adsorption media. The media is designed specifically to adsorb (remove) arsenic. As shown on Sheet 1 in Appendix A, the new tanks and piping system will tie into the existing piping from the carbon adsorption tanks inside of the W/T building. The arsenic treatment system is designed as two parallel treatment trains. Each treatment line will consist of two cartridge filters in series followed by a primary and a secondary adsorption tank in series. The two parallel systems will be piped and valved such that they can be operated individually or simultaneously. The arsenic removal system may also be by-passed if the wastewater being process does not contain arsenic.

A 2-inch high density polyethylene (HDPE) tee will be installed into the existing piping from the carbon adsorption tanks to divert water into the arsenic removal system. The 2-inch inlet pipe will then branch out to the two parallel systems. Each system will consist of the 2-inch HDPE pipe feeding into the first cartridge filter which is then connected to the second via a 2-inch stainless steel pipe. The piping will be equipped with isolation valves before and after the filters for replacing the filter cartridges. The 2-inch HDPE pipe will then run under the roller trays and extend up into the access area between the two roller trays. The pipes will be equipped with 3-inch camlock fittings. The adsorption tanks will also be equipped with 3-inch camlock fittings. A 3-inch flexible pressure rated chemical hose will be used to connect the adsorption tanks into the system for easier assembly and disassembly when changing the adsorption tanks. The flexible chemical hose will be connected to the top inlet of the first adsorption tank. Flexible hose will be installed from the bottom outlet of the first adsorption tank into the top inlet of the second adsorption tank. The bottom outlet of the second adsorption tank of each treatment line will be connected to a 3-inch HDPE header pipe by flexible hoses. The 3-inch HDPE header pipe, which after combining with the other parallel system outlet, will feed back into the discharge piping from the carbon adsorption tanks. Isolation valves will be installed before and after the adsorption tanks for changing out the tanks. Treated water from the adsorption tanks is then directed to the AWTS effluent holding tanks T-125 or T-58.

The tanks are designed for a maximum operating pressure of 100 psi at 150 degrees Fahrenheit (per Siemens), although are not expected to operate above 50 psi at less than 110 degrees Fahrenheit. Based on these design and operating conditions, an engineering evaluation of the proposed system's maximum operating pressure in

comparison to the manufacturer's maximum pressure rating for the flexible hoses, HDPE piping, and other ancillary equipment, as required by 6 NYCRR 373-2.10(c)(1)(i) was performed. The following presents a summary of the manufacturer pressure rating for the various ancillary equipment and components:

- Cartridge Filters (Harmsco) – Pressure rated to 150 psi
- Flexible Hoses (Goodyear) – Pressure rated to 150 psi
- Ball Valves (Grainger) - Pressure rated to 1,000 psi
- Male Hose Adapter (Grainger) - Pressure rated to 125 psi
- HDPE Pipe (Chevron Phillips) – Pressure rated to 200 psi
- Flange Gaskets (Durlon) – Pressure rated to 1,500 psi

As shown, the pressure rating for each of the individual system components exceeds the maximum operating pressure of the tank. Product-specific information is provided in Appendix C for each of the items listed above.

Sheet 2 in Appendix A provides additional front and side views of the tank system showing the piping arrangement and design details with respect to the hose/piping supports, as required by 6 NYCRR 373-2.10(c)(5).

Regular inlet/outlet pressure differential monitoring and testing of the treated water will be performed to determine when the cartridge filters or arsenic adsorption tanks must be replaced. When an increased pressure differential is observed via pressure gauges on the inlet an outlet piping of the filter cartridges, the cartridge filters may have become clogged. That side of the system will be shut down and the filters will be isolated using the provided ball valves. Pressure within the filters will be relieved by connecting a temporary drain hose to a Chicago fitting in the stainless steel piping between the two filters and draining the liquid within the cartridges to a portable container (i.e. 5 gallon container) and transferring the liquid to the AWTS for processing. The filter housing will then be opened and the spent cartridges removed and either cleaned or properly disposed of, including waste tracking, by CWM as hazardous waste (macroencapsulation) in accordance with applicable regulations and Site Wide Permit requirements. Cleaning of the cartridge filters will be accomplished by placing the cartridges in a container, transporting them to the adjacent A/T Building, and rinsing the cartridges above the Filter Press Sump located adjacent to tank T-910. The Filter Press Sump is permitted as a tank and has secondary containment, which is inspected daily. The rinse water and small particulates will be pumped to the alkalization tanks for processing.

When arsenic levels in the treated effluent are no longer acceptable, the adsorption tanks will be replaced. It is assumed that the arsenic media in the primary tank will be spent before that of the secondary tank. When this occurs, the secondary tank will be moved into the primary tank position and a new tank with fresh arsenic media will be installed in the secondary tank position. This sequence will be continued for the life of the system. Siemens will be responsible for supplying replacement tank(s) with fresh media, and proper management of the tank(s) with the spent arsenic contaminated media. Changing out the adsorption tanks will be done by CWM through the new overhead doors located on the north side of the building. The side of the system to be changed will be isolated, and pressure will be relieved by connecting a temporary drain hose to a Chicago fitting in the HDPE pipe between the filters and adsorption tanks and draining the liquid to a portable container and transferring the liquid to the AWTS for processing. Once the pressure is relieved from the adsorption tanks, the flex hoses will be disconnected and the stabilization bars will be removed. A fork truck will be used to lift and roll the tanks out of the Water Treatment Building and transport them to the either the A/T Building or AWTS Front Unloading Containment Area. The adsorption tanks will be fully drained using the 2 inch drain valve at the bottom of the tank which will be connected to a vacuum truck located within the containment area. The liquid would be processed through the AWTS. As an alternative, A/T personnel may transfer the liquids from

the adsorption tanks and piping to the effluent holding tanks T-58 or T-125 through the outlet piping using the Chicago fitting connection and compressed air. The remaining tanks will be repositioned as needed and the new tanks will be installed. The tanks will be locked into place using the stabilization bars, and the flex hoses will be reconnected. Once the system is fully reconnected, the isolation valves will be opened and that system will be checked for leaks. If any leaks are found, the system will be isolated and any leaks will be repaired.

It is noted that, according to Siemens, all Siemens adsorption tanks are approved as transportable hazardous waste containers by the US Department of Transportation and Siemens is an approved carrier for transportation of Hazardous Waste. Siemens will pick up all spent tanks from CWM's facility and transport the spent tanks to Siemens's Roseville, Minnesota facility for processing and, as required, each such containerized waste shipment will be properly manifested as hazardous waste. All tanks will be verified by Siemens for proper flow and pressure tested for leaks prior to shipping to CWM.

Product literature for the proposed cartridge filters, flexible hoses, HDPE piping, valves and adapters, and rollers are included in Appendix C.

CWM will revise the AWTS Operations & Maintenance (O&M) Manual to include the arsenic treatment system. The revision will include a discussion of the process operations and a detailed step-by-step procedure for periodic change-out of the cartridge filters and the periodic replacement of the adsorption tanks, including the information described above. The revision to the AWTS O&M Manual will be included in the Permit Modification Request upon approval of this design assessment report.

2.7 Overpressure Protection

Primary overpressure protection will be provided by two pressure gauge assemblies which will be monitored during system operation by AWTS personnel to assure system pressures do not exceed that specified. As noted previously, the tanks are designed for a maximum working pressure of 100 psi at 150 degrees Fahrenheit (per Siemens), although are not expected to operate above 50 psi at less than 110 degrees Fahrenheit. Pressure gauges are included in the proposed system before and after each cartridge filter and each tank as shown on Sheet 1 and Sheet 25a in Appendix A.

As noted in Section 2.6 above, an evaluation of the proposed system's maximum operating pressure within the tanks in comparison to the maximum pressure rating for the ancillary equipment and components of the system was performed. As stated, the anticipated maximum operating pressure at any point in the system will not exceed the pressure rating of any individual component of the system. Considering the inlet pressure of the new arsenic removal system will be approximated by the outlet pressure from the carbon adsorber tanks T-3007/T-3008, the system pressure cannot exceed a maximum of 75 psi, due to the presence of pressure relief rupture disks located in the T-3007/T-3008 piping. As shown on Drawing C-210 in Appendix A, there is a rupture disk on each of the carbon tank outlet pipes that is rated at a burst pressure of 75 psig. The pressure relief devices that are intended to prevent over pressurization of the carbon tanks will also act to prevent over pressurization of the arsenic removal system tanks, as the feed pipe pressure (developed by the carbon feed pumps P-3003 A/B) will not exceed that of the rupture disk. As a result, the new arsenic removal system operating pressure is not expected to exceed 75 psi, well below the maximum system design pressure. Product information for the existing 3-inch SAF-T-GRAF rupture disks is included in Appendix C.

Additionally, in the event of a leak caused by rupture of the pressure relief device, the W/T Building is equipped with floor leak detection sensors that will alarm AWTS personnel of this condition and automatically shut off the carbon adsorber tanks' feed pumps P-3003 A/B.

2.8 Protective Coatings

The interior of the tanks will be coated with 3M Scotchkote 134 to a dry film thickness (DFT) of 10-15 mils, in accordance with the manufactures specifications. The tanks will be housed within the Water Treatment Building which is a heated structure; therefore the tanks will not require any additional external coatings to protect it from UV degradation or other environmental factors. The tank's exterior will be coated with a rust preventative epoxy primer (4-6 mils DFT) and finished with high build polyurethane (3-4 mils DFT). Manufacturer's Specifications, including chemical resistance data and chart for the 3M Scotchkote are included in Appendix B.

The cartridge filters are manufactured of 304 stainless steel, which has been electro-polished for increased resistant to corrosion. Product literature for the cartridge filters, including chemical resistance data and chart is included in Appendix C.

2.9 Secondary Containment and Leak Detection

Secondary containment for the adsorption tanks is provided by the existing secondary containment system installed within the Water Treatment Building. A perimeter coated steel secondary containment wall approximately 20-inches high provides a minimum of 100% secondary containment capacity for the carbon adsorbers and the arsenic removal systems, based on the capacity of the largest tank or all interconnected tanks within the building. As presented in the Site-wide Permit Secondary Containment Calculations, the W/T Buildings available secondary containment volume of 15,317 gallons exceeds the required secondary containment volume of 15,200 gallons (combined volume of the interconnected carbon adsorber tanks T-3007/T-3008).

As noted above in Section 2.7, the W/T Building is equipped with floor leak detection sensors that will alarm AWTS personnel in the event of a leak and automatically shut off the carbon adsorber tanks' feed pumps P-3003 A/B. It is noted, however, that due to the higher elevation of the carbon tanks compared to the arsenic removal tanks it is possible that a leak somewhere in the arsenic removal tank system at a lower elevation could allow the carbon tanks to drain out or inversely, due to a reduced pressure condition, for the arsenic removal tanks to be back siphoned, thereby, essentially creating an interconnected condition between the two systems. To prevent this, the inlet pipe to the arsenic removal system at the point of by-pass from the outlet pipe from the carbon system will be elevated, by use of a vertical pipe loop, above the highest point of the carbon tanks and an anti-siphon/anti-vacuum device installed at that high point in the pipe. Refer to Sheet 1 and Sheet 25a in Appendix A for further details.

As an added measure to prevent the possibility of a leak from the connection of the flexible hose to the rigid pipe or tank, located near the north wall of the W/T Building, from potentially contacting the proposed overhead doors or building sidewall, these connection points are located a minimum of 3-feet inward from the north wall, as shown on Sheet 1 in Appendix A.

Leak detection for the entire adsorption tank system will be provided by exterior visual means through daily inspection by CWM personnel. All system components and ancillary equipment including the tank sides, top, nozzles, and system piping are all visible for easy inspection and will be checked as part of the daily inspection. As noted previously, the W/T Building is also provided with floor leak detection sensors that will alarm AWTS personnel in the event liquid is detected on the floor of the secondary containment and the inlet feed pumps to the adsorption systems automatically shut off.

3. Assessment and Certification

EnSol conducted an assessment and review of the proposed AWTS Arsenic Removal System components at CWM's Model City facility in order to assess the integrity and to confirm the compatibility of the components with materials that are to be handled.

3.1 Design and Record Information

EnSol reviewed available design and record information that were provided by CWM and/or the various equipment and tank manufacturers. Information regarding design standards, materials of construction, structural supports, hazardous characteristics of the waste stream to be handled, and corrosion protection systems (internal and external) was obtained from these sources. EnSol did not perform compatibility studies for the existing and proposed system components, although a review of and our close familiarity and extensive experience with the system materials of construction indicates adequate compatibility with the materials expected to be handled. Where available, manufacturer compatibility information was reviewed.

Regarding the chemical compatibility of the materials of construction with the materials expected to be handled (i.e., AWTS carbon adsorber tank effluent), Appendix C includes available manufacturer and/or material chemical resistance data for each of the system components to be used (refer to the end of each sub-section). Chemical compatibility and resistance information for the 3M Scotchkote Epoxy Coating used as the interior lining of the Siemens tanks is included at the end of Appendix B with other proposed tank information. Recent analytical laboratory test results for samples of the AWTS carbon effluent tested by CWM's on-site lab (for COD, Cyanide, pH, Sulfide, Volatiles, and Total Metals) and by an independent lab, Adirondack Environmental Services, Inc. (for PCB's and Semi-Volatiles) is included in Appendix D. EnSol performed a comparison of manufacturers chemical resistance information for each construction material (i.e., tank interior coatings, stainless steel, HDPE piping, flexible hose and other ancillary equipment) and the known chemical composition of the wastewater to be managed in the new tank system, to adequately demonstrate compatibility, as required by 6 NYCRR 373-2.10(c)(1). No issues or areas of concern were found and it was determined that the materials of construction were compatible with the wastewater to be handled by the system. It is also noted that all the materials of construction, including the specific products and manufacturers of the equipment in most cases, have been used extensively throughout the CWM Model City facility and other such sites for many years and have performed very well in much more aggressive environments than they will be exposed to in this system.

3.2 Summary and Conclusions

The proposed tank system is to be used by CWM for the removal of arsenic as part of the sites wastewater treatment process. The treatability study and design specification performed by Siemens was used to design the adsorption tanks and cartridge filter systems. The proposed system was specified and designed as a chemical-resistant pressure system that will provide maximum performance, within the specified limits, and to adequately remove arsenic from the treated wastewater. The system tanks, components, and ancillary equipment are expected to meet or exceed the conditions they will be exposed to.

In accordance with the requirements listed under 6 NYCRR 373-2.10(c)(2), the new tank system will be inspected by an independent, qualified, installation inspector or registered New York Professional Engineer prior to placing the system in use. In accordance with 6 NYCRR 373-2.10(c)(4), during installation and prior to initial service, the newly installed tanks will be hydrostatically tested for tightness in accordance with an established standard, such as American Petroleum Institute (API) Standard 653, using a full depth liquid test with water for minimum 24-hour duration. All new piping and ancillary equipment will be hydrostatically

pressure tested for tightness in accordance with an established standard, such as ANSI/ASME B 31.3, using water at a minimum pressure of 1.5 times maximum operating pressure or 112.5 psi (1.5 X 75 psi). In addition, during tank and pipe testing all systems will be visually inspected for signs of leaks or pressure loss and any deficiencies corrected. All initial testing will be observed and, along with the inspections, will be documented by the independent, qualified, installation inspector or registered New York Professional Engineer in written statements in accordance with 6 NYCRR 373-2.10(c)(7).

Thereafter, all in-kind replacement tanks provided by Siemens, subsequent to initial system installation as a result of tank change out activities, will be pre-certified by Siemens as to their structural integrity, adequate condition, and system tightness. All other system components and ancillary equipment will remain in place from the initial installation and will not be changed out on a regular basis. During regular tank change out installations, CWM personnel will inspect the system components prior to startup to insure they are installed properly. In addition, in accordance with 6 NYCRR 373-2.10(C)(4) (i.e., post installation tightness testing) all tanks, along with the associated flexible hoses and their connections, involved in the change out will be re-tested for tightness following the procedure used during initial tank installation. During start up after tank change out, CWM will visually inspect the system components to insure they are free of leaks and any deficiencies immediately addressed. To comply with the substantive requirements of 6 NYCRR 373-2.10(c)(2) and 6 NYCRR 373-2.10(c)(7) (i.e., installation certification by a qualified Inspector or Professional Engineer, and documentation of such), certain designated CWM Engineering or AWTS Supervisory personnel will be trained by Siemens as Manufacturer's Qualified Installers for the tanks. Documentation of each tank change out and associated tightness testing and installation inspections by the designated CWM Manufacturer's Qualified Installer will be maintained on site for Department review.

In order to satisfy the operational requirements listed under 6 NYCRR 373-2.10 to install new piping and operate the AWTS Arsenic Removal System, CWM must provide labels, signs, placards, tank identification, etc. specific to the proposed tank service. In addition, documentation of the date the tank system is initially placed into service and every time the tanks are replaced will be maintained.

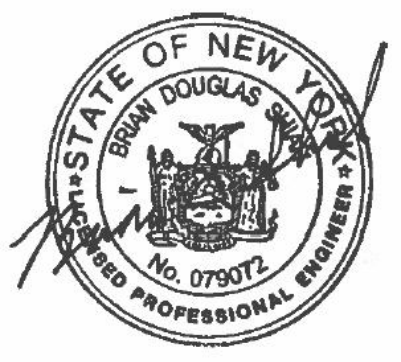
The assessment for the proposed AWTS Arsenic Removal System, as prepared by EnSol and presented in this report, includes consideration of the proposed tanks foundation, structural supports, secondary containment, leak detection, tank design standards, proposed equipment, chemical compatibility, and existing conditions. EnSol considers each of these items to be adequately designed and/or constructed for the intended use and, where applicable, to have sufficient structural strength. Proposed materials of construction for the systems appear to be sufficiently compatible with the materials expected to be handled. Considering the proposed use and service, the proposed tank systems identified herein were judged by EnSol to be adequate for its intended service, providing the tank systems operating temperature, pressure, and chemical exposure limitations are not exceeded.

TANK SYSTEM DESIGN AND ASSESSMENT REPORT FOR AWTS ARSENIC REMOVAL TANKS T-3010 A/B/C/D

CWM Chemical Services, LLC
Model City, New York Facility

CERTIFICATION

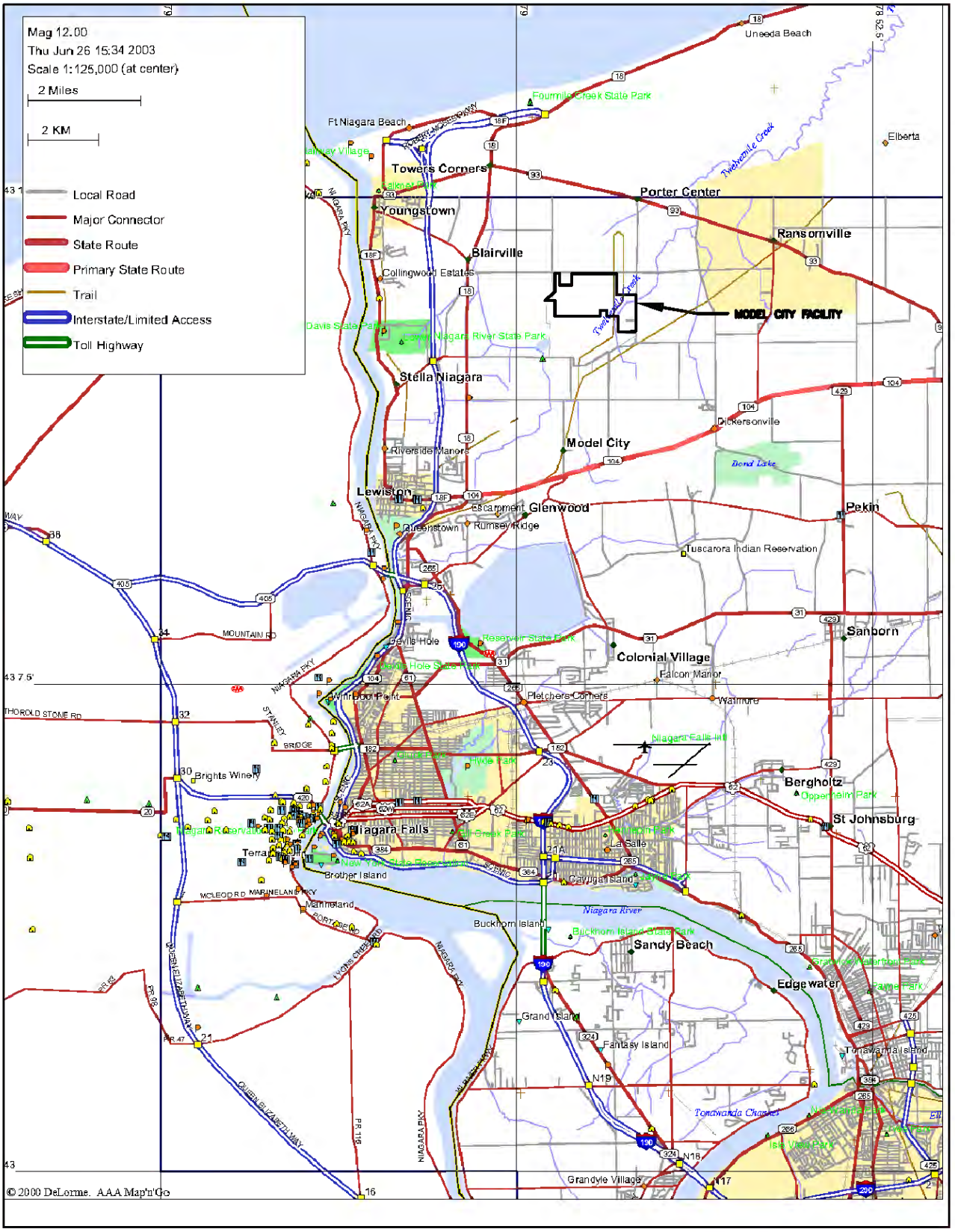
I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.



Brian D. Shiah, P.E.
ENSOL, INC.

5-24-13
Date

Figures



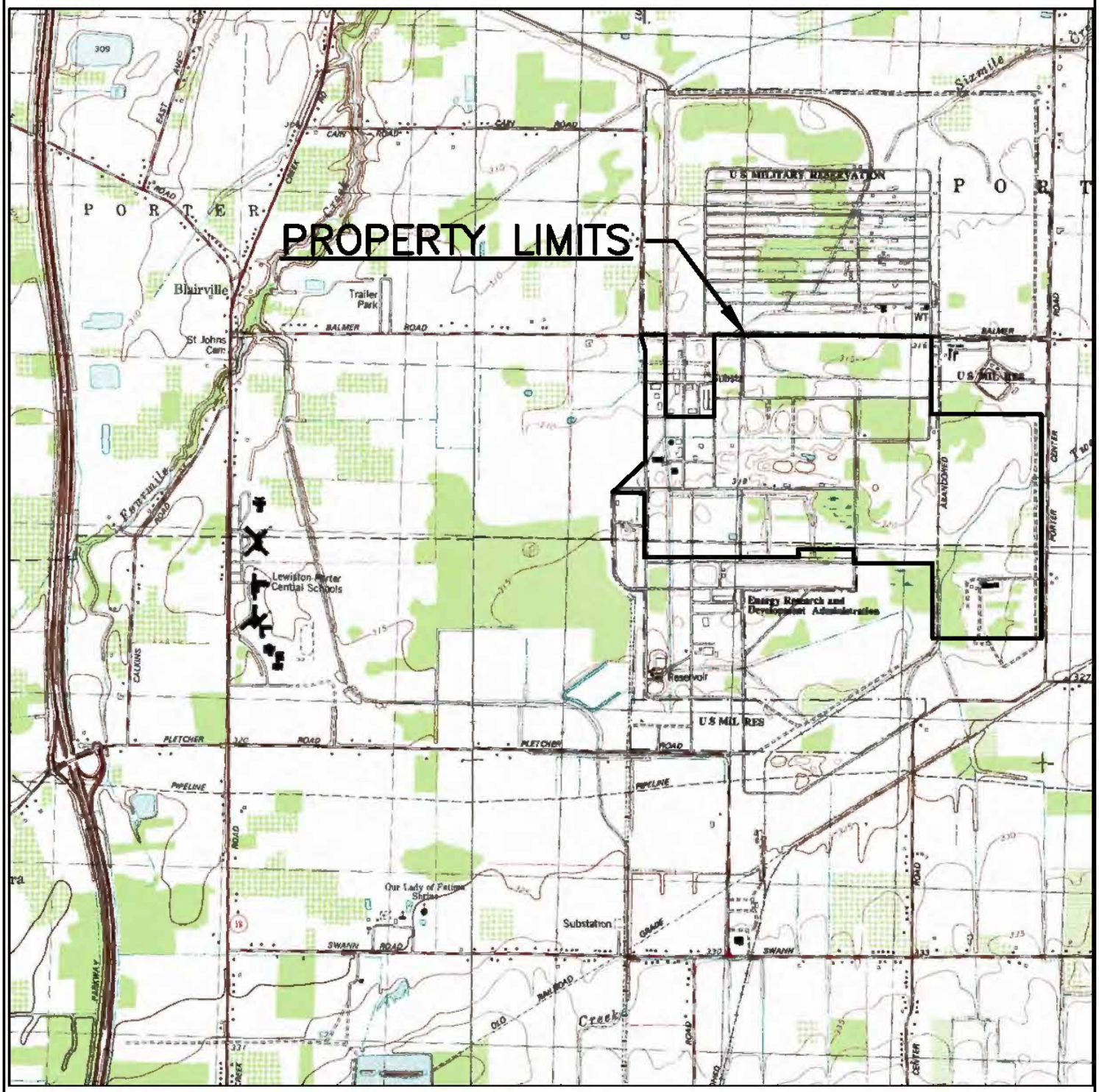
X:\AAApj\CWM\Record Site Figures, Drawings, and Documents\Report Figures (EnSol)\Fig 1_Regional Location.dwg, 8.5x11 UPDATED TITLE BLOCK, 12/4/2008 1:47:00 PM, Keith Pellerin, Ensol Inc., Letter, 1:1

EnSol, Inc.
Environmental Solutions
661 MAIN STREET
NIAGARA FALLS, NY 14301
PHONE (716) 285-3920
FAX (716) 285-3926

REGIONAL LOCATION MAP

CWM CHEMICAL SERVICES, LLC.
MODEL CITY, NY

FIGURE
1



REFERENCE: BASE MAP USGS QUADS.,7.5 MINUTE SERIES RANSOMVILLE AND LEWISTON, NY 1980.

NOTES:
1. PROPERTY LINES ARE APPROXIMATE.
2. NO DRINKING WATER WELLS EXIST WITHIN ¼ MILE OF THE FACILITY.
3. THE TREATED EFFLUENT DISCHARGE IS LOCATED AT THE NIAGARA RIVER (SHOWN ON USGS LEWISTON QUADRANGLE).
4. 710 TOTAL ACRES
5. 630 RCRA PERMITTED ACRES.

2500' 0 2500'

APPROXIMATE SCALE: 1" = 2500'

EnSol, Inc.
Environmental Solutions
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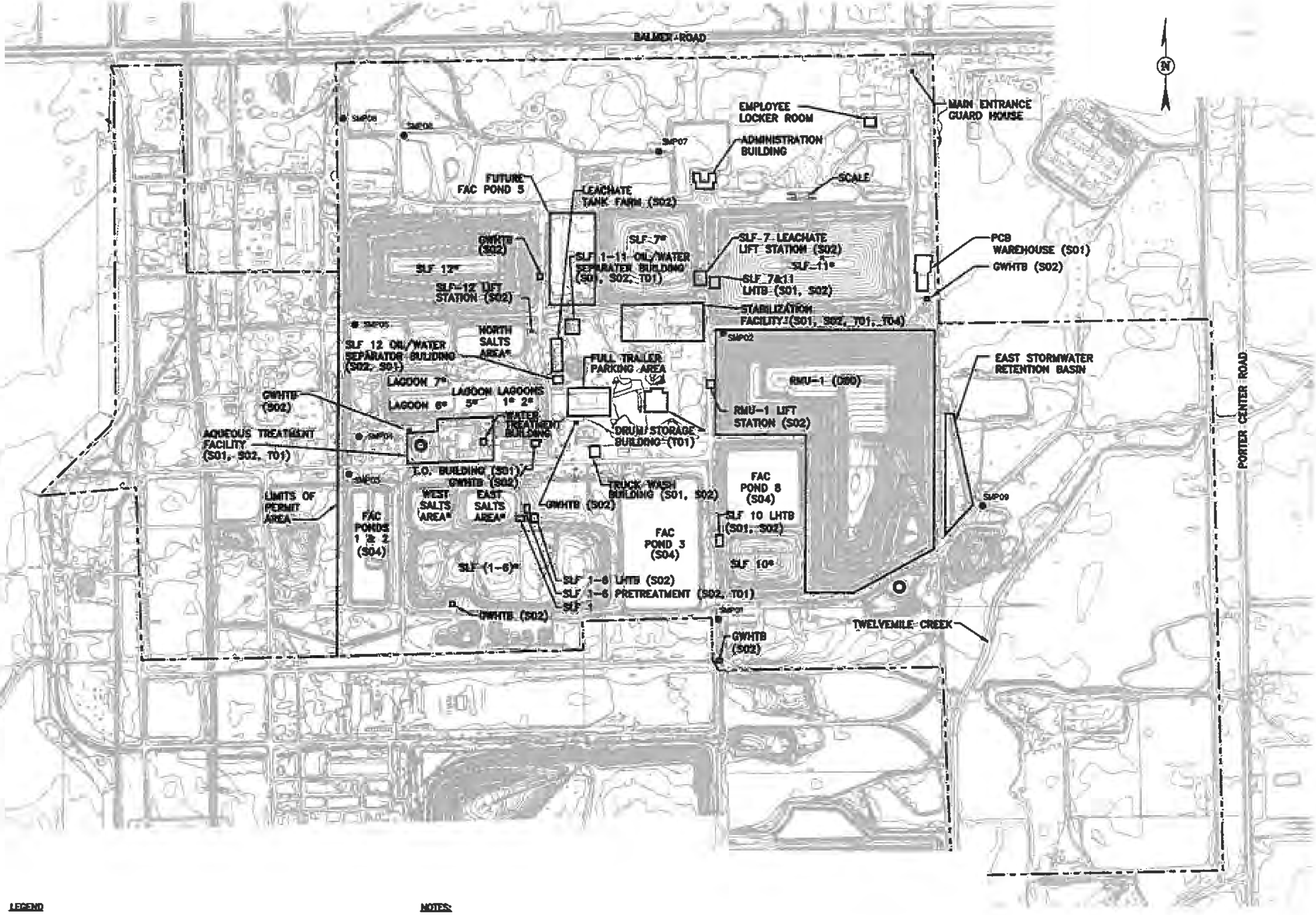
FACILITY LOCATION MAP

CWM CHEMICAL SERVICES, LLC.
MODEL CITY, NY

FIGURE
2



LEGEND

SLF = SECURE LANDFILL
FAC = FACULTATIVE
LAG = LAGOON
* = INACTIVE
LHTB = LEACHATE HOLDING TANK BUILDING
GWHTB = GROUNDWATER COLLECTION HOLDING TANK BUILDING
D80 = LANDFILL
S01 = CONTAINER STORAGE

— · — · — PROPERTY LINE
———— LIMITS OF ACTIVE LANDFILL
S02 = TANK STORAGE
S04 = SURFACE IMPOUNDMENTS
T01 = TANK TREATMENT
T04 = OTHER TREATMENT
SMP09 ● = SURFACE MONITORING POINT (SMP)

NOTES:

1. THIS MAP COMPILED BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED 5-31-01. (AIR SURVEY CORP. PROJECT NO.71010503)
2. VERTICAL DATUM BASED ON NGS MEAN SEA LEVEL.
3. GRID BASED ON LOCAL COORDINATE SYSTEM.
4. CONTOUR INTERVAL 2 FT.
5. DASHED CONTOURS INDICATE THAT GROUND IS PARTIALLY OBSCURED BY VEGETATION OR SHADOWS. THESE AREAS MAY NOT MEET STANDARD ACCURACY AND REQUIRE FIELD TESTING COMPLETION.
6. PROPERTY LINES ARE APPROXIMATE.
7. 630 PERMITTED ACRES.
8. 710 TOTAL ACRES.
9. LOCATION OF SMPs ARE APPROXIMATE.

500' 0' 500' 1000'

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FACILITY LAYOUT PLAN

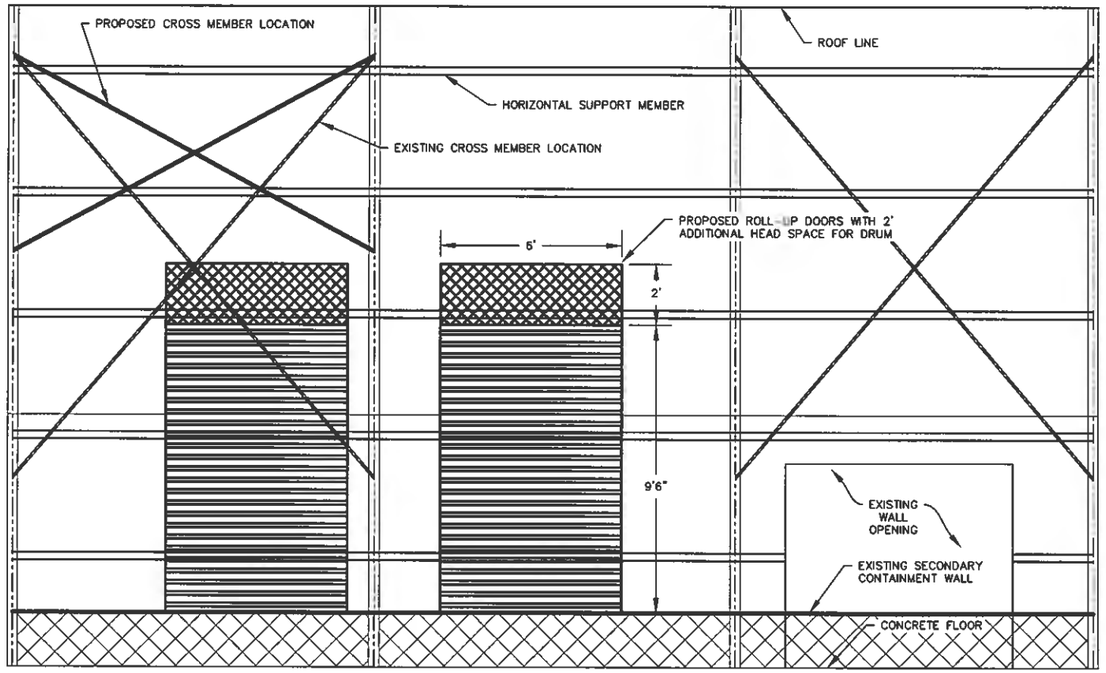
CWM CHEMICAL SERVICES, LLC.
MODEL CITY, NY

FIGURE 3

Appendix A

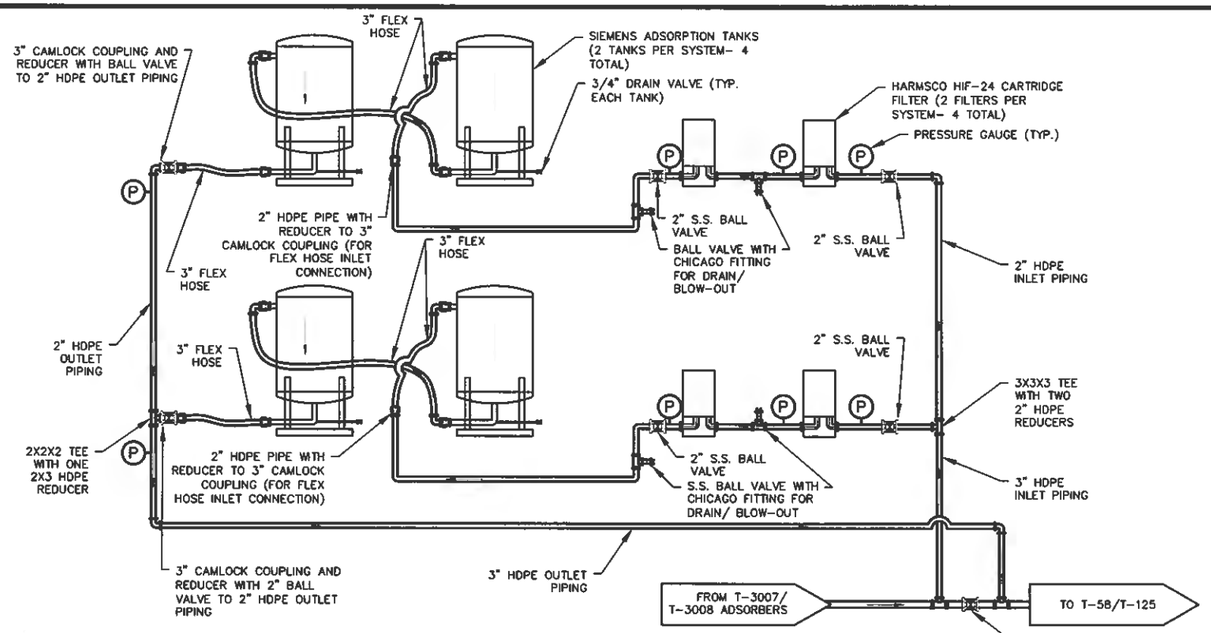
Proposed Arsenic Removal System Drawings (EnSol)

EnSol, Inc.



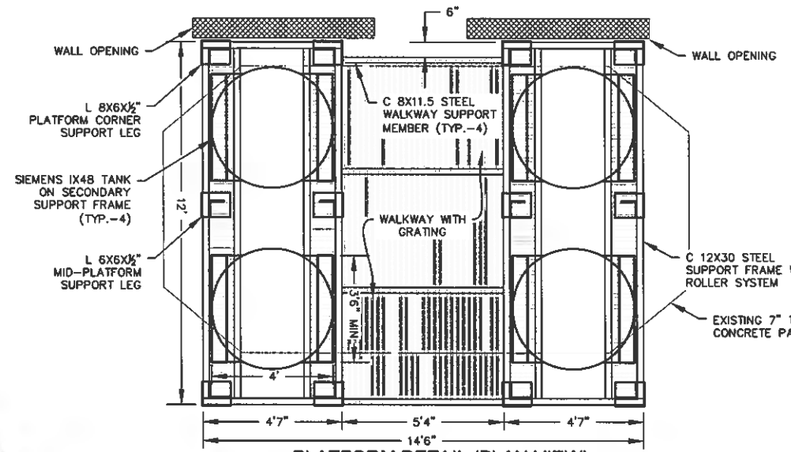
WATER TREATMENT BUILDING NORTH WALL INTERIOR ELEVATION WITH PROPOSED UPGRADES

NOT TO SACALE



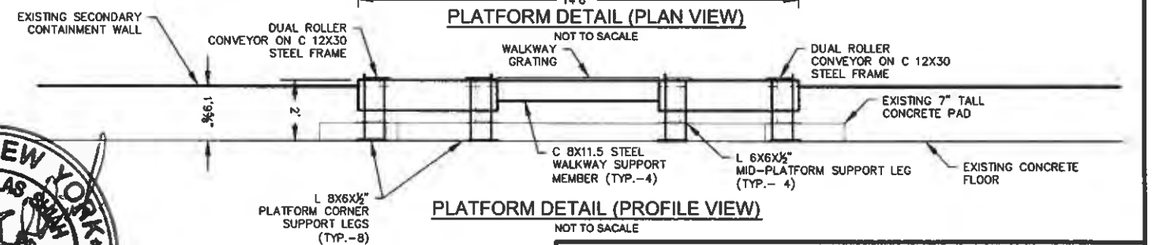
ADSORPTION SYSTEM PIPING DETAIL

NOT TO SACALE



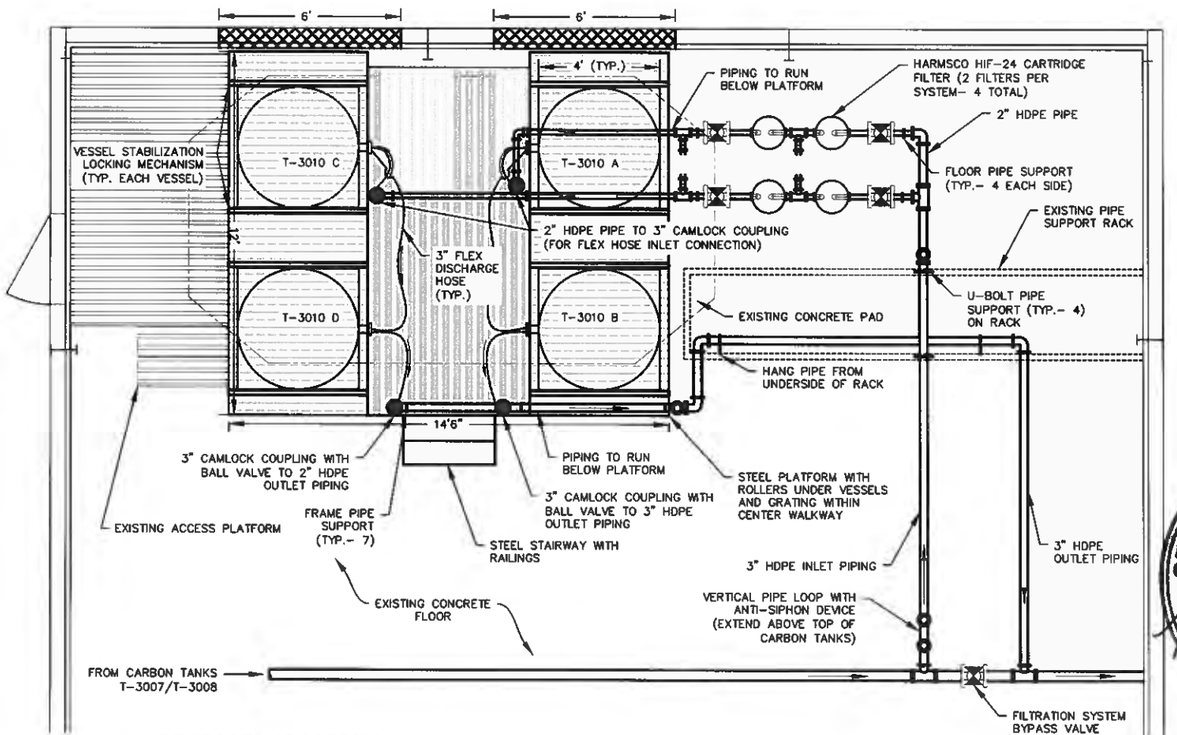
PLATFORM DETAIL (PLAN VIEW)

NOT TO SACALE



PLATFORM DETAIL (PROFILE VIEW)

NOT TO SACALE



PROPOSED ADSORPTION SYSTEM LAYOUT AND WATER TREATMENT BUILDING FLOOR PLAN

NOT TO SACALE

NOTES:

1. CONTRACTOR TO PROVIDE A PLATFORM SHOP DRAWING TO CWM PRIOR TO FABRICATION FOR APPROVAL BY THE ENGINEER.
2. ALL NEW PIPING TO BE SUPPORTED FROM EXISTING PIPE SUPPORT RACK, PROPOSED TANK SUPPORT PLATFORM, AND EXISTING FLOOR AT LOCATIONS SHOW, AND AS SHOWN ON SHEET 2, AS APPROVED BY ENGINEER DURING INSTALLATION.

PROPOSED LAYOUT PLAN

AND PIPING DIAGRAM

AWTS ARSENIC REMOVAL SYSTEM DESIGN

CWM CHEMICAL SERVICES, LLC. - MODEL CITY, NY

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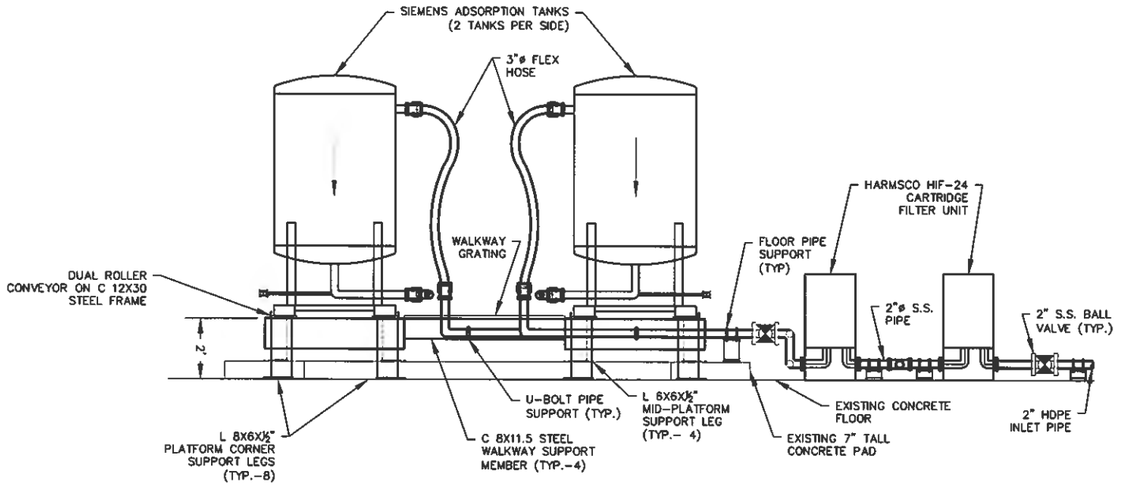
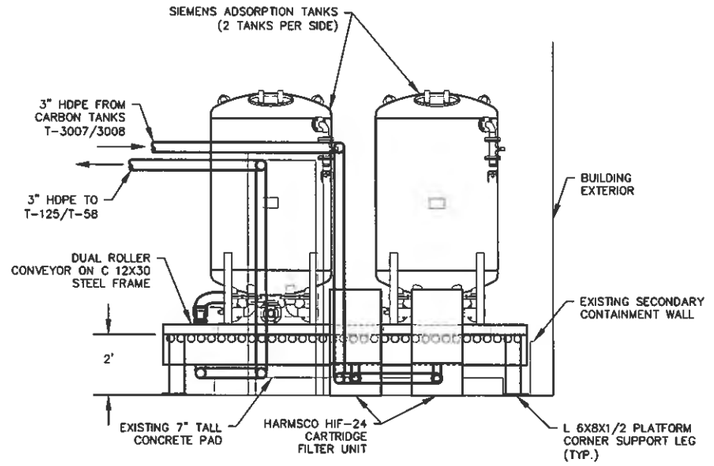
FAX (716) 285-3928

MAY 2013 | PN: 13-7009

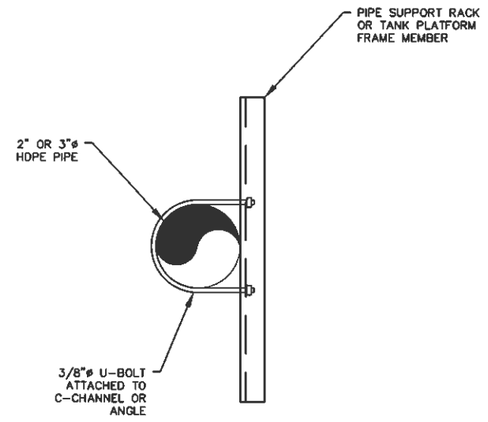
SHEET 1



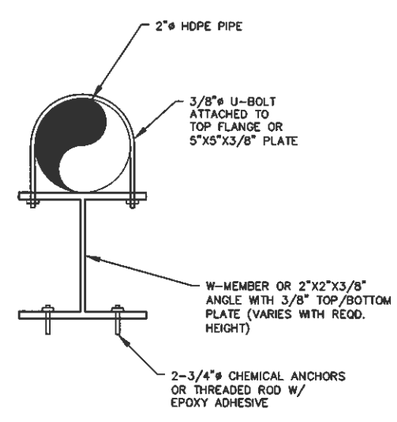
SOUTH SECTION VIEW OF TANK PLATFORM AND CARTRIDGE FILTER UNITS
NOT TO SCALE



EAST SECTION VIEW OF TANK PLATFORM AND FILTER UNITS
NOT TO SCALE



U-BOLT PIPE SUPPORT DETAIL
NOT TO SCALE



FLOOR PIPE SUPPORT DETAIL
NOT TO SCALE

NOTES:

1. CONTRACTOR TO PROVIDE A SHOP DRAWING TO CWM PRIOR TO FABRICATION FOR APPROVAL BY THE ENGINEER.

PLATFORM AND PIPING

SECTIONS AND DETAILS

AWTS ARSENIC REMOVAL SYSTEM DESIGN
CWM CHEMICAL SERVICES, LLC. - MODEL CITY, NY

EnSol, Inc.
Environmental Solutions
661 MAIN STREET
NIAGARA FALLS, NY 14301
PHONE (716) 285-3920
FAX (716) 285-3928

SHEET 2

MAY 2013 | PN: 13-7009

FROM LTF MH #3 C-1TKFR — 4" HDPE DBQ

FROM T-3011/3012 C-12A/D-1 (DB) — 3" HDPE DBQ

T-3005 MM FILTER

T-3005
975 GAL.
1/4" THICK
STEEL
LINED WITH
PLASITE
5'-0" DIA.
6'-0" HIGH

T-3004 MM FILTER

T-3004
975 GAL.
1/4" THICK
STEEL
LINED WITH
PLASITE
5'-0" DIA.
6'-0" HIGH

MULTI-MEDIA (MM) FILTERS

FROM Y-0125 C-109/D-1 (DN) — 3" HDPE — 2" STEEL DBQ

FROM ADSORBERS C-210/D-2 (EC) — 3" HDPE

BOILER CONDENSATE — 2" STEEL

FROM W/T BLDG. FLOOR TRENCH C-210 — 3" HDPE

BACKWASH

W.T. BUILDING FLOOR

T-3003
1210 GAL.
FRP
6'-6" HIGH
5"-0" DIA.

P-3003A
FLOWSERVE
MD. HDC3 3X1.5X10
40 H.P.

P-3003B
WORTHINGTON
MD. 11D81
3X1.5X6

TO ADSORBERS C-210/C-B (EA)

TO LTF VALVE XV-105 AND PUMPS P-104 & P-105

TO T-3001 VALVE AND PUMP CONTROL

TO T-100 PUMP AND VALVE CONTROLS

TO LTF PUMP AND VALVE CONTROLS

TO T-320 PUMP AND VALVE CONTROLS

TO T-310 PUMP AND VALVE CONTROLS

TO T-3001/3002 VALVE AND PUMP CONTROL

TO 200 SERIES TANKS C-112/C-B (DD) — 3" HDPE

FROM T-210, T-220, T-230 HI-HI LEVEL

P-3009 — 3" S.S DBQ — 2" HDPE

T-3009 6000 GAL. CARBON STEEL 1/4" THICK LINED W/ PLASITE 5309 8'-0" DIA. 16'-0" LONG (DOUBLE WALLED TANK)

NOTE:

1. ADAPTED FROM RUST ENVIRONMENT & INFRASTRUCTURE, MAY 1993, "PROCESS & INSTRUMENTATION DIAGRAM MULTI-MEDIA FILTRATION SYSTEM". UPDATED AND REVISED BY BBL MARCH AND DECEMBER 2001.

REVISION	NO.	BY	DATE
REMOVED MULTI-MEDIA FILTER SYSTEM AND LAB RINSE WATER PIPE TO T-3009	2	AMW	3/29/13
ADDED INTERCONNECTED TANKS PROJECT DETAILS AND REVISED T-3009 LINING.	1	BDS	5/2/06

IT IS A VIOLATION OF THE NEW YORK STATE EDUCATION LAW, ARTICLE 145 SECTION 7209, FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY.

EnSol, Inc.
Environmental Solutions
661 MAIN STREET
NIAGARA FALLS, NY 14301
PHONE (716) 285-3920 FAX (716) 285-3928

PROJECT NO:	05-7017		
SCALE:	NOT TO SCALE		
DWG:	05-7017-MMFIL SHT24.DWG		
DRAWN BY:	MJM	CHECKED BY:	BDS
DATE:	MAY 2006		

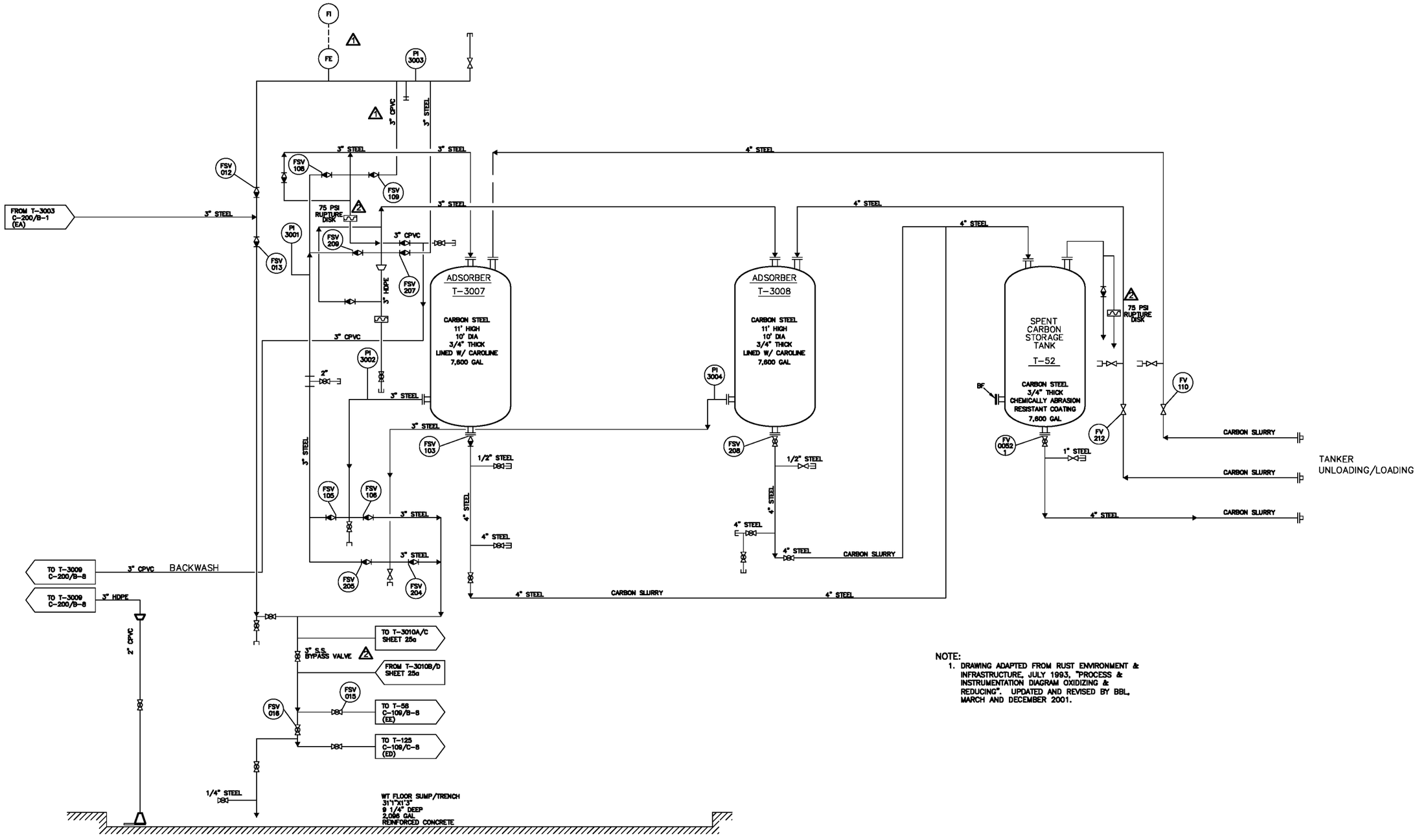
TITLE: **MULTI-MEDIA FILTRATION SYSTEM**
PROCESS AND INSTRUMENTATION DIAGRAM

PROJECT: CWM FACILITY P & ID UPDATES

PREPARED FOR: CWM CHEMICAL SERVICES, LLC., MODEL CITY FACILITY

TOWN OF PORTER | COUNTY OF NIAGARA | STATE OF NEW YORK

DRAWING C-200 (SHEET 24)



NOTE:
1. DRAWING ADAPTED FROM RUST ENVIRONMENT & INFRASTRUCTURE, JULY 1993, "PROCESS & INSTRUMENTATION DIAGRAM OXIDIZING & REDUCING". UPDATED AND REVISED BY BBL, MARCH AND DECEMBER 2001.

REVISION	NO.	BY	DATE
ADDED T-3010 SYSTEM BYPASS AND RUPTURE DISK PRESSURE	2	AMW	5/22/13
ADDED ADSORBER TANKS INLET FLOW METER.	1	BDS	5/2/06

EnSol, Inc.
Environmental Solutions
661 MAIN STREET
NIAGARA FALLS, NY 14301
PHONE (716) 285-3920 FAX (716) 285-3928

PROJECT NO:	05-7017		
SCALE:	NOT TO SCALE		
DWG:	05-7017-Sht.25.DWG		
DRAWN BY:	AJZ	CHECKED BY:	BDS
DATE:	MAY 2006		

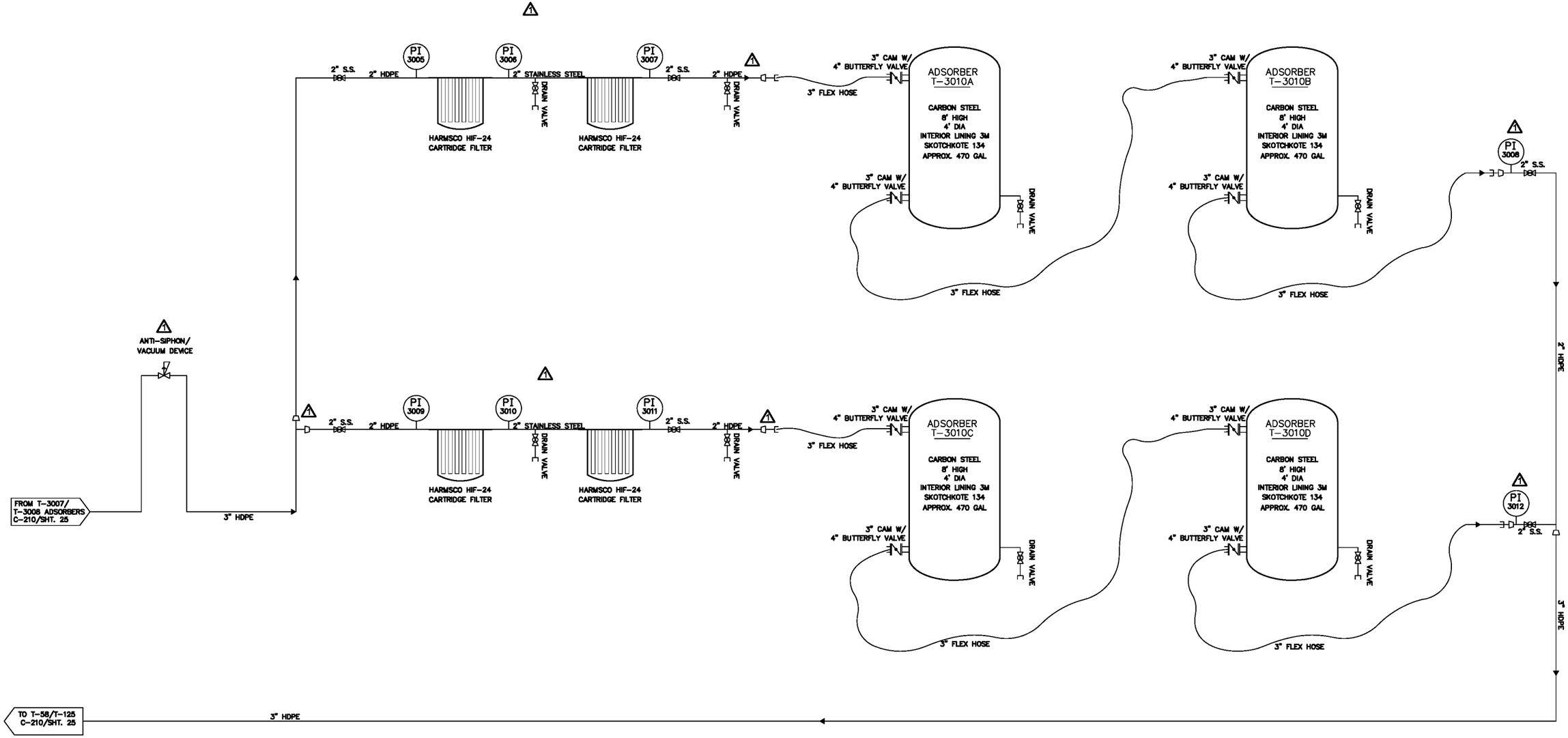
TITLE: **CARBON ADSORPTION SYSTEM**
PROCESS AND INSTRUMENTATION DIAGRAM

PROJECT: CWM FACILITY P & ID UPDATES

PREPARED FOR: CWM CHEMICAL SERVICES, LLC., MODEL CITY FACILITY

TOWN OF PORTER | COUNTY OF NIAGARA | STATE OF NEW YORK

DRAWING C-210 (SHEET 25)



REVISION	NO.	BY	DATE
ADDED PRESSURE INDICATORS, ANTI-SIPHON LOOP, AND REDUCERS	1	AMW	5/22/13

EnSol, Inc.
Environmental Solutions
661 MAIN STREET
NIAGARA FALLS, NY 14301
PHONE (716) 285-3920 FAX (716) 285-3928

PROJECT NO:	13-7009		
SCALE:	NOT TO SCALE		
DWG:	D25A_13-7009-SHT.25A.DWG		
DRAWN BY:	AMW	CHECKED BY:	BDS
DATE:	APRIL 2013		

TITLE: **ARSENIC REMOVAL SYSTEM**
PROCESS AND INSTRUMENTATION DIAGRAM

PROJECT: AWTS ARSENIC REMOVAL SYSTEM DESIGN

PREPARED FOR: CWM CHEMICAL SERVICES, LLC., MODEL CITY FACILITY

TOWN OF PORTER | COUNTY OF NIAGARA | STATE OF NEW YORK

SHEET 25a

Appendix B

Proposed Tank Information (Siemens)

Tank Product Data

(Siemens)

EnSol, Inc.

IX48HF

Description:

IX48HF vessels are designed to treat a wide range of contaminated process streams. The vessels are equipped with under drains capable of a nominal maximum flowrate of 200 gpm. Maximum flowrate is dependent on treatment media and application. Projects with very low discharge requirements will require reduced flow rates and longer media contact time for best performance and removal efficiency.

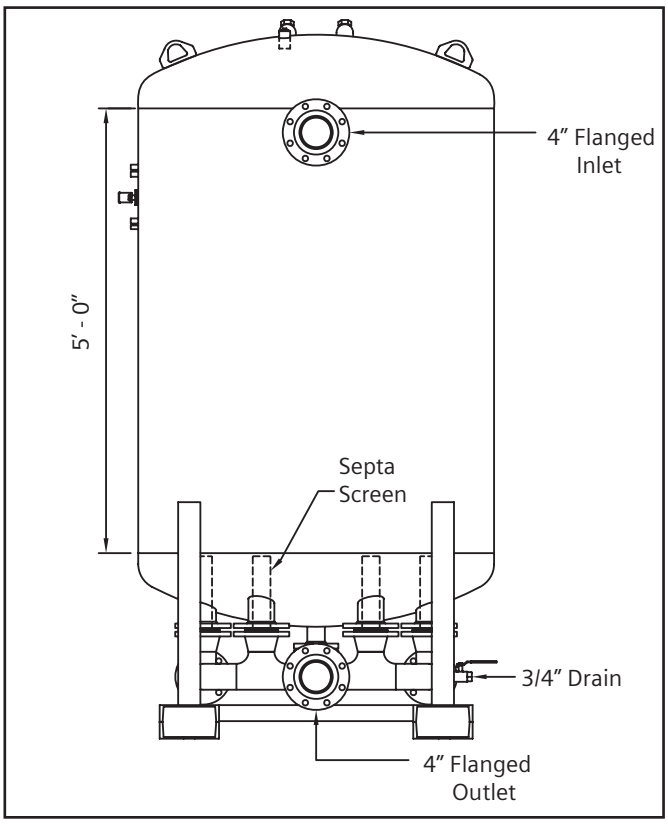
Standard Vessel Features

Diameter .....48”
Side Shell Height .....60”
Overall Height (Approx).....96”
Maximum Working Pressure.....100 psi @ 150 Deg F
Design Criteria .....ASME
ASME Code Stamped .....No stamp on standard rental equipment
Seismic rating.....Zone 4
Media Volume (max) ..... 60 cuft
Material..... Carbon Steel
Manway type.....Elliptical
One (1) upper head.....12” x 16”
Supports..... .....Tube Channel
Lifting.....Lifting Lugs
Interior Surface Prep SSPC-SP5
Interior Surface Coating.....Plasite 4110 35 mil DFT min
Exterior Surface Primer.....Rust Preventive Epoxy 3 mil DFT min
Exterior Surface Coating.....High Solids Urethane 3mil DFT min
Standard Color.....Blue

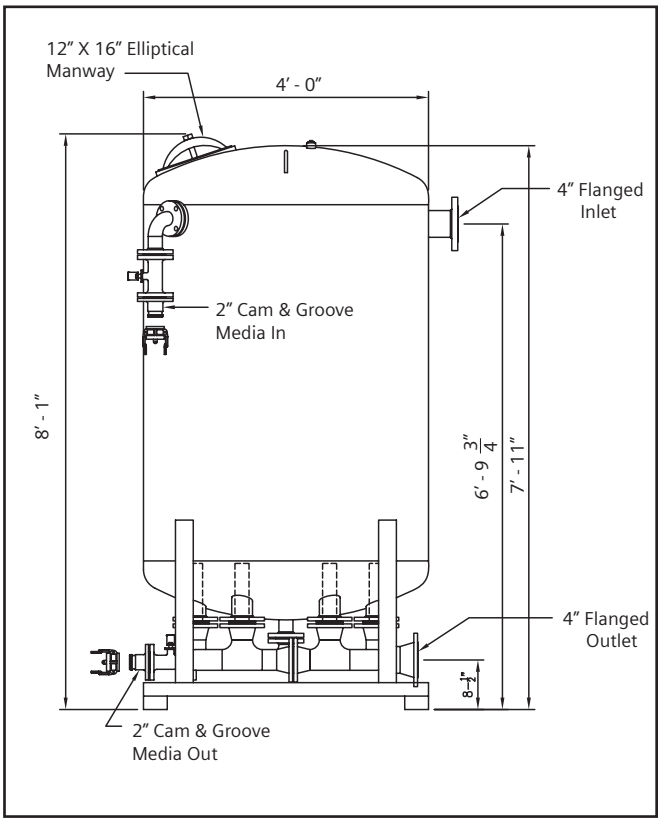
Valve assembly, piping and miscellaneous

Piping:
Underdrain Piping..... 3” Schedule 40 Carbon Steel
Resin Transfer Piping..... ...2” Schedule 10 304L Stainless Steel
Valves (rental units):
Process.....4" butterfly valve with 3" CAM inlet/outlet connections
Resin Transfer....2” Flanged 316 Stainless Steel Full Port Ball Valve
Vent/Wash .....2” Ball Valve
Sample Valve... .....1/2” Ball Valve
Pressure Gauge Assemblies.....Two (2)

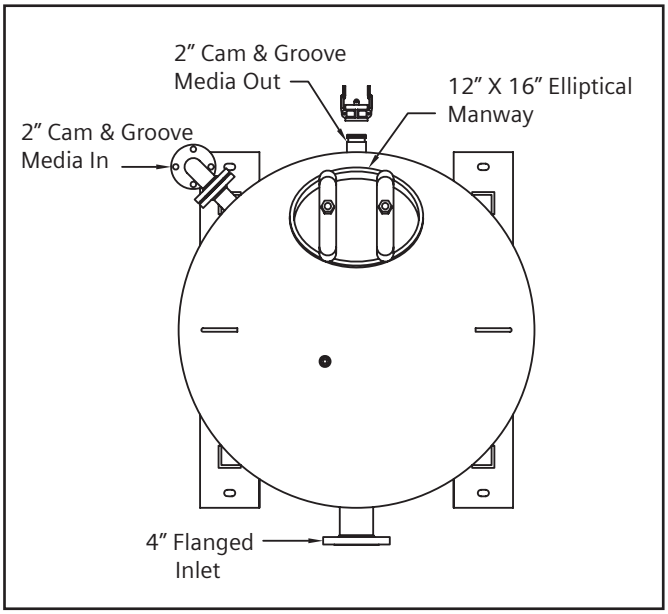
System weight
Vessel shipping weight .....1,710 lb
Media weight .....3,000 lb
Vessel operating weight .....8,100 lb



Front View



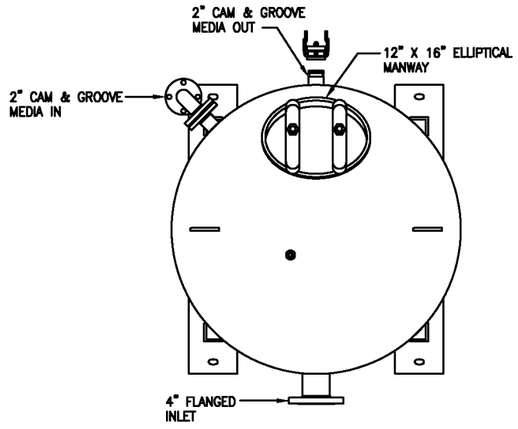
Side View



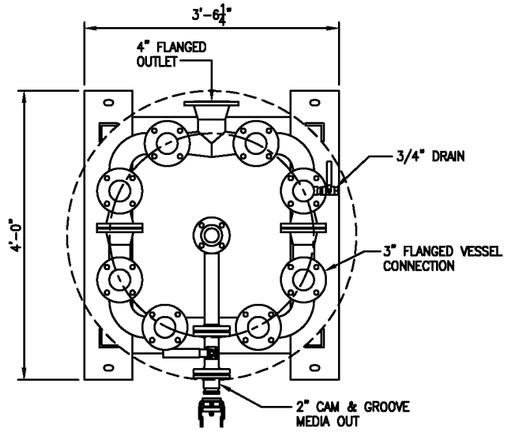
Top View

Siemens
Water Technologies
2430 Rose Place
Roseville, MN 55113
Tel: 651.638.1300
Fax: 651.633.6423

ES-IX48HFdr-DS-0508



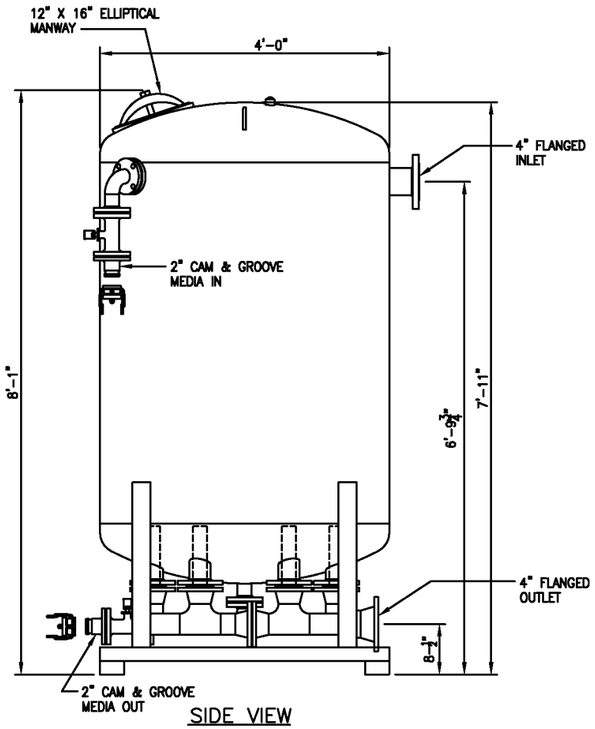
TOP VIEW



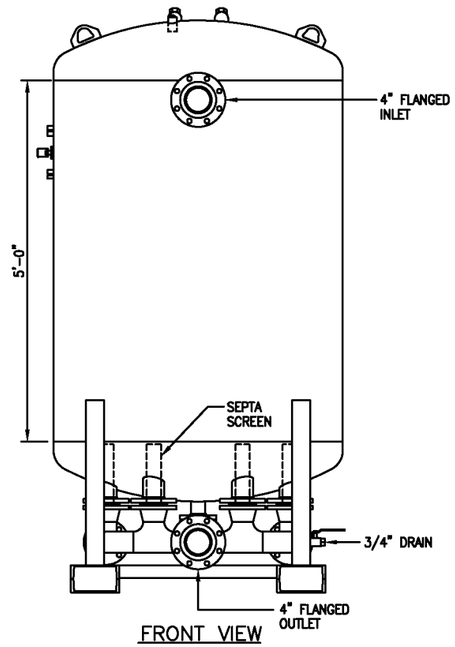
RING HEADER
PLAN VIEW

NOTES:

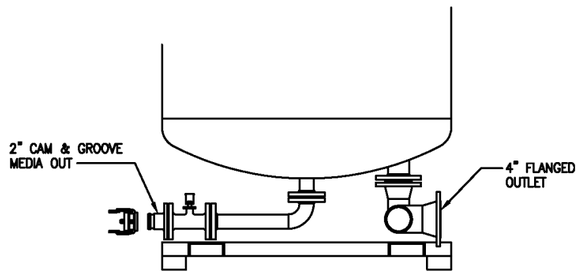
1. THIS DRAWING IS TO SHOW PIPING AND EQUIPMENT FOR CUSTOMER APPROVAL.
2. PROVIDE STAINLESS STEEL SCREENS AT SEPTA UNDER DRAIN.
3. VESSELS SHALL BE CARBON STEEL 100 PSI, NON-ASME CODE.
4. FINISH INTERIOR WITH SCOTCHKOTE 134, PREPARE AND APPLY STRICTLY IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
5. PIPING MATERIALS SHALL MEET: CS PIPE ASTM A-53 GRADE B (ERW); CS FITTINGS SA-234, ASME B16.9; SS THREADED FITTINGS ASTM A-351; SS PIPE ASTM A-312; SS BW FITTINGS ASTM A-403; MI THREADED FITTINGS ASME B-16.3.
6. FINISH EXTERIOR WITH POLYURETHANE 3-4 MILL DFT OVER EPOXY PRIMER 4-6 MIL DFT APPLIED PER MANUFACTURERS RECOMMENDATIONS.
7. SYSTEM ESTIMATED WEIGHTS: SHIPPING: 1,710 LBS.
   WITH RESIN MEDIA: 5,460 LBS.
   OPERATING: 8,065 LBS.
8. GROUTING BY OTHERS IF REQUIRED.
9. DESIGNED FOR SEISMIC ZONE 4.
10. SYSTEM PROCESS CONNECTIONS: 4" 150# RF FLANGES, BOLTS STRADDLE CENTERLINE AS SHOWN.
11. MEDIA CAPACITY: 60 C.F.
12. MAX. PROCESS FLOW: 340 GPM
13. OPERATING TEMPERATURE 150° F MAX.



SIDE VIEW



FRONT VIEW



MEDIA OUT DETAIL

	INTL REF:		REV	DESCRIPTION	DATE	DWN	CHKD	APVD	ECN	COMPANY CONFIDENTIAL	DESIGNER CAR DATE 9-20-06; CHECKER DATE; ENGINEER DATE; MANAGER DATE; FILE:; SCALE:

TITLE: ION EXCHANGE 48" DIA. SINGLE TANK
SALES DRAWING

CLIENT

SIEMENS Water Technologies
RED BLUFF, CA
(530) 527-2664

PROJECT	DRAWING	SHEET	REV
	IX48-ST-SALES	1 OF 1	

Design Specification / Application Memo

(Siemens)

EnSol, Inc.

SIEMENS Water Technologies Business Unit

Siemens Industry Inc., 2430 Rose Place, Roseville, MN 55113-2511

Ion Exchange Application Memo

To:	Jennifer Ellis
From:	Chris Riley
Date:	November 21, 2012
Client:	CWM Chemical Services Inc. (Model City, NY)
Subject:	Landfill Leachate Pond Water (WP# 12919743) Treatability Testing
cc:	Sam Mason, Jim Mathieu, Penny Skoby, Brandon Turk

The sample referenced above was received and analyzed and a full analytical report is given at the end of this memo. The sample had a pH of 7.77, a conductivity of 26,300µS/cm, a total suspended solids (TSS) of 136mg/L and contained 201µg/L (ppb) of total arsenic (As) of which 160ppb was dissolved As. The treatment goal is to reduce the total As concentration to less than 20ppb.

A sample of the wastewater was passed through progressively-smaller filter pore-sizes to evaluate the prefiltration requirements; the data are given in the table below.

Filter Pore Size	25µm	10µm	5µm	1µm	0.45µm
Total As (ppb)	201	201	198	167	160

The sample, filtered to 1µm, was processed through two columns of ASG media, in a series configuration, at an empty bed contact time (EBCT) of approximately 3.5 minutes. Column effluent samples were taken every at varying intervals through 560 bed volumes (BV) at which time the sample volume was exhausted. Analysis of the column effluent samples showed that every sample contained less than 1ppb of total As indicating excellent removal of As by the ASG media.

The system flowrate is expected to average 125 gallons per minute (gpm), 24 hours per day and 7 days per week. Based on this and the data above the following considerations and recommendations are given:

1. The recommended configuration is stepped filtration of 10-µm→1-µm followed by one 60-ft^3 tank of CAR and two 60-ft^3 tanks of ASG media in series (lead-lag).
2. The TSS of 136mg/L warrants the evaluation of a backwashable media filter, microfilter or other alternative to compare to bag and cartridge filters for TSS-removal.
3. Ultimate filtration to 1µm is required to remove particulate As (34ppb of which was removed with 1µm-filtration in this sample) that would otherwise pass through the media.
4. The CAR tank is required to remove TOC that may foul the ASG and reduce its effectiveness for As-removal.
5. Based on the flowrate, the As-concentration and the wastewater ionic background it is estimated that the lead ASG tank will last approximately 29 days.
6. The data indicate that there will be enough As on the spent ASG media to potentially fail TCLP. Based on experience with this media it will likely pass TCLP but this must be confirmed by the generator.

SIEMENS Water Technologies Business Unit

ION EXCHANGE SYSTEM ENGINEERING REPORT

Generator:
CWM Chemical Services Inc. (Model City, NY)

Sales Representative:
Jim Mathieu

Sample Description:
Landfill Leachate Pond Water

Part Numbers: **WXCAR6000CNWVD**
WXASG6000CNWVD

Cations (ppm)	*Total*	*Dissolved*
Aluminum	BDL	BDL
Antimony	0.10	0.096
Barium	BDL	BDL
Beryllium	BDL	BDL
Cadmium	BDL	BDL
Calcium	200	187
Chromium(+3)	0.012	0.009
Copper	0.032	0.032
Iron	BDL	BDL
Lead	BDL	BDL
Magnesium	100	100
Manganese	BDL	BDL
Nickel	0.016	0.012
Potassium	562	550
Sodium	4,590	4,590
Thallium	BDL	BDL
Titanium	BDL	BDL
Zinc	0.022	0.022

Anions (ppm)	*Total*	*Dissolved*
Bicarbonate	NA	NA
Carbonate	NA	NA
Chloride	NA	7,635
Fluoride	NA	66.3
Hydroxide	NA	NA
Nitrate	NA	102
Phosphate	NA	2.10
Sulfate	NA	3,000
Arsenic	0.20	0.16
Chromium(+6)	BDL	BDL
Cyanide	BDL	BDL
Gold	NA	NA
Molybdenum	0.24	0.21
Palladium	NA	NA
Platinum	NA	NA
Selenium	BDL	BDL
Silver	BDL	BDL
Vanadium	0.10	0.09

Parameter	*Value*	*Units*
pH	7.77	S.U. (by meter)
Conductivity	26,300	µS/cm
Color	Slight tan	
Odor	None	
Silica	22.5	mg/L SiO_2
TOC	25.5	mg/L
TSS	136	mg/L
Total Mercury	BDL	µg/L
Dissolved Mercury	BDL	µg/L

Current Process Information	
Flowrate (gpm)	125
Batch Size (gpd)	180,000
Operating Temp. (°F)	55
Hours/Day	24
Days/Week	7
Process Water Source	Landfill Leachate
Water Reuse/Discharge	Discharge
Process Water Quality	Not Given
Discharge Water Quality	As < 20ppb

Observations and Comments:

1) BDL = Below Detectable limits, NA = Not Analyzed
2) Evaluation of particulate As showed the following: 25µm filtration: 201ppb As, 10µm: 201ppb, 5µm: 198ppb, 1µm: 167ppb, 0.45µm: 160ppb.
3) Bench-scale ASG treatment removed dissolved As to <1ppb through 560 bed volumes.
4) Spent ASG assumed D004 (arsenic) hazardous waste; TCLP recommended.

SIEMENS Water Technologies Business Unit

ION EXCHANGE SYSTEM ENGINEERING REPORT

GENERATOR :	Part Numbers:	WXCAR6000CNWVD
CWM Chemical Services Inc. (Model City, NY)		

Suggested Treatment System

Pretreatment

Maximum Temperature:	120 °F
Optimum pH Range:	5 to 8 S.U.
Prefiltration Required:	10 → 1 micron

Ion Exchange Treatment

Type	Size, cu. ft.	Number	Media	Tmt. Code
Carbon	60	1	CAR	23
Cation	NA	NA	NA	NA
Arsenic	60	2	ASG	89
Mixed Bed	NA	NA	NA	NA

The suggested ion exchange system is based on the process information and sample analytical results shown on page 1 of this report.

Post Treatment

Post-filtration Required:	NA	micron

Estimated Canister Life Expectancy

Type	Gallons	Days	Changes/Yr.
Carbon	16,200,000	90	4
Cation	NA	NA	NA
Arsenic	5,231,250	29	13
Mixed Bed	NA	NA	NA

Carbon and resin service life is estimated based upon the sample and system shown above.

SIEMENS Water Technologies Business Unit

ION EXCHANGE SYSTEM ENGINEERING REPORT

GENERATOR :	Part Numbers: WXCAR6000CNWVD
CWM Chemical Services Inc. (Model City, NY)	

Hazardous Waste Indicators

Toxic	USEPA Code
Characteristic Waste	
Arsenic	D004*
Listed Waste	
None Applicable	
State Waste	
None Applicable	

* ASG only

Highlighted toxics in the box at the left indicate that exhausted carbon and ion exchange resin from the treatment system is considered a RCRA hazardous waste for those components and is subject to all RCRA and DOT rules and regulations governing handling and transportation of hazardous wastes.

The absence of hazardous waste indicators is not to be interpreted to mean that Siemens Industry, Inc. implies or warrants that spent carbon and ion exchange resin resulting from waste water treatment is not a hazardous waste. The U.S. Environmental Protection Agency requires the generator of the waste to determine whether a waste is a hazardous waste according to regulations found in the Code of Federal Regulations, see 40 CFR 260. Siemens Industry, Inc. testing is for the purposes of treatability and compatibility with its treatment systems. Analytical methods are in accordance with Siemens Industry, Inc. standard operating procedures and may not strictly adhere to EPA or equivalent test methods.

November 21, 2012

Christopher T. Riley, P.E.
Siemens Industry, Inc.
Roseville, Minnesota

3M Scotchkote Product Data

(3M)

EnSol, Inc.

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 134

Product Description

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 134 is a one-part, heat curable, thermosetting epoxy coating designed for corrosion protection of metal. The epoxy is applied to preheated steel as a dry powder which melts and cures to a uniform coating thickness. This bonding process provides excellent adhesion and coverage on applications such as valves, pumps, pipe drains, hydrants and porous castings. Scotchkote 134 coating is resistant to wastewater, corrosive soils, hydrocarbons, harsh chemicals, and sea water. Powder properties allow easy manual or automatic application by electrostatic or air-spray equipment.

Product Features

- No primer required for most applications.
- Particularly suitable for electrostatic or air-spray application on preheated metal articles.
- Can be electrostatically applied to unheated metal parts and subsequently cured by baking.
- Long gel time allows application on large or complex articles, minimizing fear of runs, sags, laminations, or unsightly overspray.
- Especially useful for coating the inside of pipe or other fabrications where a smooth, corrosion resistant coating is required.
- Can be machined by grinding or cutting to meet close tolerance requirements.
- Allows easy visual inspection of coated articles.
- Can be painted with alkyd paint, acrylic lacquer, polyurethane, or acrylic enamel for color coding.
- Will not sag, cold flow, or become soft in storage. Long term storage under most climatic conditions.
- Lightweight for lower shipping costs.
- Protects over wide temperature range.
- Resists direct burial soil stress.
- High adhesion and toughness.
- Resists cavitation and cathodic disbondment.
- Excellent chemical resistance.
- Suitable for elevated temperature service in presence of H_2S, CO_2, CH_4, crude oil and brine when applied over phenolic primer such as Scotchkote 345.
- Long-term performance history in water, sewage, and other service environments.
- Scotchkote 134 coating has been tested and certified to NSF /ANSI Standard 61, Drinking Water System Components. For NSF certified applications,max approved thickness is 60 mil (1.5 mm).
- Scotchkote 134 FBEC meets the requirements of AWWA Standard C213 and C550.
- Operating temperature dry is 235°F/ 113°C and wet is 175°F/79°C.

General Application Information

1. Remove oil, grease and loosely adhering deposits.
2. Abrasive blast clean the surface to NACE No. 2/SSPC-SP10 ISO 8501:1, Grade SA 2 1/2 near-white metal.
3. Apply mechanical masks or mask with materials such as Scotch Glass Cloth Tape 361 or Scotch Aluminum Foil Tape 425 as required.
4. Preheat article to the desired application temperature per cure specifications.
5. Deposit Scotchkote 134 coating by powder spray to the specified thickness.
6. Cure according to cure specifications.
7. Visually and electrically inspect for coating flaws after the coating has cooled.
8. Repair all defects.

Cure Specifications

Scotchkote 134 coating may be applied to metal articles which have been preheated to a temperature of 300°F/149°C to 475°F/246°C. After application, Scotchkote 134 coating must be cured according to the cure guide to achieve maximum performance properties.

If Scotchkote 134 coating is electrostatically applied to unheated parts, the cure time should be measured from the time the coated part reaches the cure temperature. After cure, the coating may be force cooled using air or water to facilitate inspection and handling.

3M™ Scotchkote™ Fusion-Bonded Epoxy Coating 134 Cure Guide

Temperature of Article at Time of Powder Application	Typical Gel Time	Cure Time
475°F/246°C	40 seconds	7 minutes
450°F/232°C	60 seconds	10 minutes
400°F/204°C	120 seconds	15 minutes
350°F/177°C	330 seconds	25 minutes
425°F/218°C	90 seconds	25 minutes for NSF/ANSI 61 approved applications

Typical Properties

Property	Value
Color	Forest Green
Specific Gravity - Powder (Air Pycnometer)	1.51
Coverage	127 ft^2/lb/mil (0,66 m^2/kg/mm)
Fluid Bed Density	33 lbs/ft^3 (530 kg/m^3)
Shelf Life at 80°F/27°C	18 months
Average Gel Time 400°F/204°C	120 seconds
Edge Coverage	12% to 18%
Minimum Explosive Concentration	0.03 oz/ft^3 (30,6 g/m^3)
Ignition Temperature	986°F/530°C
V.O.C. (As Supplied)	0 g/L, as calculated

Chemical/Pressure/Temperature Resistance

All tests performed on Scotchkote™ Fusion Bonded Epoxy Coating 134 applied over a 1 mil/25,4 µm phenolic primer. Liquid phase for all test conditions: 33% kerosene, 33% toluene, 34% brine solution of 5% NaCl.

Test Conditions	Gas Phase	Results
Autoclave, 120°F/49°C 48 hours, 1500 psi/10.3 MPa	99.5% CO_2 0.5% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 150°F/66°C 48 hours, 2200 psi/15.2 MPa	80% CH_4 12% CO_2 8% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 200°F/93°C 24 hours, 3300 psi/22.8 MPa	86% CH_4 8% CO_2 6% H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase
Autoclave, 300°F/149°C 24 hours, 3000 psi/20.7 MPa	90% CH 10% CO_2 Trace H_2S	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon, or gas phase

3M™ Scotchkote Fusion-Bonded Epoxy Coating 134 Test Data

Property	Test Description	Results
Adhesion	Elcometer	> 3000 psi (glue failure)/ 210 kg/cm^2
Adhesion to Steel (Shear)	ASTM D 1002 10 mil/254 µm glue line	4300 psi/302 kg/cm^2 cohesive failure
Impact	Gardner 5/8 in/1,6 cm diameter tup 1/8" x 3" x 3" (0,32 cm x 7,6 cm x 7,6 cm) steel panel	160 in-lbs 1,8 kg•m
Hardness	Barcol ASTM D 2583	23
Abrasion Resistance	ASTM D 4060 CS-17 1000g weight / 5000 cycles	0,07 g loss
Thermal Shock	310°F/154°C to -320°F/-195°C coated pipe	10 cycles, no effect
Penetration	ASTM G 17 -40°F/-40°C to 240°F/116°C	0
Tensile Strength	ASTM D 2370	7300 psi/512 kg/cm^2
Elongation	ASTM D 2370	4.2%
Compressive Strength	ASTM D 695	12800 psi/900 kg/cm^2
Coefficient of Friction	API RP5L2-1968, App 8	23°
Electric Strength	ASTM D 149	1000 volts/mil (39,4 kv/mm)
Hot Water Resistance	160°F/71°C immersion / 120 days	Good adhesion, no blistering
Electrical Resistivity	ASTM D 257	1.2 x 10^{15} ohm•cm
Thermal Conductivity	MIL-I-16923E	7 x 10^{-4} cal/sec/cm^2/°C/cm
Water Absorption	3M 10 mil/254 µm free film 30 days	6,5 g/m^2
Fungus Resistance	MIL-STD 810-B Method 508	Funginert
Salt Fog	MIL-E-5272C	No effect
Weatherometer	ASTM G 23 5000 hours	Surface chalk
Soil Stress - Burial	Bureau of Reclamation 25 cycles	No effect
Salt Crock	30 day, 5 volt, 5% NaCl sand crock 230°F/110°C	Disbondment diameter 24 mm average
Bendability	3/8"/9,5 mm coupon mandrel bend at 73°F/23°C	30 pipe diameters 1.9° / diameter length

Handling and Safety Precautions

Read all Health Hazard, Precautionary and First Aid, Material Safety Data Sheet, and/or product label prior to handling or use.

Ordering Information/Customer Service

For ordering technical or product information, or a copy of the Material Safety Data Sheet, call:
Phone: 800/722-6721
Fax: 877/601-1305

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Infrastructure Protection Division

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www.3M.com/corrosion

80-6111-8506-9 Rev. A

3M™ Scotchkote™ Fusion Bonded Epoxy Coating 134

Information, Properties and Test Result

September 2012
80-6111-8429-4-C

3M

Table of Contents

3M™ Scotchkote™ Fusion Bonded Epoxy Coating 134

1 - Introduction

The cost of the coating is only a small fraction of the cost of a tubing string, yet the coating is the major means of assuring extended operation by preventing deterioration and service disruption due to corrosion loss. 3M™ Scotchkote™ Fusion Bonded Epoxy Coatings represent a significant improvement in internal coating technology for the oil, gas and water industries.

2 - Description

Scotchkote fusion bonded epoxy coating 134 is a one - part, heat curable, thermosetting epoxy coating designed for corrosion protection of metal. The epoxy is applied to preheated steel as a dry powder which melts and cures to a uniform, coating thickness. This bonding process provides excellent adhesion and coverage on applications such as valves, pumps, pipe drains, hydrants and porous castings. Scotchkote 134 FBEC assistant to waste water, corrosive soils, hydrocarbons, harsh chemicals and sea water. Powder properties allow easy manual or automatic application by electrostatic or air - spray equipment. When applied over a suitable primer, it is appropriate for operation at moderate temperatures and pressures in the presence of H_2O, CO_2 and CH_4, crude oil and brine.

Scotchkote 134 FBEC consists of a blend of epoxy resin and curing agent additives, pigments, catalysts, leveling and flow control agents. Possible combinations of raw materials are extensive; hence careful selection has been made by 3M so that the resultant coating will serve in the environment encountered. Scotchkote 134 FBEC has been designed to allow trouble - free, consistent production application at the coating plant. Selection of the chemical elements for the fusion bonded epoxy coating is very important. The molecular structure of the epoxy resin, the type and reactivity of the hardener, catalyst and additives all play an important role in the ultimate coatability and performance of the fusion bonded epoxy.

3M Company maintains a divisional laboratory group dedicated to the research and development of fusion bonded epoxy coating. The group's personnel have many years of experience in the formulation and evaluation of epoxy coatings. This effort is assisted by 3M staff laboratories with broad - based expertise in scientific disciplines applicable to coating and surface technology. In addition, 3M synthesizes and manufactures specialized epoxy resins, hardeners, catalysts and additives used to formulate Scotchkote FBE coatings to meet unusual performance and operational requirements.

3 - History

Scotchkote 134 FBEC has been used extensively in the oil and gas industry to coat the exterior and interior of line pipe. Over 40,000 miles (65,000 km) of Scotchkote coated pipe have been installed thoughout the world. This technology has been expanded through 3M research to develop chemically stable, high temperature/pressure resistant internal linings for use in drill pipe, primary and secondary recovery tubing, and pipe for oil, gas and water transportation. Coating properties have been proven by rigorous 3M autoclave testing, and the results verified by independent laboratory and customer investigation.

4 - Manufacturing

All Scotchkote fusion bonded epoxy coating powders are made using the fusion blend process developed by 3M. Ingredients are first pulverized, properly proportioned and homogeneously dry mixed. Next, the blended materials are carefully and thoroughly mixed in the molten state using a continuous melt mixer. The fused blend is cooled and then pulverized into the final powered form. Particle size distribution is carefully monitored to meet optimum application standards required by the various coating plants. The fusion blend process assures that each particle of the coating powder contains all active ingredients, thus eliminating changes in reactivity due to separation or stratification of ingredients during transportation and application.

5 - Process and Quality Control

Process control is essential to the quality of the finished product. 3M maintains rigid incoming quality inspection of raw materials, precise measurement and metering of critical components, controlled environmental conditions and processing temperatures for the chemical constituents, and a discerning outgoing inspection of the finished coating powder to assure uniformity of product application and performance. Among the quality control tests performed on 3M powder coatings are: gel time, cure, flow, fluidization, particle distribution, adhesion, impact, appearance and moisture content.

6 - Packaging, Storage and Shipping

Scotchkote 134 FBEC is packaged in a heavy duty, polyethylene bag in a stout, easy open, fiberboard carton which is clearly labeled with product number and manufacturing identification. This package protects the coating powder from humidity and contamination during shipment and storage. The net weight is 65 U.S. lbs. (29.5 kilos). The sealed cartons are palletized on wooden pallets with net weight of 1170 lbs. (530 kilos) and securely banded for shipment. The packaged product must be shipped and stored at temperatures not exceeding 80˚F (27˚C).

7 - Properties of the Powder

3M™ Scotchkote™ Fusion Bonded Epoxy Coating 134

Property	Test Method	Value
Classification	ASTM D 1763	Type 1, Grade 2
Color	–	Forest Green
Gloss	Gardener 60˚ gloss meter, 350˚ (177˚C) application temperature	34 average
Specific Gravity (Powder)	Air Pycnometer	1.51
Coverage	Calculated from air pycnometer specific gravity of powder	125 ft^2/lb/mil 0.66 m^2/kg/mm
Gel time at 400˚F (204˚C)	Hot plate	120 sec average
Glass Plate Pill Flow	3M glass slide 300˚F (149˚C) 12 mm diameter, 0,85 gram pill, 1 min horizontal, 15 min. at 63˚ angle	75 - 100 mm average flow
Moisture Content at time of manufacture	Carl Fischer	<0.3%
Particle size	Alpine sieve analysis	>177 μm 1% <44 μm 45 - 55%
Heat of Polymerization	Differential Scanning Calorimeter	70 J/gm typical
Glass Transition Temperature of Cured Coating	Differential Scanning Calorimeter (midpoint)	107˚C (225˚F) typical

8 - Properties of the Coating

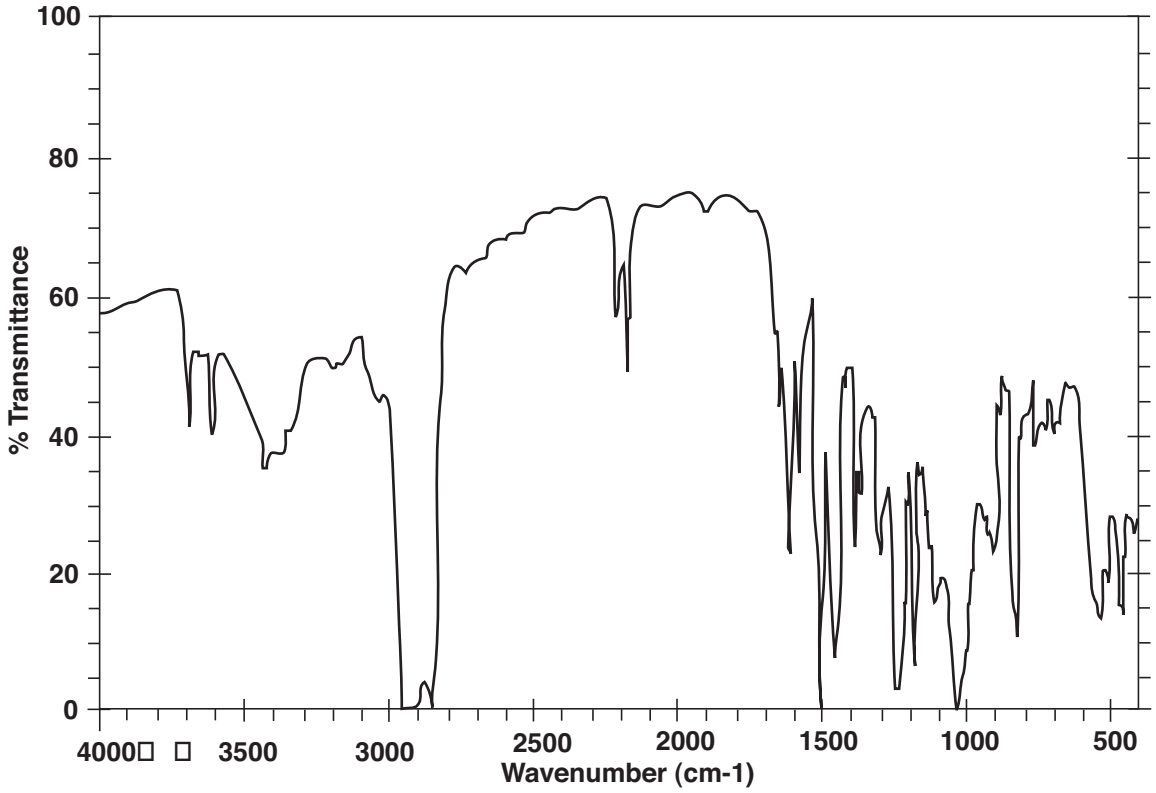
All tests have been conducted at 73˚F (23˚C) on unprimed surfaces unless otherwise noted.

8.1 Hardness

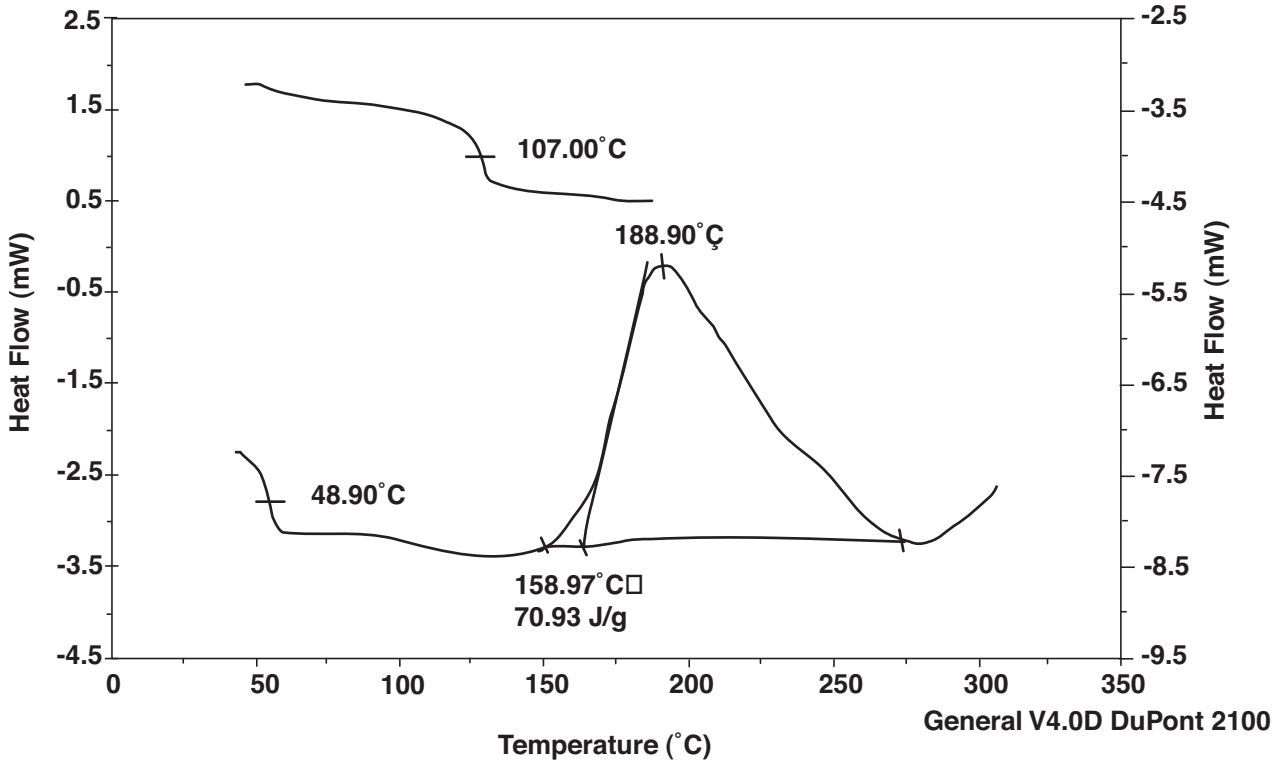
Property	Test Method	Test Results
Hardness	Barcol, ASTM D 2583	23
	ASTM D 785	89
	Rockwell M	55

8.2 Tensile Strength

Property	Test Method	Test Results
Tensile Strength	ASTM D 2370	7300 psi
	free film	513 kg/cm2



Sample: S/K 134 3B26-51 L09D2139
Size: 7.2000 mg
Method: S/K 134
Comment: EQUIL. 20˚C/MIN-70˚C, 20˚C/MIN-310˚C, 20˚C/MIN-160˚C, N2



8.3 Elongation

Property	Test Method	Test Results
Elongation	ASTM D 2370 free film	4.2%

8.4 Impact Resistance

Property	Test Method	Test Results
Impact	Gardener, 5/8 in. (16 mm) diameter tup, 0,125 in (3.2 mm) panel	160 in - lbs. 18,1 J

8.5 Adhesive Strength

Property	Test Method	Test Results
Shear	ASTM D 1002, 10 mil (254 μm glue line)	4300 psi 302 kg/cm^2

8.6 Penetration Resistance

Property	Test Method	Test Results
Penetration	ASTM G 17 - 40˚ to 240˚F (- 40˚ to 116˚C)	0
Compression strength	ASTM D 695	12800 psi 900 kg/cm^2

8.7 Bendability

Property	Test Method	Test Results
Bend	3/8 in. (9,5 mm) primed and unprimed coupon mandrel bend	Pipe Dia.=30 Elongation (%)=1.7 Angle of Deflection (˚/PDL) =1.9

8.8 Thermal - Mechanical

Property	Test Method	Test Results
Thermal Conductivity	MIL - I - 16923E	7x10 - 4 cal/sec/cm2/C˚/cm
Thermal Shock	3M, 10 cycles - 100˚ to 300˚F (- 70˚ to 150˚C)	Unaffected by thermal shock

8.9 Volume Resistivity

Property	Test Method	Test Results
Volume Resistivity	ASTM D 257	1.2×10^{15} ohm•cm

8.10 Electric Strength

Property	Test Method	Test Results
Electric Strength	ASTM D 149	1000 V/mil 40 kV/mm

8.11 Weathering Resistance

Property	Test Method	Test Results
Weathering Resistance	Weatherometer ASTM G 53, 5000 hrs. Condensation test temp. 50˚C Cycle time 4 hours UV/ Four hours condensation	Surface chalk No blistering
Salt Fog	MIL - E - 5272C	No blistering No discoloration No loss of adhesion

8.12 Cathodic Disbondment Resistance

Property	Test Method	Test Results
Cathodic Disbondment Resistance	30 day, 5 volt 5% NaCl, sand crock 230˚F (110˚C)	Disbondment radius 24 mmr average
	4 day 3 volt 3% NaCl 71˚C (160˚F)	5 mmr average

8.13 Moisture Resistance

Property	Test Method	Test Results
Water Immersion	ASTM D 570 free film, 30 day 10 mil (250 mm)	6,5 g/m 2 weight gain

8.9 Volume Resistivity

Property	Test Method	Test Results
Volume Resistivity	ASTM D 257	1.2×10^{15} ohm•cm

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Property	Test Method	Test Results
Electric Strength	ASTM D 149	1000 V/mil 40 kV/mm

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Property	Test Method	Test Results
Cathodic Disbondment Resistance	30 day, 5 volt 5% NaCl, sand crock 230˚F (110˚C)	Disbondment radius 24 mmr average
	4 day 3 volt 3% NaCl 71˚C (160˚F)	5 mmr average

8.13 Moisture Resistance

Property	Test Method	Test Results
Water Immersion	ASTM D 570 free film, 30 day 10 mil (250 mm)	6,5 g/m 2 weight gain

Notes on Autoclave Testing

Notes: All tests conducted on coatings applied over 1 mil (25.4 µm) liquid phenol primer.

'Pass' means excellent adhesion, no blisters, no swelling in a phases, i.e.: aqueous, hydrocarbon or gas phase.
'Fail' means loss of adhesion, or blisters, or excessive swelling in any phases.

8.14 Autoclave Testing

Property	Test Method	Test Results
Pressure / Temperature Duration	1500 psi (10.3 MPa) 120˚F (49˚C) 24 hours	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon or gas phase
Gas Phase	99.5% CO_2 0.5% H_2S	
Liquid Phase	33.0% Kerosene 33.0% Toluene 34.0% Brine Solution (5% NaCl)	
Discharge	Discharge Rapid at Test Temperature	

Autoclave Test #1

Property	Test Method	Test Results
Pressure/Temperature Duration	5 psi (0.03 MPa) 68˚F (20˚C) 72 hours	Pass
Gas Phase	100% H_2S	
Liquid Phase	Turks Island Sea Water	
Discharge	Release pressure over 5 min. @ test temperature	

Autoclave Test #2

Property	Test Method	Test Results
Pressure/Temperature Duration	60 psi (0.4 MPa) 150˚F (66˚C) 24 hours	Pass
Gas Phase	100% CO_2	
Liquid Phase	5% NaCl Brine	
Discharge	Release pressure over 1/2 hour period @ test temperature	

Autoclave Test #3

Property	Test Method	Test Results
Pressure/Temperature	450 psi (3.1 MPa)	Pass
Duration	185˚F (85˚C) 24 hours	
Gas Phase	15% CO_2 84.9% N_2 0.1% H_2S 71˚C (160˚F)	
Liquid Phase	Deionized Water Crude Oil	
Discharge	Release pressure over 5 min. @ test temperature	

Autoclave Test #4

Property	Test Method	Test Results
Pressure/Temperature	2000 psi (13.8 MPa)	Pass
Duration	200˚F (93˚C) 16 hours	
Gas Phase	5% CO_2 94.5% Methane 0.5% H_2S	
Liquid Phase	5% NaCl Brine	
Discharge	Cool for 4 hours then rapidly release pressure	

Autoclave Test #5

Property	Test Method	Test Results
Pressure/Temperature	3300 psi (22.8 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Liquid Phase	8% CO_2 86% Methane 6% H_2S	
Discharge	Cool overnight to ambient release pressure over 1/2 hr. period	

Autoclave Test #6

Property	Test Method	Test Results
Pressure/Temperature	2500 psi (17.2 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	10% CO_2 90% N_2	
Liquid Phase	Wasia Water	
Discharge	Release pressure over 1/2 hr. period @ test temperature	

Autoclave Test #7

Property	Test Method	Test Results
Pressure/Temperature	1500 psi (10.3 MPa)	Pass
Duration	120˚F (49˚C) 48 hours	
Gas Phase	95.5% CO_2 0.5% H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Instant pressure release @ test temperature	

Autoclave Test #8

Property	Test Method	Test Results
Pressure/Temperature	35 psi (0.2 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	Air	
Liquid Phase	15% HCl	
Discharge	Force cool to ambient release pressure over 5 min. period	

Autoclave Test #9

Property	Test Method	Test Results
Pressure/Temperature	2200 psi (15.2 MPa)	Pass
Duration	150˚F (66˚C) 24 hours	
Gas Phase	12% CO_2 80% Methane 8% H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Release pressure over 1/2 hr. period @ test temperature	

Autoclave Test #10

Property	Test Method	Test Results
Pressure/Temperature	4000 psi (27.5 MPa)	Pass
Duration	225˚F (107˚C) 24 hours	
Gas Phase	100% CO_2	
Liquid Phase	5% NaCl Solution saturated with H_2S	
Discharge	Cool to ambient release pressure over 45 sec.	

Autoclave Test #11

Property	Test Method	Test Results
Pressure/Temperature	150 psi (1.0 MPa)	Pass
Duration	250˚F (121˚C) 24 hours	
Gas Phase	25% $C0_2$ 55% H_2S 10% Methane 10% N_2	
Liquid Phase	28% NaCl Solution	
Discharge	Cool for 2 hours release pressure over 15 min.	

Autoclave Test #12

Property	Test Method	Test Results
Pressure/Temperature	3000 psi (20.7 MPa)	Slight swell
Duration	300˚F (149˚C) 24 hours	
Gas Phase	10% $C0_2$ 90% Methane Trace H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Cool to 104˚F (40˚C) release pressure over 1/2 hr.	

8.15 Taste and Odor Production Potential

Property	Test Method	Test Results	
		TON	
Threshold Odor		5 days	10 days
Number (TON)	20˚C	1	1
(Ton of 10 or less	60˚C	1	1
is passing)			
		Results: Pass Type Odor: None	

8.16 VOC Production Potential

Property	Test Method	Test Results
VOC Analysis	5 day soak cycle	Pass. Appears clean and free of significant VOC contamination

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80-6111-8429-4-C

Appendix C

Proposed Filters, Piping, And Equipment Information

EnSol, Inc.

HARMSCO® UP-FLOW FILTERS

Up-Flow -

A design so superior it's patented!

Harmsco® Up-Flow Cartridge Filters outperform conventional filter designs!

Venting valves are not necessary and filtration efficiency is improved.

Fail safe wing nuts
Wing nuts are used so no tools are required. Finger tight is generally sufficient. Hex nuts are recommended with 75 inch lbs. of torque above 100 psi.

Features:

- *Rugged 304 stainless steel construction (316 optional)*
- *Electro-polished for increased resistance to corrosion*
- *Extensive choice of cartridge micron ratings and media including carbon*
- *Flow rates to 800 GPM*
- *Pressure rated to 150 psi and hydrostatically tested*
- *Individual studs for safe, secure lid closure*
- *Easy cartridge installation, removal and service*
- *Optional high temperature ratings*
- *Chemical resistant coating optional*

Specifications:

Filter vessel & metal components	*304 stainless steel, electropolished for increased resistance to corrosion.*
Holding rods, lifting rods & standpipes	*CPVC, standard models; 304 stainless steel, All-Stainless models*
Pipe caps	*CPVC, standard models; 304 stainless steel, All-Stainless models.*
Rim gaskets	*EPDM, standard. Buna-N and Viton available.*
O-Rings	*Buna-N, standard. EPDM and Viton available.*
Bottom seals	*Natural gum rubber, standard. EPDM and Buna-N available.*
Wing nuts	*Brass. (Brass hex nuts and stainless steel flat washers available.)*
Temperature	*Rated to 140°F (60°C) with CPVC rods, pipe caps, standpipes and standard Harmsco cartridges. To 200°F (93°C) for all stainless models with stainless steel rods, pipe caps and standpipes and Harmsco High-Temp cartridges. Temperature limits vary and depend on pressure and time under load.*
Pressure	*Rated for pressures to 150 psi (10 bar) maximum.*
Flow	*Up to 800 GPM (Typical flow rates are 4-6 GPM per single length (9-3/4") Harmsco cartridge. Published data is for guidelines only. Please consult pressure drop charts.)*

Harmsco® Filtration Products
P.O. Box 14066, North Palm Beach, FL 33408
(561) 848-9628 • Toll Free: (800) 327-3248
Fax: (561) 845-2474 • e-mail: sales@harmsco.com

MADE IN U.S.A.

017 4/07

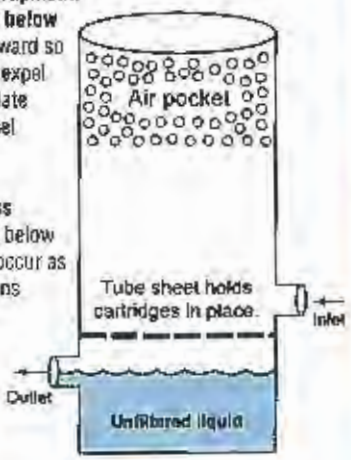
Harmsco® Up-Flow Filters

Filter Model	HIF 7	HIF 14	HIF 16	HIF 21	HIF 24	HIF 42	HIF 75	HIF 100	HIF 150FL	HIF 200FL
Flow rate(U.S. GPM)	Up to 30	Up to 60	Up to 75	Up to 90	Up to 100	Up to 175	Up to 300	Up to 400	Up to 600	Up to 800
Flow rate (LPM)	Up to 113	Up to 226	Up to 284	Up to 340	Up to 397	Up to 662	Up to 1,135	Up to 1,514	Up to 2,271	Up to 3,028
Flow rate (M3HR)	Up to 7	Up to 14	Up to 16	Up to 21	Up to 24	Up to 42	Up to 75	Up to 100	Up to 150	Up to 200
Cartridges	7RD 9-3/4	7RD 19-1/2	8RD 19-1/2	7RD 29-1/4	8RD 29-1/4	14RD 29-1/4	25RD 29-1/4	50RD 19-1/2	50RD 29-1/4	100RD 19-1/2
	7 Singles	7 Doubles	8 Doubles	7 Triples	8 Triples	14 Triples	25 Triples	50 Doubles	50 Triples	100 Doubles

Typical Competitive Multi-Cartridge Filters

Potential for air entrapment.
With outlets located **below** inlets, air travels upward so vents are needed to expel air that can accumulate within the filter vessel during operation.

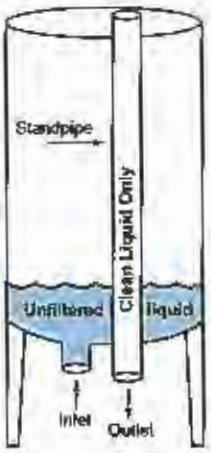
Potential for by-pass
With outlets located below inlets, by-pass can occur as unfiltered liquid drains downward to the sump while the cartridges are removed. This may result in by-pass when the filter is put back into service.



Harmsco® HIF Up-Flow Filters

No air entrapment
Air is self purged from Harmsco® Up-Flow filters because outlets (top of standpipes) are at the high point of the filters.

No by-pass during service
No liquid can by-pass Harmsco® filters during servicing because outlet standpipes are always on the "clean side" of the filter.

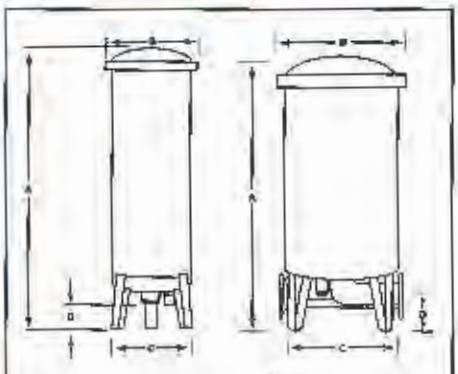


Harmsco® All Stainless Filter Housing

Filters come with stainless steel holding rods, bottom plate and standpipes for high temperatures 200°F. (93°C) and aggressive chemicals. O-rings are Buna-N; rim gaskets are EPDM; other options, including viton available.

Note:
Optional 222 by flat end configuration accepts seven cartridges and is available for HIF 7SS through HIF 24SS.

Model	Flow Rate	Pipe Size	Ship Wt.
HIF 7SS	To 30 GPM	1-1/2"	30 lbs. 14 Kg
HIF 14SS	To 60 GPM	1-1/2"	40 lbs. 18 Kg
HIF 16SS	To 75 GPM	2"	42 lbs. 19 Kg
HIF 24SS	To 100 GPM	2"	52 lbs. 24 Kg



Model	A	B	C	D	Service Mt. Clear	Inlet/ Outlet	Drain
HIF 7	19-1/2"	13"	13"	3-1/2"	35"	1-1/2" NPT	1" NPT
HIF 14	28"	13"	13"	3-1/2"	43"	1-1/2" NPT	1" NPT
HIF 16	28"	13"	13"	4"	46"	2" NPT	1" NPT
HIF 21	37"	13"	13"	3-1/2"	52"	1-1/2" NPT	1" NPT
HIF 24	37"	13"	13"	4"	56"	2" NPT	1" NPT
HIF 42	40"	18"	18"	5-3/8"	60"	2" NPT	1" NPT
HIF 75	42"	20"	20"	6-3/8"	70"	3" NPT	1-1/2" NPT
HIF 100	52"	20"	20"	5-7/8"	87"	3" NPT	1-1/2" NPT
HIF 150FL	48"	28"	28"	5-3/16"**	76"	4" flange	1-1/2" NPT
HIF 200FL	58"	28"	28"	5-3/16"**	93"	4" flange	1-1/2" NPT

** Diameter of flange fittings

Harmsco® Filtration Products
P.O. Box 14066, North Palm Beach, FL 33408
(561) 848-9628 • Toll Free: (800) 327-3248 • Fax: (561) 845-2474
e-mail: sales@harmsco.com

HARMSCO®

HIF

Up-Flow Cartridge Housings

Commercial/Industrial

Up-Flow Filtration

A design so superior it's patented.

NSF

Certified to ANSI/NSF 61

- **This product is designed with a patented Up-flow technology which prevents the accumulation of air inside the filter housing keeping the filter operating at 100%.**

Features

- 304 stainless steel construction, standard
- Electropolished finish, standard
- 150 psi (10.3 bar) pressure rating
- Flow Rates up to 800 gpm
- All filter housings hydrostatically tested
- Easy cartridge installation, removal and service
- Individual studs for safe, secure lid closure
- Extensive choice of cartridge micron ratings and media

Options:
316 stainless steel
Chemical resistent coating
Flanged options on HIF 24, HIF 42, HIF 75 and HIF 100

HIF 7 HIF 24 HIF 200FL

Not shown:
HIF 14, HIF 16, HIF 21, HIF 42, HIF 75, HIF 100 and HIF 150FL

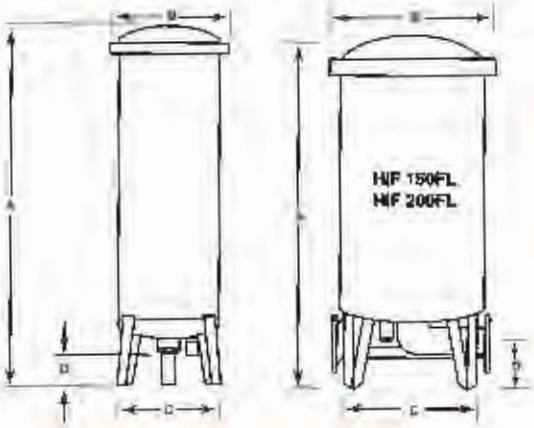
Applications

- Residential and Commercial Drinking Water
- Cooling Tower Filtration
- Process Water
- Reverse Osmosis Pre-filtration
- Ground Water Remediation
- Utility Water
- Industrial Waste Water Treatment
- Surface Water Treatment Rule (SWTR) LT2

Harmsco® Up-Flow Cartridge Housings HIF

Cartridge Cluster Filters

All cartridges in our 7, 14, 16, 21 and 24 models are arranged in a single "cartridge cluster," so all cartridges are removed at one time for easy cartridge cleaning or replacement.



Dimensions

Filter Model	A Height	B Diameter	C Leg Width	D Height	Service Ht.	Inlet/Outlet	Drain
HIF 7	19-1/2"	13"	13"	3-1/2"	35"	1-1/2" NPT	1" NPT
HIF 14	28"	13"	13"	3-1/2"	48"	1-1/2" NPT	1" NPT
HIF 16	28"	13"	13"	4"	48"	2" NPT	1" NPT
HIF 21	37"	13"	13"	3-1/2"	68"	1-1/2" NPT	1" NPT
HIF 24	37"	13"	13"	4"	68"	2" NPT	1" NPT
HIF 42	40"	18"	18"	5-3/8"	68"	2" NPT	1" NPT
HIF 75	42"	20"	20"	6-3/8"	70"	3" NPT	1-1/2" NPT
HIF 100	52"	20"	20"	5-7/8"	67"	3" NPT	1-1/2" NPT
HIF 150FL	48"	26"	26"	5-3/16"	76"	4" flange	1-1/2" NPT
HIF 200FL	58"	26"	26"	5-3/16"	93"	4" flange	1-1/2" NPT

Flanged options on HIF 24, HIF 42, HIF 75 and HIF 100

Ordering Information

Filter Model	HIF 7	HIF 14	HIF 16	HIF 21	HIF 24	HIF 42	HIF 75	HIF 100	HIF 150FL	HIF 200FL
Flow Rate* (GPM)	Up to 30	Up to 60	Up to 75	Up to 90	Up to 100	Up to 175	Up to 300	Up to 400	Up to 600	Up to 800
Flow Rate* (LPM)	Up to 113	Up to 226	Up to 284	Up to 340	Up to 397	Up to 662	Up to 1,135	Up to 1,514	Up to 2,271	Up to 3,028
Flow Rate* (M^3/HR)	Up to 7	Up to 14	Up to 17	Up to 20	Up to 23	Up to 40	Up to 68	Up to 91	Up to 136	Up to 181
Cartridges	7 - 9-3/4" "Singles"	7 - 19-1/2" "Doubles"	8 - 19-1/2" "Doubles"	7 - 29-1/4" "Triples"	8 - 29-1/4" "Triples"	14 - 29-1/4" "Triples"	25 - 29-1/4" "Triples"	50 - 19-1/2" "Doubles"	50 - 29-1/4" "Triples"	100 - 19-1/2" "Doubles"

*Flow rates shown above are for guidelines only. Actual flow rates are based on cartridge type, micron rating, viscosity, solids content and a number of other factors. For complete flow and pressure drop information please refer to your cartridge manufacturer guidelines.

Specifications

- **Filter Vessel/Metal Components** - 304 stainless steel, electropolished for increased resistance to corrosion
- **Holding/Lifting Rods, Standpipes and Pipe Caps** - CPVC, standard models; 304 stainless steel for All-Stainless models
- **Rim Gaskets** - EPDM, standard; Buna-N, Viton available
- **O-rings** - Buna-N, standard; EPDM, Viton available
- **Bottom Seals** - natural gum rubber, standard; EPDM, Viton available
- **Pressure** - rated for pressures to 150 PSI (10.3 bar) max
- **Temperature** - rated to 140°F (60°C) with CPVC rods, pipe caps, standpipes and standard Harmsco cartridges; to 200°F (93°C) for all stainless models with stainless steel rods, pipe caps and standpipes, and Harmsco High-Temp cartridges
- **Flow** - up to 800 gpm; typical flow rates are 4-6 gpm per single length (9-3/4")
- **Wing Nuts** - brass; optional brass hex nuts and stainless steel flat washers

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www.harmsco.com

Made in USA

 018 10 7/11

Chemical Compatibility Results

Chemical and their Compatibility Rating with your selected Material are listed below:

Material Selected: stainless steel - 304

Chemical	Compatibility
Acetaldehyde	A-Excellent
Acetamide	B-Good
Acetate Solvent	A-Excellent
Acetic Acid	D-Severe Effect
Acetic Acid 20%	B-Good
Acetic Acid 80%	D-Severe Effect
Acetic Acid, Glacial	C-Fair
Acetic Anhydride	B-Good
Acetone	A-Excellent
Acetyl Bromide	N/A
Acetyl Chloride (dry)	A-Excellent
Acetylene	A-Excellent
Acrylonitrile	A[1]-Excellent
Adipic Acid	A[1]-Excellent
Alcohols: Amyl	A-Excellent
Alcohols: Benzyl	B-Good
Alcohols: Butyl	A-Excellent
Alcohols: Diacetone	A-Excellent
Alcohols: Ethyl	A-Excellent
Alcohols: Hexyl	A-Excellent
Alcohols: Isobutyl	A-Excellent
Alcohols: Isopropyl	B-Good
Alcohols: Methyl	A-Excellent
Alcohols: Octyl	A-Excellent
Alcohols: Propyl	A-Excellent
Aluminum Chloride	B-Good
Aluminum Chloride 20%	D-Severe Effect
Aluminum Fluoride	D-Severe Effect
Aluminum Hydroxide	A[1]-Excellent
Aluminum Nitrate	A-Excellent
Aluminum Potassium Sulfate 10%	A-Excellent
Aluminum Potassium Sulfate 100%	D-Severe Effect
Aluminum Sulfate	B-Good
Alums	N/A
Amines	A-Excellent
Ammonia 10%	A-Excellent
Ammonia Nitrate	A-Excellent
Ammonia, anhydrous	A-Excellent
Ammonia, liquid	B[2]-Good
Ammonium Acetate	B-Good
Ammonium Bifluoride	D-Severe Effect

Explanation of Footnotes
1. Satisfactory to 72°F (22°C)
2. Satisfactory to 120°F (48°C)

Ratings -- Chemical Effect

A = Excellent.
B = Good -- Minor Effect, slight corrosion or discoloration.
C = Fair -- Moderate Effect, not recommended for continuous use. Softening, loss of strength, swelling may occur.
D = Severe Effect, not recommended for ANY use.
N/A = Information not available.

Ammonium Carbonate	B-Good
Ammonium Caseinate	N/A
Ammonium Chloride	C-Fair
Ammonium Hydroxide	A[2]-Excellent
Ammonium Nitrate	A[2]-Excellent
Ammonium Oxalate	A-Excellent
Ammonium Persulfate	A-Excellent
Ammonium Phosphate, Dibasic	B-Good
Ammonium Phosphate, Monobasic	B-Good
Ammonium Phosphate, Tribasic	B-Good
Ammonium Sulfate	B-Good
Ammonium Sulfite	B-Good
Ammonium Thiosulfate	N/A
Amyl Acetate	A[2]-Excellent
Amyl Alcohol	A-Excellent
Amyl Chloride	A[2]-Excellent
aniline	A-Excellent
Aniline Hydrochloride	D-Severe Effect
Antifreeze	N/A
Antimony Trichloride	D-Severe Effect
Aqua Regia (80% HCl, 20% HNO3)	D-Severe Effect
Arochlor 1248	B-Good
Aromatic Hydrocarbons	N/A
Arsenic Acid	A[2]-Excellent
Arsenic Salts	N/A
Asphalt	B-Good
Barium Carbonate	B[1]-Good
Barium Chloride	A[1]-Excellent
Barium Cyanide	A[1]-Excellent
Barium Hydroxide	B[1]-Good
Barium Nitrate	B[1]-Good
Barium Sulfate	B[1]-Good
Barium Sulfide	B[1]-Good
Beer	A-Excellent
Beet Sugar Liquids	A-Excellent
Benzaldehyde	B-Good
Benzene	B-Good
Benzene Sulfonic Acid	B-Good
Benzoic Acid	B-Good
Benzol	A[1]-Excellent
Benzonitrile	D-Severe Effect
Benzyl Chloride	C[1]-Fair
Bleaching Liquors	N/A
Borax (Sodium Borate)	A-Excellent
Boric Acid	B[2]-Good
Brewery Slop	N/A
Bromine	D-Severe Effect
Butadiene	A-Excellent
Butane	A[2]-Excellent
Butanol (Butyl Alcohol)	A-Excellent
Butter	C-Fair
Buttermilk	A-Excellent
Butyl Amine	N/A

WARNING

The information in this chart has been supp sources and is to be used ONLY as a guide i chemical compatibility. Before permanent in chemicals and under the specific conditions

Ratings of chemical behavior listed in this ch Cole-Parmer has no knowledge of possible i does not warrant (neither express nor impli accurate or complete or that any material in

DANGER

Variations in chemical behavior during hand pressure, and concentrations can cause cou initial test.

SERIOUS INJURY MAY RESULT

Use suitable guards and/or personal protect

Butyl Ether	N/A
Butyl Phthalate	B[1]-Good
Butylacetate	B-Good
Butylene	A-Excellent
Butyric Acid	B[1]-Good
Calcium Bisulfate	N/A
Calcium Bisulfide	B-Good
Calcium Bisulfite	B-Good
Calcium Carbonate	A[2]-Excellent
Calcium Chlorate	N/A
Calcium Chloride	C[2]-Fair
Calcium Hydroxide	B[2]-Good
Calcium Hypochloride	C[2]-Fair
Calcium Nitrate	C[2]-Fair
Calcium Oxide	A-Excellent
Calcium Sulfate	B-Good
Calgon	A-Excellent
Cane Juice	A-Excellent
Carbolic Acid (Phenol)	B-Good
Carbon Bisulfide	A-Excellent
Carbon Dioxide (dry)	A-Excellent
Carbon Dioxide (wet)	A-Excellent
Carbon Disulfide	A[1]-Excellent
Carbon Monoxide	A-Excellent
Carbon Tetrachloride	B-Good
Carbon Tetrachloride (dry)	B-Good
Carbon Tetrachloride (wet)	A[2]-Excellent
Carbonated Water	A-Excellent
Carbonic Acid	A[1]-Excellent
Catsup	A-Excellent
Chloric Acid	D-Severe Effect
Chlorinated Glue	N/A
Chlorine (dry)	A[1]-Excellent
Chlorine Water	C-Fair
Chlorine, Anhydrous Liquid	C[1]-Fair
Chloroacetic Acid	B[1]-Good
Chlorobenzene (Mono)	A-Excellent
Chlorobromomethane	N/A
Chloroform	A-Excellent
Chlorosulfonic Acid	D-Severe Effect
Chocolate Syrup	A-Excellent
Chromic Acid 10%	B-Good
Chromic Acid 30%	B[2]-Good
Chromic Acid 5%	B-Good
Chromic Acid 50%	C-Fair
Chromium Salts	N/A
Cider	A-Excellent
Citric Acid	B[1]-Good
Citric Oils	A-Excellent
Clorox (Bleach)	A-Excellent
Coffee	A-Excellent
Copper Chloride	D-Severe Effect
Copper Cyanide	B-Good

Copper Fluoborate	D-Severe Effect
Copper Nitrate	A-Excellent
Copper Sulfate >5%	B-Good
Copper Sulfate 5%	B-Good
Cream	A-Excellent
Cresols	A[2]-Excellent
Cresylic Acid	A[2]-Excellent
Cupric Acid	D-Severe Effect
Cyanic Acid	A-Excellent
Cyclohexane	A[1]-Excellent
Cyclohexanone	A[1]-Excellent
Detergents	A[1]-Excellent
Diacetone Alcohol	B[1]-Good
Dichlorobenzene	N/A
Dichloroethane	B-Good
Diesel Fuel	A[1]-Excellent
Diethyl Ether	B[1]-Good
Diethylamine	A-Excellent
Diethylene Glycol	A[1]-Excellent
Dimethyl Aniline	B[2]-Good
Dimethyl Formamide	A-Excellent
Diphenyl	B-Good
Diphenyl Oxide	B[1]-Good
Dyes	A-Excellent
Epsom Salts (Magnesium Sulfate)	A-Excellent
Ethane	A-Excellent
Ethanol	A-Excellent
Ethanolamine	A-Excellent
Ether	A-Excellent
Ethyl Acetate	B-Good
Ethyl Benzoate	N/A
Ethyl Chloride	A-Excellent
Ethyl Ether	B-Good
Ethyl Sulfate	D-Severe Effect
Ethylene Bromide	A-Excellent
Ethylene Chloride	B-Good
Ethylene Chlorohydrin	B-Good
Ethylene Diamine	B[1]-Good
Ethylene Dichloride	B-Good
Ethylene Glycol	B-Good
Ethylene Oxide	B-Good
Fatty Acids	B-Good
Ferric Chloride	D-Severe Effect
Ferric Nitrate	B-Good
Ferric Sulfate	B[1]-Good
Ferrous Chloride	D-Severe Effect
Ferrous Sulfate	B-Good
Fluoboric Acid	B-Good
Fluorine	C-Fair
Fluosilicic Acid	C-Fair
Formaldehyde 100%	C-Fair
Formaldehyde 40%	A[1]-Excellent
Formic Acid	B[2]-Good

Freon 113	N/A
Freon 13	B[1]-Good
Freon 22	A-Excellent
Freon TF	A-Excellent
Freon-11	A-Excellent
Fruit Juice	A-Excellent
Fuel Oils	A-Excellent
Furan Resin	A[1]-Excellent
Furfural	A-Excellent
Gallic Acid	A-Excellent
Gasoline (high-aromatic)	A-Excellent
Gasoline, leaded, ref.	A[1]-Excellent
Gasoline, unleaded	A[1]-Excellent
Gelatin	A[2]-Excellent
Glucose	A[1]-Excellent
Glue, P.V.A.	A[1]-Excellent
Glycerin	A[2]-Excellent
Glycolic Acid	A-Excellent
Gold Monocyanide	A-Excellent
Grape Juice	A-Excellent
Grease	N/A
Heptane	A-Excellent
Hexane	A-Excellent
Honey	A-Excellent
Hydraulic Oil (Petro)	A-Excellent
Hydraulic Oil (Synthetic)	A-Excellent
Hydrazine	A-Excellent
Hydrobromic Acid 100%	D-Severe Effect
Hydrobromic Acid 20%	D-Severe Effect
Hydrochloric Acid 100%	D-Severe Effect
Hydrochloric Acid 20%	D-Severe Effect
Hydrochloric Acid 37%	D-Severe Effect
Hydrochloric Acid, Dry Gas	D-Severe Effect
Hydrocyanic Acid	B[1]-Good
Hydrocyanic Acid (Gas 10%)	N/A
Hydrofluoric Acid 100%	B[2]-Good
Hydrofluoric Acid 20%	D-Severe Effect
Hydrofluoric Acid 50%	D-Severe Effect
Hydrofluoric Acid 75%	D-Severe Effect
Hydrofluorsilicic Acid 100%	D-Severe Effect
Hydrofluorsilicic Acid 20%	C[2]-Fair
Hydrogen Gas	A-Excellent
Hydrogen Peroxide 10%	B[2]-Good
Hydrogen Peroxide 100%	B[2]-Good
Hydrogen Peroxide 30%	B[2]-Good
Hydrogen Peroxide 50%	B[2]-Good
Hydrogen Sulfide (aqua)	C-Fair
Hydrogen Sulfide (dry)	C[1]-Fair
Hydroquinone	B-Good
Hydroxyacetic Acid 70%	N/A
Ink	C-Fair
Iodine	D-Severe Effect
Iodine (in alcohol)	N/A

Iodoform	A-Excellent
Isooctane	A[1]-Excellent
Isopropyl Acetate	C-Fair
Isopropyl Ether	A-Excellent
Isotane	N/A
Jet Fuel (JP3, JP4, JP5)	A-Excellent
Kerosene	A-Excellent
Ketones	A-Excellent
Lacquer Thinners	A[1]-Excellent
Lacquers	A[1]-Excellent
Lactic Acid	B[1]-Good
Lard	A-Excellent
Latex	A[1]-Excellent
Lead Acetate	B-Good
Lead Nitrate	B[1]-Good
Lead Sulfamate	C-Fair
Ligroin	N/A
Lime	A-Excellent
Linoleic Acid	B-Good
Lithium Chloride	A[1]-Excellent
Lithium Hydroxide	B-Good
Lubricants	A[1]-Excellent
Lye: Ca(OH)2 Calcium Hydroxide	B[1]-Good
Lye: KOH Potassium Hydroxide	B-Good
Lye: NaOH Sodium Hydroxide	B-Good
Magnesium Bisulfate	A[1]-Excellent
Magnesium Carbonate	B-Good
Magnesium Chloride	D-Severe Effect
Magnesium Hydroxide	B-Good
Magnesium Nitrate	B-Good
Magnesium Oxide	A-Excellent
Magnesium Sulfate (Epsom Salts)	A-Excellent
Maleic Acid	A-Excellent
Maleic Anhydride	A-Excellent
Malic Acid	A-Excellent
Manganese Sulfate	B-Good
Mash	A-Excellent
Mayonnaise	C-Fair
Melamine	N/A
Mercuric Chloride (dilute)	D-Severe Effect
Mercuric Cyanide	C-Fair
Mercurous Nitrate	A[1]-Excellent
Mercury	A-Excellent
Methane	A-Excellent
Methanol (Methyl Alcohol)	A-Excellent
Methyl Acetate	A-Excellent
Methyl Acetone	A-Excellent
Methyl Acrylate	A-Excellent
Methyl Alcohol 10%	A-Excellent
Methyl Bromide	A-Excellent
Methyl Butyl Ketone	A-Excellent
Methyl Cellosolve	B-Good
Methyl Chloride	A-Excellent
Methyl Dichloride	N/A

Methyl Ethyl Ketone	A-Excellent
Methyl Ethyl Ketone Peroxide	N/A
Methyl Isobutyl Ketone	B-Good
Methyl Isopropyl Ketone	A-Excellent
Methyl Methacrylate	B-Good
Methylamine	A-Excellent
Methylene Chloride	B-Good
Milk	A-Excellent
Mineral Spirits	A-Excellent
Molasses	A-Excellent
Monochloroacetic acid	A[1]-Excellent
Monoethanolamine	A-Excellent
Morpholine	N/A
Motor oil	A[1]-Excellent
Mustard	A-Excellent
Naphtha	A-Excellent
Naphthalene	A-Excellent
Natural Gas	A-Excellent
Nickel Chloride	D-Severe Effect
Nickel Nitrate	B-Good
Nickel Sulfate	B-Good
Nitrating Acid (<15% HNO3)	C-Fair
Nitrating Acid (>15% H2SO4)	C-Fair
Nitrating Acid (5% Acid)	C-Fair
Nitrating Acid (515% H2SO4)	C-Fair
Nitric Acid (20%)	A-Excellent
Nitric Acid (50%)	A[2]-Excellent
Nitric Acid (5-10%)	A-Excellent
Nitric Acid (Concentrated)	A[1]-Excellent
Nitrobenzene	B-Good
Nitrogen Fertilizer	N/A
Nitromethane	A-Excellent
Nitrous Acid	B-Good
Nitrous Oxide	B-Good
Oils:Aniline	A-Excellent
Oils:Anise	N/A
Oils:Bay	N/A
Oils:Bone	N/A
Oils:Castor	A-Excellent
Oils:Cinnamon	A-Excellent
Oils:Citric	A-Excellent
Oils:Clove	A-Excellent
Oils:Coconut	A-Excellent
Oils:Cod Liver	A-Excellent
Oils:Corn	A-Excellent
Oils:Cottonseed	A-Excellent
Oils:Creosote	B-Good
Oils:Diesel Fuel (2D, 3D, 4D, 5D)	A-Excellent
Oils:Fuel (1, 2, 3, 5A, 5B, 6)	A-Excellent
Oils:Ginger	D-Severe Effect
Oils:Hydraulic Oil (Petro)	A-Excellent
Oils:Hydraulic Oil (Synthetic)	A-Excellent
Oils:Lemon	A-Excellent
Oils:Linseed	A-Excellent
Oils:Mineral	A-Excellent

Oils:Olive	A-Excellent
Oils:Orange	A-Excellent
Oils:Palm	A-Excellent
Oils:Peanut	A-Excellent
Oils:Peppermint	A-Excellent
Oils:Pine	A-Excellent
Oils:Rapeseed	A-Excellent
Oils:Rosin	A[1]-Excellent
Oils:Sesame Seed	A-Excellent
Oils:Silicone	A-Excellent
Oils:Soybean	A-Excellent
Oils:Sperm (whale)	A-Excellent
Oils:Tanning	A-Excellent
Oils:Transformer	A-Excellent
Oils:Turbine	A-Excellent
Oleic Acid	A-Excellent
Oleum 100%	A-Excellent
Oleum 25%	B[2]-Good
Oxalic Acid (cold)	B-Good
Ozone	B-Good
Palmitic Acid	B[1]-Good
Paraffin	A-Excellent
Pentane	C-Fair
Perchloric Acid	C-Fair
Perchloroethylene	B-Good
Petroleum	A-Excellent
Petroleum	A[1]-Excellent
Phenol (10%)	B-Good
Phenol (Carbolic Acid)	B-Good
Phosphoric Acid (>40%)	D-Severe Effect
Phosphoric Acid (crude)	D-Severe Effect
Phosphoric Acid (molten)	N/A
Phosphoric Acid (<40%)	D-Severe Effect
Phosphoric Acid Anhydride	N/A
Phosphorous	A[2]-Excellent
Phosphorus Trichloride	A[1]-Excellent
Photographic Developer	A-Excellent
Photographic Solutions	D-Severe Effect
Phthalic Acid	B[2]-Good
Phthalic Anhydride	A-Excellent
Picric Acid	B-Good
Plating Solutions, Antimony Plating 130°F	A-Excellent
Plating Solutions, Arsenic Plating 110°F	A-Excellent
Plating Solutions, Brass Plating: High-Speed Brass Bath 110°F	N/A
Plating Solutions, Brass Plating: Regular Brass Bath 100° F	A-Excellent
Plating Solutions, Bronze Plating: Cu-Cd Bronze Bath R.T.	A-Excellent
Plating Solutions, Bronze Plating: Cu-Sn Bronze Bath 160° F	A-Excellent
Plating Solutions, Bronze Plating: Cu-Zn Bronze Bath 100° F	A-Excellent

Plating Solutions, Cadmium Plating: Cyanide Bath 90°F	N/A
Plating Solutions, Cadmium Plating: Fluoborate Bath 100°F	A-Excellent
Plating Solutions, Chromium Plating: Barrel Chrome Bath 95°F	N/A
Plating Solutions, Chromium Plating: Black Chrome Bath 115°F	N/A
Plating Solutions, Chromium Plating: Chromic-Sulfuric Bath 130°F	N/A
Plating Solutions, Chromium Plating: Fluoride Bath 130°F	N/A
Plating Solutions, Chromium Plating: Fluosilicate Bath 95°F	N/A
Plating Solutions, Copper Plating (Acid): Copper Fluoborate Bath 120°F	A-Excellent
Plating Solutions, Copper Plating (Acid): Copper Sulfate Bath R.T.	N/A
Plating Solutions, Copper Plating (Cyanide): Copper Strike Bath 120°F	N/A
Plating Solutions, Copper Plating (Cyanide): High-Speed Bath 180°F	N/A
Plating Solutions, Copper Plating (Cyanide): Rochelle Salt Bath 150°F	N/A
Plating Solutions, Copper Plating (Misc): Copper (Electroless)	N/A
Plating Solutions, Copper Plating (Misc): Copper Pyrophosphate	N/A
Plating Solutions, Gold Plating: Acid 75°F	N/A
Plating Solutions, Gold Plating: Cyanide 150°F	N/A
Plating Solutions, Gold Plating: Neutral 75°F	N/A
Plating Solutions, Indium Sulfamate Plating R.T.	N/A
Plating Solutions, Iron Plating: Ferrous Am Sulfate Bath 150°F	N/A
Plating Solutions, Iron Plating: Ferrous Chloride Bath 150°F	N/A
Plating Solutions, Iron Plating: Ferrous Sulfate Bath 150°F	N/A
Plating Solutions, Iron Plating: Fluoborate Bath 145°F	N/A
Plating Solutions, Iron Plating: Sulfamate 140°F	N/A
Plating Solutions, Iron Plating: Sulfate-Chloride Bath 160°F	N/A
Plating Solutions, Lead Fluoborate Plating	N/A
Plating Solutions, Nickel Plating: Electroless 200°F	N/A
Plating Solutions, Nickel Plating: Fluoborate 100-170°F	N/A
Plating Solutions, Nickel Plating: High-Chloride 130-160°F	N/A
Plating Solutions, Nickel Plating: Sulfamate 100-140°F	N/A
Plating Solutions, Nickel Plating: Watts Type 115-160°F	N/A
Plating Solutions, Rhodium Plating 120°F	N/A
	N/A

Plating Solutions, Silver Plating 80-120°F	
Plating Solutions, Tin-Fluoborate Plating 100°F	N/A
Plating Solutions, Tin-Lead Plating 100°F	N/A
Plating Solutions, Zinc Plating: Acid Chloride 140°F	N/A
Plating Solutions, Zinc Plating: Acid Fluoborate Bath R.T.	N/A
Plating Solutions, Zinc Plating: Acid Sulfate Bath 150°F	N/A
Plating Solutions, Zinc Plating: Alkaline Cyanide Bath R.T.	N/A
Potash (Potassium Carbonate)	B-Good
Potassium Bicarbonate	B-Good
Potassium Bromide	B-Good
Potassium Chlorate	B[2]-Good
Potassium Chloride	B[2]-Good
Potassium Chromate	B[1]-Good
Potassium Cyanide Solutions	B[1]-Good
Potassium Dichromate	B-Good
Potassium Ferricyanide	B[1]-Good
Potassium Ferrocyanide	B-Good
Potassium Hydroxide (Caustic Potash)	B-Good
Potassium Hypochlorite	C[1]-Fair
Potassium Iodide	A[2]-Excellent
Potassium Nitrate	B-Good
Potassium Oxalate	B-Good
Potassium Permanganate	B[1]-Good
Potassium Sulfate	B[1]-Good
Potassium Sulfide	B-Good
Propane (liquefied)	A-Excellent
Propylene	B[2]-Good
Propylene Glycol	B-Good
Pyridine	A-Excellent
Pyrogallic Acid	B[2]-Good
Resorcinol	N/A
Resins	A[2]-Excellent
Rum	A-Excellent
Rust Inhibitors	A-Excellent
Salad Dressings	A-Excellent
Salicylic Acid	B[1]-Good
Salt Brine (NaCl saturated)	B[1]-Good
Sea Water	C-Fair
Shellac (Bleached)	A-Excellent
Shellac (Orange)	A-Excellent
Silicone	A-Excellent
Silver Bromide	C-Severe Effect
Silver Nitrate	B-Good
Soap Solutions	A-Excellent
Soda Ash (see Sodium Carbonate)	A-Excellent
Sodium Acetate	B-Good
Sodium Aluminate	A-Excellent
Sodium Benzoate	N/A

Sodium Bicarbonate	A-Excellent
Sodium Bisulfate	D-Severe Effect
Sodium Bisulfite	B[1]-Good
Sodium Borate (Borax)	B[1]-Good
Sodium Bromide	C-Fair
Sodium Carbonate	A-Excellent
Sodium Chlorate	A-Excellent
Sodium Chloride	B-Good
Sodium Chromate	B[1]-Good
Sodium Cyanide	A[1]-Excellent
Sodium Ferrocyanide	B-Good
Sodium Fluoride	D-Severe Effect
Sodium Hydrosulfite	N/A
Sodium Hydroxide (20%)	B-Good
Sodium Hydroxide (50%)	B-Good
Sodium Hydroxide (60%)	C-Fair
Sodium Hypochlorite (<20%)	C-Fair
Sodium Hypochlorite (100%)	D-Severe Effect
Sodium Hyposulfate	A-Excellent
Sodium Metaphosphate	A-Excellent
Sodium Metasilicate	A-Excellent
Sodium Nitrate	B[1]-Good
Sodium Perborate	B-Good
Sodium Peroxide	A-Excellent
Sodium Polyphosphate	B-Good
Sodium Silicate	A-Excellent
Sodium Sulfate	B-Good
Sodium Sulfide	B-Good
Sodium Sulfite	B-Good
Sodium Tetraborate	A[1]-Excellent
Sodium Thiosulfate (Hypo)	A[1]-Excellent
Sorghum	A-Excellent
Soy Sauce	A-Excellent
Stannic Chloride	D-Severe Effect
Stannic Fluoborate	N/A
Stannous Chloride	D[1]-Fair
Starch	A-Excellent
Stearic Acid	B-Good
Stoddard Solvent	A-Excellent
Styrene	A-Excellent
Sugars (Liquids)	A-Excellent
Sulfate (Liquors)	B-Good
Sulfur Chloride	D-Severe Effect
Sulfur Dioxide	D-Severe Effect
Sulfur Dioxide (dry)	D-Severe Effect
Sulfur Hexafluoride	N/A
Sulfur Trioxide	A-Excellent
Sulfur Trioxide (dry)	D-Severe Effect
Sulfuric Acid (≤10%)	D-Severe Effect
Sulfuric Acid (10-75%)	D-Severe Effect
Sulfuric Acid (75-100%)	C-Fair
Sulfuric Acid (cold concentrated)	C-Fair
Sulfuric Acid (hot concentrated)	D-Severe Effect
Sulfurous Acid	B[1]-Good
Sulfuryl Chloride	N/A

Tallow	A-Excellent
Tannic Acid	B^1-Good
Tanning Liquors	A^2-Excellent
Tartaric Acid	C^2-Fair
Tetrachloroethane	B-Good
Tetrachloroethylene	N/A
Tetrahydrofuran	A-Excellent
Tin Salts	N/A
Toluene (Toluol)	A-Excellent
Tomato Juice	A-Excellent
Trichloroacetic Acid	D-Severe Effect
Trichloroethane	B-Good
Trichloroethylene	B-Good
Trichloropropane	A-Excellent
Tricresylphosphate	B-Good
Triethylamine	A-Excellent
Trisodium Phosphate	B-Good
Turpentine	A-Excellent
Urea	B-Good
Uric Acid	B-Good
Urine	A-Excellent
Varnish	A-Excellent
Vegetable Juice	A-Excellent
Vinegar	A-Excellent
Vinyl Acetate	B-Good
Vinyl Chloride	B^2-Good
Water, Acid, Mine	B-Good
Water, Deionized	A^1-Excellent
Water, Distilled	A-Excellent
Water, Fresh	A-Excellent
Water, Salt	B-Good
Weed Killers	A-Excellent
Whey	A-Excellent
Whiskey & Wines	A-Excellent
White Liquor (Pulp Mill)	A-Excellent
White Water (Paper Mill)	A-Excellent
Xylene	B-Good
Zinc Chloride	B-Good
Zinc Hydrosulfite	A-Excellent
Zinc Sulfate	B^1-Good

Flex Hose Cut Sheet

(Goodyear)

EnSol, Inc.

INTRODUCING THE

PLICORD® EXTREMEFLEX™ PURPLE & BROWN CHEMICAL TRANSFER HOSES

TAKING LIGHTWEIGHT FLEXIBILITY TO THE ***XTREME!***

GOODYEAR
ENGINEERED PRODUCTS

XPANDING YOUR CHOICES IN CHEMICAL HOSE.

Veyance Technologies Inc., the exclusive manufacturer of **Goodyear Engineered Products** branded hose, is proud to introduce **Plicord® ExtremeFlex™ Purple and Brown Chemical Transfer Hoses.** They are our latest innovations in the chemical production and petroleum refining industries. Their advanced formulation and construction results in two incredibly flexible, lightweight hoses at a great value. Destined to be the new standard in chemical transfer hoses, **ExtremeFlex™ Purple and Brown** feature technologically advanced rubber compounding that allows them to leap past other hoses in this category.

AMONG THEIR MANY COMPETITIVE ADVANTAGES, THEY ARE:

MORE FLEXIBLE:
Easier to move in and out of tight spaces and around corners.

LIGHTER WEIGHT:
Easier to lift and carry, resulting in fewer workplace injuries.

LOWER FORCE TO BEND:
Easier to connect and disconnect for increased productivity.

IMPROVED FLEX PERFORMANCE:
More durable and longer lasting.

V-WING SERIES
FLEXIBLE • LIGHTWEIGHT • DURABLE

INNOVATION BREEDS SUCCESS.

Veyance Technologies, Inc., the exclusive manufacturer of **Goodyear Engineered Products**, has the competitive advantage when it comes to rubber compounding due in part to our diverse product offering. From conveyor belts to tank tracks, we know how to use our cutting-edge research to meet the extremes of challenging environments and materials. We then bridge the knowledge from our latest finds into new categories. That's how the **V-Wing** line developed.

CHEM ONE™ was born out of the need for a durable, lightweight and flexible hose that met the demands of chemical transfer applications. Once we had that under our belt, we expanded similar technology into the petroleum and food industries under the family name **ExtremeFlex.**™ These new hoses have the advantage of giving you tremendous flexibility in a corrugated hose at a non-corrugated price.

Today, two new chemical transfer hoses – **Plicord**® **ExtremeFlex**™ **Purple and Brown** – now feature the same innovations as the rest of the **V-Wing** line. So you can experience the ease of handling that comes with their improved flexibility and the lower force required to bend them, along with fewer workplace injuries due to their lightweight nature. You're getting high-tech chemical transfer solutions wrapped up in two colorful hoses.

No matter which **Goodyear Engineered Products** Industrial Hose you spec,
you can be certain that success is near.

Because we know how to compound for extremes.

All of our Chemical Hose temperature ratings are contingent on the specific chemical conveyed. Contact Customer Service at 1-800-235-4632 for any chemical above the temperature stated in the Goodyear Engineered Products Chemical Resistance Guide. Refer to the Chemical Resistance Guide for specific chemical and temperature compatibility.

Plicord® eXtremeFlex™ Purple

CHEMICAL TRANSFER HOSE | DESIGNED FOR EXCELLENT CHEMICAL RESISTANCE

INDUSTRIES SERVED: Chemical production

APPLICATION: A high-tech, flexible and versatile chemical hose capable of handling a wide range of chemicals, acids and alcohols in both suction and discharge service.

CONSTRUCTION:

Tube: Black Versigard® (EPDM) synthetic rubber

Cover: Corrugated Purple Versigard® (EPDM) synthetic rubber with yellow spiral stripe

Reinforcement: Spiral-plied synthetic fabric with double wire helix

TEMPERATURE: -40°F to 221°F (-40°C to 104°C)

PACKAGING: 100' Exact cut length, coiled, polywrapped

BRANDING (SPIRAL): Goodyear® Plicord® ExtremeFlex™ Purple
150 PSI Made in Canada

COUPLINGS: Use Goodyear Engineered Products Insta-Lock™ Cam & Groove fittings with this product

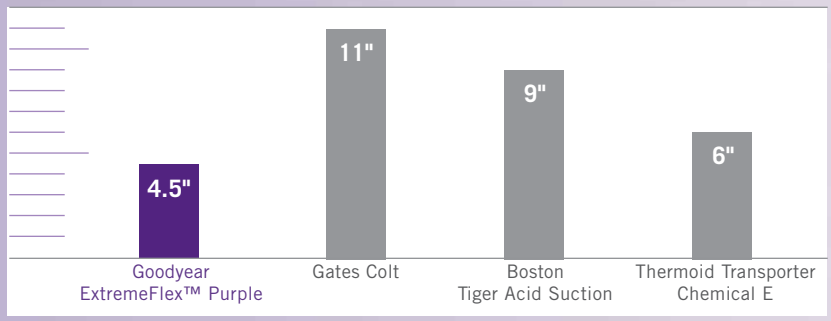
NON-STOCK/SIZES: 400' Min. if not stocked

ORDER CODE: 546-721

PLICORD® EXTREMEFLEX™ PURPLE

ID		NOM. OD		MAX. WP		BEND RADIUS		VACUUM HG		WEIGHT	
in.	mm.	in.	mm.	psi	mpa	in.	mm.	in.	mm.	lb./ft.	kg./m.
1½	38.00	1.92	48.70	150	1.03	2.25	57.2	29	737	0.73	1.09
2	51.20	2.44	61.90	150	1.03	3.00	76	29	737	0.95	1.42
3	76.10	3.54	89.80	150	1.03	4.50	114	29	737	1.76	2.62
4	102.10	4.57	116.10	150	1.03	6.00	152	29	737	2.41	3.59

COMPETITIVE ADVANTAGE: BETTER BEND RADIUS



Radius for 3-inch diameter

Plicord® eXtremeFlex™ Brown

CHEMICAL TRANSFER HOSE | DESIGNED FOR EXCELLENT CHEMICAL RESISTANCE

INDUSTRIES SERVED: Chemical production and petroleum refining

APPLICATION: A high-tech flexible and versatile chemical hose capable of handling a wide variety of acids, alcohols, salt solutions and petroleum-based products.

CONSTRUCTION:

Tube: Black Chemrin® (CPE) synthetic rubber

Cover: Corrugated Brown Versigard® (EPDM) synthetic rubber with white spiral stripe

Reinforcement: Spiral-plied synthetic fabric with double wire helix

TEMPERATURE: -30°F to 275°F (-34°C to 135°C)

PACKAGING: 100' Exact cut length, coiled, polywrapped

BRANDING (SPIRAL): Goodyear® Plicord® ExtremeFlex™ Brown w/ Chemrin®
150 PSI Made in Canada

COUPLINGS: Use Goodyear Engineered Products Insta-Lock™
Cam & Groove fittings with this product

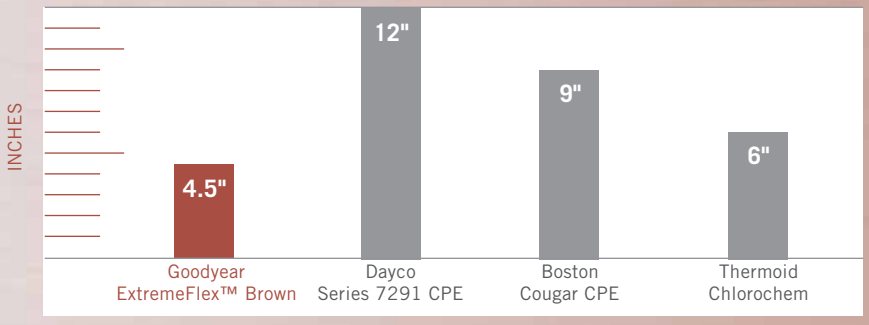
NON-STOCK/SIZES: 400' Min. if not stocked

ORDER CODE: 546-723

PLICORD® EXTREMEFLEX™ BROWN

ID		NOM. OD		MAX. WP		BEND RADIUS		VACUUM HG		WEIGHT	
in.	mm.	in.	mm.	psi	mpa	in.	mm.	in.	mm.	lb./ft.	kg./m.
1	25.30	1.42	36.00	150	1.03	1.50	38.10	29	737	0.50	0.75
1¼	32.00	1.63	41.50	150	1.03	2.00	50.80	29	737	0.57	0.85
1½	38.00	1.92	48.70	150	1.03	2.25	57.20	29	737	0.74	1.10
2	51.20	2.44	61.90	150	1.03	3.00	76.00	29	737	0.97	1.45
3	76.20	3.54	89.80	150	1.03	4.50	114.00	29	737	1.80	2.68
4	102.10	4.57	116.10	150	1.03	6.00	152.00	29	737	2.47	3.68

COMPETITIVE ADVANTAGE: BETTER BEND RADIUS



Radius for 3-inch diameter

U.S.A.
1-800-235-4632
FAX 1-800-762-4017

CANADA
1-888-275-4397
FAX 1-888-464-4397

GOODYEAREP.COM/HOSE

700-821-947-550

10GHOS027-04/10

CHEMICAL RESISTANCE CHARTS

GOODYEAR
ENGINEERED PRODUCTS

APPLICATION WARNING

The products in this catalog have been tested under controlled laboratory conditions to meet specific test criteria. These tests are not intended to reflect the performance of the product or any other material in any specific application, but are intended to provide the user with application guidelines. The products are intended for use by knowledgeable persons having the technical skills necessary to evaluate their suitability for specific applications.

Since Veyance Technologies, Inc. has no control over the number and variety of applications for which its products may be purchased or the conditions under which its products may be used by others, Veyance Technologies assumes no responsibility for performance results and applications. This catalog, however, contains available information to allow the user to determine the product's acceptability and fitness for specific applications. No statement contained herein shall be construed as a license to operate, or as a recommendation or inducement to infringe existing patents or as an endorsement of products of specific manufacturers or systems.

Failure to follow procedures for selection, installation, care, maintenance and storage of hoses may result in the hose's failure to perform properly and may result in damage to property and/or serious injury. Please refer to the General Information section of the catalog for hose care, maintenance, and storage information.

All product design, dimensional, and general information in this catalog is subject to change without prior notice. Working pressures and other technical information have been prepared from actual test results and other data considered to be reliable. However, Veyance Technologies assumes no responsibility for the accuracy of this information under varied conditions found in field use.

CHEMICAL HOSE

Do not use chemical hose at temperatures or pressures above those recommended by the manufacturer. All operators must be thoroughly trained in the care and use of this hose and must, at all times, wear protective clothing. A hose or system failure could cause the release of poisonous, corrosive or flammable material.

Detailed information concerning storage, care and maintenance may be found in the Hose Handbook published by the Rubber Manufacturer's Association, 1400 K Street, N.W., Washington, D.C. 20005 and in SAE Recommended Practices J1273.

CHEMICAL CHARTS

GOODYEAR ENGINEERED PRODUCTS CHEMICAL RESISTANCE CHARTS

RATINGS AND DEFINITIONS

The Goodyear Engineered Products Chemical Resistance Chart is to be used as a guide only.

A The chemical is expected to have minor or no effect on the product. Product may be used for continuous service. Changes in working conditions, such as concentration of the chemical or temperature, may affect product performance and cause degradation of the product.

B The product may be used for continuous or intermittent service, however the product properties will be affected by the exposure to the chemical. Changes in working conditions, such as concentration of the chemical or temperature, may affect product performance and cause degradation of the product.

X The product should not be used with this chemical.

I Insufficient or no data available for this chemical. Further testing is recommended to determine compatibility of the chemical with the product.

Caution: Unless otherwise specified, the ratings applied to tube stocks are based on fully concentrated or saturated solutions at 100˚F under normal service conditions.

Note: Hose ratings are for the effect on the polymer only. The degree of resistance of a rubber compound to a specific chemical depends on many variables such as temperature, concentration, length of exposure, stability of chemical, etc. For a specific compound, many grades of polymers are available which can alter the compound's chemical resistance.

WHEN IN DOUBT, before using a specific product, contact your local Goodyear Engineered Products Sales Representative for assistance if unusual service conditions or high temperatures are present in the product application.

THIS CHEMICAL RESISTANCE CHART SUPERSEDES ALL PREVIOUSLY PUBLISHED INFORMATION REGARDING GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE RESISTANCE RATINGS.

CHEMICAL CHARTS

Common Name & Description	Veyance Technologies, Inc. Trade Name	Goodyear Engineered Products Examples with Polymer in the Tube
UHMWPE (Ultra High Molecular Weight Polyethylene)	Pliosyn™	Fabchem™
Butyl (Isobutylene and Isoprene)	Weatherex®	Gray Flexwing®
Hypalon® (Chlorosulfonated Polyethylene)	Hysunite™	Yellow Flexwing®
NR - Natural Rubber (Isoprene, natural)	Pureten™	Tan Flexwing®
Viton®	Flosyn®	Orange Flexwing®
Nitrile		Flexwing® Petroleum
CPE (Chlorinated Polyethylene)	Chemrin®	Brown Flexwing®
EPDM (Ethylene Propylene Diene)	Versigard®	Purple Flexwing®
EPDM (Heat Resistant)	Pyrosyn®	Flexsteel® 250 Steam, Whitewater®
Cross-Link Polyethylene (XLPE)	Speclar®	Blue Flexwing®, Green XLPE
Alphasyn® (Modified Cross-Link Polyethylene)	Alphasyn®	Viper™
Teflon®		Hi-Per®
316 Stainless Steel		Insta-Lock™
Aluminum		Insta-Lock™
Brass		Insta-Lock™

Caution: This chart and the following chemical resistance charts are intended to reflect the various tube compounds as they pertain to Goodyear Engineered Products petroluem and chemical hose. Always use a Goodyear Engineered Products petroleum or chemical hose when the hose is to be used for conveyance of petroleum or chemicals. Consult the following pages for chemical compatability of the various tube stocks.

CHEMICAL CHARTS

This chemical chart is offered as a guide only. There are many variables to be considered with each application. Ratings are for tube polymer only! For explanation of ratings see page 2. Contact customer services for chemicals or polymers not listed at 800-235-4632.

RATING SCALE

A = May be used for Continuous Service
B = May be used for Intermittent Service
X = Do not Use
I = Insufficient Data, contact customer services

GASKET

T = Teflon®
V = Viton®
B = Nitrile
N = Neoprene
S = Silicone

A	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
Acetaldehyde	100	B	B	X	X	X	X	I	A	A	A	A	A	B	X	TS
Acetic Acid, Conc.	100	A	A	X	B	X	X	A	A	A	A	A	A	B	X	T
Acetic Acid, Dilute 10	150	B	A	X	A	X	X	A	A	A	A	A	A	I	X	TVN
Acetic Acid, Glacial	100	A	B	X	X	X	X	A	A	A	A	A	A	B	X	TS
Acetic Aldehyde	100	A	B	X	X	X	X	I	A	A	A	A	A	B	X	T
Acetic Anhydride	100	B	A	B	X	X	X	A	A	A	A	A	A	B	X	T S
Acetic Ester	100	B	B	X	X	X	X	B	A	A	A	A	A	A	A	T V
Acetic Ether	100	B	B	X	X	X	X	B	A	A	A	A	A	A	A	T
Acetic Oxide	100	B	A	B	X	X	X	A	A	A	A	A	A	B	X	T
Acetone	100	A	A	X	B	X	X	A	A	A	A	A	A	A	I	T
Acetone Cyanohydrin	100	B	A	X	X	X	X	A	A	A	A	A	I	I	I	T S
Acetyl Acetone	100	B	B	X	X	X	X	B	I	A	A	A	I	B	I	T
Acetyl Chloride	100	B	X	X	X	B	X	A	B	B	A	A	B	X	A	T V
Acetyl Oxide	100	B	A	B	X	X	X	A	A	A	A	A	A	B	X	T
Acetylene (dry)	100	A	A	A	A	A	A	A	A	A	X	A	A	I	I	TVBNS
Acetylene Dichloride	100	B	X	X	X	A	X	I	I	A	X	A	I	A	X	T V
Acetylene Tetrachloride	100	B	X	X	X	A	X	I	I	A	I	A	A	X	X	T V
Acrolein	100	B	A	B	B	A	B	I	I	A	A	A	I	I	I	T V
Acrylic Acid	100	B	X	X	X	A	X	X	X	A	A	A	A	I	I	T V
Acrylonitrile	100	B	X	X	X	X	X	A	X	B	A	A	A	X	I	T
Alk-Tri	100	I	X	X	X	A	X	I	I	A	I	A	A	I	I	T V
Allyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	A	TBN
Allyl Bromide	100	B	X	X	X	B	X	B	I	B	I	A	I	I	I	T
Allyl Chloride	100	B	X	X	X	B	X	B	X	B	I	A	A	X	X	T S
Alum	150	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBNS
Aluminum Acetate	100	A	A	A	X	X	X	A	A	A	A	A	A	I	X	T
Aluminum Chloride	150	A	A	A	A	A	A	A	A	A	A	A	I	I	X	TVB
Aluminum Formate	100	A	B	X	X	X	X	I	I	A	A	A	I	I	I	T
Aluminum Hydroxide	150	A	A	B	A	X	B	A	A	A	A	A	A	I	X	T S
Aluminum Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Aminoethanol	100	A	A	B	B	I	B	A	I	A	A	A	A	B	I	TBN
Aminoethylethanolamine	100	A	A	B	B	I	B	A	I	A	A	A	I	I	I	T
Ammonia	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														

GOODYEAR ENGINEERED PRODUCTS

CHEMICAL CHARTS

This chemical chart is offered as a guide only. There are many variables to be considered with each application. Ratings are for tube polymer only! For explanation of ratings see page 2. Contact customer services for chemicals or polymers not listed at 800-235-4632.

RATING SCALE

- **A** = May be used for Continuous Service
- **B** = May be used for Intermittent Service
- **X** = Do not Use
- **I** = Insufficient Data, contact customer services

GASKET

T = Teflon® **V** = Viton®
B = Nitrile **N** = Neoprene
S = Silicone

A	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
Ammonia Cupric Sulfate	150	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVB
Ammonium Chloride	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN
Ammonium Hydroxide	150	A	A	B	A	X	X	A	X	A	A	A	A	X	I	TNS
Ammonium Nitrate (ANFO)	150	SPECIAL HOSE REQUIRED											A	B	X	TVBS
Ammonium Phosphate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Ammonium Sulfate	150	A	A	A	A	A	X	A	A	A	A	A	A	X	X	TVNS
Ammonium Sulfide	150	A	A	A	A	A	X	A	A	A	A	A	A	X	X	TVN
Ammonium Sulfite	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBN
Ammonium Thiosulfate	100	A	A	A	A	A	A	A	A	A	A	A	A	B	X	TVBN
Amyl Acetate	100	A	A	B	X	X	X	X	B	A	A	A	A	A	I	T
Amyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	A	TBNS
Amyl Chloride	100	A	X	X	X	A	X	X	X	A	B	A	A	X	I	T V
Amyl Oleate	100	A	X	X	X	I	B	I	I	A	I	A	I	I	I	T
Amyl Phenol	100	A	X	X	X	A	X	I	I	A	I	A	I	I	I	T V
Amyl Phthalate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Amylamine	100	A	B	X	X	X	X	B	X	A	I	A	I	I	I	T
Anethole	100	X	X	X	X	B	X	X	I	X	I	A	I	I	I	T
Anhydrous Ammonia	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Aniline	100	A	A	X	X	A	X	B	A	A	A	A	A	B	X	T V
Animal Grease	100	A	X	X	X	A	A	B	X	A	A	A	A	A	I	TVB
Animal Oils	100	A	B	X	X	A	A	A	X	A	B	A	A	A	I	TVB
Antimony Pentachloride	100	A	X	X	X	I	X	I	X	B	B	A	I	I	I	T
Aqua Ammonia	150	A	A	B	A	A	B	B	B	A	A	A	A	X	I	T V
Aromatic Spirits	100	A	X	X	X	A	X	I	X	A	I	A	A	I	I	T V
Aromatic Tar	100	A	X	X	X	A	X	B	X	A	I	A	I	I	I	T V
Arquads	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Arsenic Acid	100	A	A	A	A	I	X	A	A	A	A	A	A	X	X	TVS
Arsenic Chloride	100	I	X	X	X	X	X	X	X	X	X	A	I	I	I	T N
Arsenic Trichloride	100	I	X	X	X	X	X	X	X	X	X	A	X	I	I	T N
Asphalt	500	SPECIAL HOSE REQUIRED											A	I	I	TVN
ASTM #1 Oil	100	A	X	B	X	A	A	A	X	A	A	A	A	A	I	TVBNS
ASTM #2 Oil	100	A	X	X	X	A	A	A	X	A	A	A	A	A	A	TVB
ASTM #3 Oil	100	A	X	X	X	A	A	A	X	A	A	A	A	A	A	TVB

GOODYEAR ENGINEERED PRODUCTS

CHEMICAL CHARTS

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RATING SCALE

A = May be used for Continuous Service
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GASKET

T = Teflon®
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B = Nitrile
N = Neoprene
S = Silicone

		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
B	Temperature (°F)															
Barium Carbonate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBN
Barium Chloride	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBN
Barium Hydroxide	150	A	A	A	A	B	A	A	A	A	A	A	A	X	X	TBNS
Barium Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	B	A	X	TVBS
Barium Sulfide	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBS
Benzal Chloride	100	A	B	I	I	I	X	X	I	A	I	A	B	X	I	T
Benzaldehyde	100	A	B	X	X	X	X	X	B	A	B	A	A	B	I	T
Benzene (Benzol)	100	A	X	X	X	A	X	X	X	B	B	A	A	A	A	T V
Benzine (Ligroin)	100	A	X	X	X	A	A	I	X	A	B	A	A	A	I	TVB
Benzine Solvent (Ligroin)	100	A	X	X	X	A	A	I	X	A	I	A	A	A	I	TVBS
Benzoic Acid	100	A	B	B	X	I	I	A	B	A	A	A	B	B	X	TVN
Benzoic Aldehyde	100	A	B	X	X	X	X	X	B	A	I	A	A	I	B	T
Benzotrichloride	100	X	I	I	I	I	X	X	X	X	X	A	I	I	I	T
Benzoyl Chloride	100	X	I	I	I	I	X	X	X	B	X	A	B	I	I	T
Benzyl Acetate	100	A	A	B	X	X	X	B	I	A	B	A	B	I	I	T
Benzyl Alcohol	100	A	A	X	X	A	X	A	X	A	A	A	A	B	I	TVS
Benzyl Chloride	100	A	X	X	X	A	X	X	X	A	I	A	A	X	X	T V
Bichromate of Soda	150	A	A	X	I	I	I	I	I	A	A	A	I	I	I	T
Black Sulfate Liquor	150	A	X	B	B	B	B	A	B	A	A	A	A	X	X	TVBN
Black Sulfate Liquor	275	X	X	X	X	X	X	A	X	X	X	A	A	X	X	T
Bleach	100	X	B	X	X	B	X	I	A	X	B	A	X	X	X	T V
Brine	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBNS
Bromine	100	X	X	X	X	B	X	I	X	X	X	A	X	X	X	T V
Bromo Benzene	100	B	X	X	X	B	X	X	X	X	X	A	I	I	I	T V
Bromo Toluene	100	X	X	X	X	B	X	X	X	X	X	A	I	I	I	T
Bromochloromethane	100	X	B	X	X	B	X	X	I	X	A	A	A	X	X	T
Bunker C.	100	B	X	X	X	A	A	I	X	A	B	A	A	I	I	TVB
Bunker Oil	100	B	X	X	X	A	A	I	X	X	B	A	A	I	I	TVB
Butanol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBN
Butyl (Normal) Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBN
Butyl (Secondary) Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBN
Butyl Acetate	100	A	A	B	X	X	X	B	B	A	B	A	A	B	I	T
Butyl Acetoacetate	100	A	X	X	X	X	X	X	I	A	B	A	I	I	I	T

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B = Nitrile **N** = Neoprene
S = Silicone

		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
B																
Butyl Acrylate	100	B	X	X	X	X	X	B	X	B	B	A	I	I	I	T
Butyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBN
Butyl Aldehyde	100	A	B	X	X	X	X	B	X	A	B	A	X	A	X	T
Butyl Amine	100	A	B	X	X	X	X	B	X	A	B	A	A	A	I	T
Butyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	I	I	I	T V
Butyl Benzl Phthalate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Butyl Bromide	100	B	X	X	X	B	X	X	X	B	B	A	I	I	I	T
Butyrate	100	B	X	X	X	X	X	X	I	B	I	A	I	I	I	T V
Butyl Carbitol	100	A	A	A	X	I	X	A	B	A	A	A	I	I	I	T
Butyl Cellosolve	100	A	A	A	X	X	X	A	A	X	A	A	A	A	X	T
Butyl Chloride	100	B	X	X	X	A	X	X	I	B	I	A	B	I	I	T V
Butyl Ether	100	A	X	B	X	X	B	A	X	A	A	A	A	I	I	T
Butyl Ethyl Acetaldehyde	100	A	B	X	X	X	X	I	I	A	B	A	I	I	I	T
Butyl Ethyl Ether	100	A	X	B	X	I	B	I	X	A	A	A	I	I	I	T
Butyl Phthalate	100	A	A	X	X	X	X	I	I	A	A	A	A	A	I	T
Butyl Stearate	100	A	X	X	X	I	A	B	X	A	B	A	A	A	A	TBS
Butylate	100	A	I	I	I	I	I	I	A	I	I	I	I	I	I	I
Butyraldehyde	100	A	B	X	X	X	X	B	X	A	B	A	X	A	X	T
Butyric Acid	100	A	X	B	X	I	X	A	B	A	A	A	A	B	I	T
Butyric Anhydride	100	A	X	B	X	I	X	I	I	A	I	A	I	I	I	T
C																
Cadmium Acetate	100	A	A	A	X	X	X	A	I	A	A	A	I	I	I	T
Calcium Acetate	100	A	A	A	X	X	X	A	A	A	A	A	A	I	I	T B
Calcium Aluminate	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Calcium Bichromate	150	X	A	X	I	I	I	I	I	X	I	A	I	I	I	T
Calcium Bisulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN
Calcium Bisulfite	150	A	A	A	A	A	A	A	A	I	A	A	A	X	X	TVBNS
Calcium Carbonate	150	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBNS
Calcium Chloride	150	A	A	A	A	A	A	A	A	A	A	A	B	X	X	TVBNS
Calcium Hydroxide (Caustic Lime)	100	A	A	B	A	X	B	A	A	A	A	A	A	X	X	TNS
Calcium Hypochlorite	100	B	B	X	X	B	X	A	B	X	A	A	A	X	X	T V
Calcium Nitrate	150	A	A	A	A	A	A	A	A	A	A	A	B	X	X	TVBN
Calcium Silicate	150	A	A	A	A	A	A	A	A	A	A	A	I	A	I	TVBN

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S = Silicone

C	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
Calcium Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	I	I	TVBS
Calcium Sulfhydrate	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Calcium Sulfide	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN
Calcium Sulfite	150	A	A	A	X	A	A	A	A	A	A	A	B	B	X	TVBNS
Caprylic Acid	100	A	X	B	X	I	X	A	I	A	A	A	B	I	X	T
Carbitol	100	A	A	A	X	I	X	A	A	A	A	A	B	A	X	T
Carbitol Acetate	100	A	B	B	X	I	X	I	I	A	A	A	I	I	I	T
Carbolic Acid, Phenol	100	A	A	X	X	A	X	A	X	A	B	A	A	B	A	T V
Carbon Dioxide	100	A	A	A	A	A	A	A	A	A	A	A	A	B	I	TVBNS
Carbon Disulfide	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Carbon Tetrachloride	100	B	X	X	X	A	X	X	X	A	B	A	A	I	I	T V
Carbonic Acid	100	A	A	A	A	A	A	A	A	A	A	A	A	B	B	TVBS
Casinghead Gasoline	100	B	X	X	X	A	A	B	X	B	B	A	I	I	I	TVB
Caster Oil (Castor Oil)	100	A	A	A	X	A	A	A	A	A	A	A	A	A	I	TVBS
Caustic Potash	150	A	A	B	A	X	B	A	B	A	A	A	A	X	X	T
Caustic Soda	150	A	A	B	A	X	B	A	A	A	A	A	A	X	X	TNS
Cellosize	100	A	A	X	X	I	X	I	I	A	A	A	I	I	I	T
Cellosolve	100	A	A	A	X	X	X	I	A	A	A	A	A	A	X	T
Cellosolve Acetate	100	A	B	B	X	X	X	X	B	A	A	A	A	I	X	T
Chloracetic Acid	100	A	X	X	B	X	X	A	X	A	A	A	A	X	X	T
Chlorinated Solvents	100	B	X	X	X	A	X	B	X	A	I	A	B	X	A	T V
Chlorine (Dry) (Gas)	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Chlorine (Wet)	100	X	X	X	X	B	X	X	X	X	X	A	X	X	X	T V
Chloroacetone	100	A	I	X	X	X	X	X	X	A	I	A	A	X	X	T
Chlorobenzene	100	B	X	X	X	A	X	X	X	A	B	A	A	B	I	T V
Chlorobenzol	100	A	X	X	X	A	X	I	X	A	B	A	A	B	I	T V
Chlorobutane	100	X	X	X	X	A	X	X	I	X	I	A	I	I	I	T V
Chloroethylbenzene	100	A	X	X	X	A	X	I	X	A	I	A	I	I	I	T V
Chloroform	100	B	X	X	X	B	X	X	X	X	B	A	A	B	I	T V
Chloropentane	100	A	X	X	X	A	X	X	X	A	I	A	A	X	I	T V
Chlorophenol	100	A	X	X	X	B	X	X	X	X	B	A	I	I	I	T V
Chloropropanone	100	A	I	X	X	X	X	X	X	A	I	A	I	I	I	T
Chlorosulfonic Acid	100	X	X	X	X	X	X	I	X	X	X	A	B	X	X	T

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GASKET

T = Teflon®
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B = Nitrile
N = Neoprene
S = Silicone

C	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		HOSE TUBE POLYMER											METAL			
Chlorothene	100	X	X	X	X	A	X	I	X	A	I	A	A	I	I	T V
Chlorotoluene	100	X	X	X	X	A	X	X	X	X	I	A	A	I	I	T V
Chlorpyrifos	100	I	I	I	I	I	I	I	X	I	I	I	I	I	I	I
Chromic Acid 25%	100	B	X	B	X	I	X	A	X	X	B	A	B	X	X	T V
Coal Oil	100	A	X	X	X	A	A	A	X	A	A	A	A	X	A	TVB
Coal Tar	100	A	X	X	X	A	X	B	X	A	A	A	A	I	I	TVS
Coal Tar Naptha	100	A	X	X	X	A	X	B	X	A	A	A	A	A	I	T V
Copper Chloride	100	A	A	A	X	A	A	A	A	A	A	A	X	X	X	TVBNS
Copper Hydrate	100	A	A	B	X	X	B	I	I	A	A	A	I	I	I	T B
Copper Hydroxide	100	A	A	B	X	X	B	I	I	A	A	A	I	I	I	T B
Copper Nitrate	100	A	A	A	X	A	A	A	A	A	A	A	A	X	X	TVBNS
Copper Nitrite	100	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVB
Copper Sulfate	100	A	A	A	X	A	A	A	A	A	A	A	A	X	X	TVBNS
Copper Sulfide	100	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVB
Creosols	100	A	A	X	X	A	X	A	X	A	B	A	A	I	X	T V
Creosote	100	A	X	X	X	A	B	I	X	A	B	A	A	I	I	T V
Cresylic Acid	100	A	A	X	X	I	X	X	X	A	I	A	A	B	X	T V
Crotonaldehyde	100	A	A	X	X	X	X	A	I	A	A	A	I	I	I	T
Crude Oil	100	A	X	X	X	A	A	B	X	A	B	A	A	A	I	TVB
Cumene	100	A	X	X	X	A	X	X	X	A	B	A	I	I	I	T V
Cupric Carbonate	100	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVBN
Cupric Chloride	100	A	A	A	X	A	A	A	A	A	A	A	B	X	I	TVBNS
Cupric Nitrate	100	A	A	A	X	A	A	A	A	A	A	A	B	I	I	TVBN
Cupric Nitrite	100	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVB
Cupric Sulfate	100	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVBNS
Cyclohexane	100	A	X	X	X	A	B	A	X	A	B	A	A	B	X	T V
Cyclohexanol	100	A	X	X	X	B	B	A	X	A	B	A	A	X	X	TVB
Cyclohexanone	100	A	X	X	X	X	X	X	X	A	B	A	A	I	I	T
Cyclopentane	100	A	X	X	X	A	B	B	X	A	B	A	I	I	I	TVN
Cyclopentane, methyl	100	A	X	X	X	A	B	I	X	A	B	A	I	I	I	T V
Cyclopentanol	100	A	X	X	X	B	B	A	X	A	A	A	I	I	I	TVB
Cyclopentanone	100	A	X	X	X	X	X	X	X	A	B	A	I	I	I	T

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D	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
D.D.T. in Kerosene	100	A	X	X	X	A	A	A	X	A	B	A	I	I	A	TVB
D.M.P.	100	X	X	X	X	X	X	X	X	X	A	A	A	I	I	T V
Decalin®	100	X	X	X	X	A	X	X	X	A	X	A	I	I	I	T V
Decanol	100	A	A	A	X	B	A	A	A	A	A	A	I	I	I	T B
Decyl Alcohol	100	A	A	A	X	B	A	A	A	A	A	A	I	I	I	T B
Decyl Aldehyde	100	A	X	X	X	X	X	I	I	A	B	A	I	I	I	T
Decyl Butyl Phthalate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Denatured Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	B	A	T B
Diacetone Alcohol	100	A	A	B	B	X	X	A	X	A	A	A	A	I	I	T
Diamyl Phenol	100	A	X	X	X	A	X	A	X	A	I	A	I	I	I	T V
Diamylamine	100	A	A	X	B	I	B	A	I	A	B	A	I	I	I	T B
Diamylene	100	A	X	X	X	A	X	B	X	A	B	A	I	I	I	T V
Dibenzyl Ether	100	A	B	X	X	I	X	X	X	A	B	A	A	A	X	T
Dibromobenzene	100	B	X	X	X	A	X	I	X	A	I	A	I	I	I	T V
Dibutyl Amine	100	A	X	X	B	X	B	A	X	A	A	A	I	I	I	T
Dibutyl Ether	100	A	X	B	X	X	X	A	X	A	A	A	A	A	X	T
Dibutyl Phthalate	100	A	A	X	X	X	X	X	A	A	A	A	A	A	I	T V
Dibutyl Sebacate	100	A	A	X	X	X	X	B	X	A	I	A	I	I	I	TVS
Dicalcium Phosphate	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Dicamba	100	A	I	I	I	I	I	I	A	A	I	A	I	I	I	T
Dichloroacetic Acid	100	A	X	X	B	X	X	B	I	A	I	A	I	I	I	T
Dichlorobenzene	100	A	X	X	X	A	X	X	X	A	B	A	A	B	I	T V
Dichlorobutane	100	A	X	X	X	A	X	X	X	A	I	A	I	I	I	T V
Dichlorodifluoromethane	100	I	X	X	X	B	B	I	X	I	X	A	I	I	I	TVB
Dichloroethane	100	A	X	X	X	A	X	X	X	A	A	A	I	A	I	T V
Dichloroethyl Ether	100	A	X	X	X	I	X	B	X	A	B	A	I	I	I	T
Dichloroethylene	100	X	X	X	X	A	X	I	I	X	X	A	I	A	X	T V
Dichlorohexane	100	A	X	X	X	A	X	X	X	A	A	A	I	I	I	T V
Dichloropentane	100	A	X	X	X	A	X	X	X	A	B	A	I	I	I	T V
Dichloropropane	100	A	X	X	X	A	X	X	X	B	I	A	A	X	I	T V
Diesel Oil	150	A	X	X	X	A	A	A	X	A	B	A	A	A	I	TVB
Diethanol Amine	100	A	A	X	B	I	B	A	I	A	A	A	A	I	I	T
Diethyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	I	I	I	T V

GOODYEAR ENGINEERED PRODUCTS

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D	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
Diethyl Carbinol	100	A	A	A	A	B	A	I	I	A	A	A	I	I	I	TBN
Diethyl Ketone	100	A	B	X	X	X	X	X	X	A	B	A	I	I	I	T
Diethyl Oxalate	100	A	B	X	B	I	X	A	X	A	B	A	I	I	I	T
Diethyl Phthalate	100	A	A	X	X	X	X	B	X	A	B	A	I	I	I	T
Diethyl Sebacate	100	A	A	X	X	X	X	B	X	A	B	A	A	A	I	T
Diethyl Sulfate	100	A	B	X	X	X	X	A	I	A	A	A	X	I	I	TNS
Diethyl Triamine	100	A	A	X	B	I	B	A	I	A	A	A	I	I	I	T B
Diethylamine	100	A	A	X	B	I	B	B	B	A	B	A	A	I	X	T B
Diethylene Dioxide	100	A	B	X	X	X	X	B	A	A	A	A	X	X	X	T
Diethylene Glycol	100	A	A	A	A	A	A	X	A	A	A	A	A	B	A	TVBN
Diethylene Triamine	100	A	A	X	B	I	B	A	I	A	A	A	I	I	X	T
Dihydroxydiethyl Ether	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBN
Dihydroxyethyl Amine	100	A	A	X	B	I	B	A	I	A	A	A	I	I	I	T B
Diisobutyl Ketone	100	A	B	X	X	X	X	I	B	A	B	A	I	I	I	T
Diisobutylene	100	A	X	X	X	A	A	X	X	A	B	A	A	I	I	TVB
Diisoctyl Adipate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Diisoctyl Phthalate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Diisocyanate	100	X	X	X	X	X	X	X	X	X	B	A	I	I	I	T
Diisodecyl Adipate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Diisodecyl Phthalate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Diisopropanol Amine	100	A	A	X	B	I	B	I	I	A	B	A	I	I	I	T B
Diisopropyl Amine	100	A	A	X	B	I	B	I	I	A	B	A	I	I	I	T B
Diisopropyl Ether	100	A	X	B	X	I	B	I	X	A	B	A	A	I	I	T B
Diisopropyl Ketone	100	A	B	X	X	X	X	I	B	A	B	A	A	A	I	T
Dilauryl Ether	100	A	I	B	X	I	B	I	I	A	B	A	I	I		T B
Dimethyl Amine	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Dimethyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	A	I	I	T V
Dimethyl Ether	100	A	X	B	X	I	B	I	X	B	B	A	I	I	I	T B
Dimethyl Ketone	100	A	A	X	B	X	X	A	A	B	A	A	A	A	I	T
Dimethyl Phenol	100	A	X	X	X	A	X	I	X	A	A	A	I	I	I	T V
Dimethyl Phthalate	100	A	A	X	X	X	X	A	B	A	A	A	A	I	I	T V
Dimethyl Sulfate	100	A	B	X	X	X	X	A	I	A	A	A	I	I	I	T
Dimethyl Sulfide	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														

GOODYEAR ENGINEERED PRODUCTS

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N = Neoprene
S = Silicone

		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
D																
Dimethyl Carbinol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBNS
Dinitrobenzene	100	A	X	X	X	A	X	I	I	A	B	A	I	I	I	T V
Dioctyl Adipate	100	A	A	X	X	X	X	X	B	A	I	A	I	I	I	T
Dioctyl Amine	100	A	A	X	B	I	B	I	I	A	B	A	I	I	I	T
Dioctyl Phthalate	100	A	B	X	X	A	X	X	X	A	A	A	A	I	I	T V
Dioctyl Sebacate	100	A	A	X	X	X	X	X	B	A	I	A	I	I	I	T V
Dioxane	100	A	B	X	X	X	X	B	X	A	A	A	A	I	I	T
Dioxolane	100	A	X	X	X	I	X	B	X	A	B	A	I	I	I	T
Diphenyl Phthalate	100	A	A	X	X	X	X	I	I	A	A	A	I	I	I	T
Dipropyl Ketone	100	A	B	X	X	X	X	X	I	A	A	A	I	I	I	T
Dipropylamine	100	A	A	X	B	I	B	B	I	A	A	A	I	I	I	T
Dipropylene Glycol	100	A	A	A	A	A	A	A	I	A	A	A	I	I	I	TVB
Disodium Phosphate	100	A	A	A	A	I	A	A	I	A	A	A	A	I	B	T B
Divinyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	I	I	I	T V
Dodecyl Benzene	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Dodecyl Toluene	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Dow-Per	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Dowtherm® A	100	A	I	X	X	A	X	X	X	A	A	A	I	A	I	T V
Dowtherm® E	100	A	X	X	X	A	X	X	X	A	A	I	I	X	I	V
Dowtherm® SR-1	100	A	A	A	A	A	A	I	I	A	A	A	I	I	I	TVB
E																
Endolene	100	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Epichlorohydrin	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Ethanol	100	A	A	A	A	B	A	A	A	A	A	A	A	B	A	TBN
Ethanol Amine	100	A	A	B	B	I	B	A	B	A	B	A	A	B	I	T B
Ethyl Acetate	100	A	B	X	X	X	X	B	A	A	A	A	A	A	A	T
Ethyl Acetoacetate	100	A	B	X	X	X	X	A	B	A	A	A	B	I	I	T
Ethyl Acrylate	100	A	X	X	X	X	X	B	X	B	B	A	A	A	A	T
Ethyl Alcohol	100	A	A	A	A	A	A	A	A	A	A	A	A	B	A	TVBNS
Ethyl Aldehyde	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Ethyl Aluminum Dichloride	100	X	X	X	X	B	X	I	X	B	I	A	I	I	I	T V
Ethyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	A	A	X	T V
Ethyl Butanol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B

GOODYEAR ENGINEERED PRODUCTS

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S = Silicone

E	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE: HOSE TUBE POLYMER											FITTING: METAL			
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
Ethyl Butyl Acetate	100	A	A	B	X	X	X	I	I	A	B	A	I	I	I	T
Ethyl Butyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Ethyl Butyl Amine	100	A	A	X	B	I	B	I	I	I	I	A	I	I	I	T B
Ethyl Butyl Ketone	100	A	B	X	X	X	X	X	I	A	A	A	I	I	I	T
Ethyl Butyraldehyde	100	A	B	X	X	X	X	X	I	A	B	A	I	I	I	T
Ethyl Chloride	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Ethyl Dichloride	100	B	X	X	X	B	X	X	X	B	B	A	I	I	I	T V
Ethyl Ether	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Ethyl Formate	100	A	B	X	X	X	X	A	B	A	A	A	A	I	I	T V
Ethyl Hexanol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	TBN
Ethyl Hexoic Acid	100	A	X	B	X	I	X	I	I	A	A	A	I	I	I	T
Ethyl Hexyl Acetate	100	A	A	B	X	X	X	I	I	A	B	A	I	I	I	T
Ethyl Hexyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	TBN
Ethyl Iodide	100	X	X	X	X	B	X	X	X	B	B	A	I	I	I	T V
Ethyl Isobutyl Ether	100	A	X	B	X	I	B	I	X	A	B	A	I	I	I	T
Ethyl Methyl Ketone	100	A	B	X	X	X	X	I	I	A	A	A	A	A	A	T
Ethyl Oxalate	100	A	A	X	A	I	X	A	X	A	B	A	I	I	I	T V
Ethyl Phthalate	100	A	A	X	X	X	X	B	I	A	I	A	I	I	I	T
Ethyl Propyl Ether	100	A	X	B	X	I	B	A	X	A	B	A	I	I	I	T B
Ethyl Propyl Ketone	100	A	B	X	X	X	X	I	I	A	A	A	I	I	I	T
Ethyl Silicate	100	A	A	I	X	I	A	A	I	A	A	A	A	I	I	TBN
Ethyl Sulfate	100	A	B	X	X	X	X	A	I	A	A	A	X	I	I	TBS
Ethylamine	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Ethylene Bromide	100	X	X	X	X	B	X	I	X	B	B	A	A	X	I	T V
Ethylene Chloride	100	B	X	X	X	B	X	I	X	B	B	A	A	B	I	T V
Ethylene Diamine	100	A	A	X	B	I	B	I	B	A	I	A	A	I	I	T B
Ethylene Dibromide	100	X	X	X	X	B	X	I	X	B	B	A	A	X	I	T V
Ethylene Dichloride	100	B	X	X	X	B	X	X	X	B	A	A	A	B	I	T V
Ethylene Glycol	150	A	A	A	A	A	A	A	A	A	A	A	A	A	I	TVBNS
Ethylhexil Phosphorodieth	100	I	X	X	I	I	A	A	X	X	I	I	I	I	I	B
Ex-Tri	100	A	X	X	X	A	X	I	I	A	B	A	I	I	I	T V

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		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
	Temperature (°F)	HOSE TUBE POLYMER											METAL			
F																
Ferric Bromide	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Ferric Chloride	150	A	A	A	A	A	A	A	A	A	A	A	X	X	X	TVBNS
Ferric Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN
Ferrous Acetate	100	A	A	A	X	X	X	I	I	A	A	A	I	I	I	T
Ferrous Chloride	150	A	A	A	A	B	A	A	A	A	A	A	I	X	X	T B
Ferrous Hydroxide	100	A	A	B	A	X	B	I	I	A	A	A	B	I	I	T N
Ferrous Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	B	X	X	TVBN
Fluoboric Acid 65%	150	B	A	A	A	I	I	A	I	I	A	A	I	I	X	T N
Fluorine (wet)	100	X	X	X	X	X	X	X	X	X	X	B	X	X	X	T
Fluosilicic Acid 50%	150	B	A	A	A	I	I	A	I	I	A	A	A	X	X	T N
Formaldehyde 40%	100	A	A	A	B	B	A	A	A	A	A	A	A	B	I	T B
Formalin	100	A	A	A	B	A	A	A	A	A	A	A	A	B	I	TVB
Formic Acid	100	A	A	X	B	X	X	A	A	B	A	A	B	I	X	T V
Freon® 12	100	A	X	X	X	B	B	I	X	B	X	A	A	I	I	T N
Freon® 22	100	A	X	X	X	X	X	I	I	B	X	A	A	I	I	T N
Fuel A (ASTM)	100	B	X	X	X	A	A	I	X	B	B	A	A	A	A	TVB
Fuel B (ASTM)	100	B	X	X	X	A	A	I	X	B	B	A	I	I	I	TVB
Fuel Oil	100	A	X	X	X	A	A	X	X	B	B	A	A	A	I	TVB
Furfural	100	A	A	I	I	X	X	A	B	A	A	A	A	A	X	T
Furfuryl Alcohol	100	A	X	I	I	X	I	A	I	A	A	A	A	A	I	T
G																
Gallic Acid	100	A	B	I	A	I	I	A	B	I	B	A	B	I	I	T S
Gasoline	100	B	X	X	X	A	A	B	X	B	B	A	A	I	I	TVB
Glacial Acetic Acid	100	A	B	X	X	X	X	B	A	A	A	A	A	B	X	T
Gluconic Acid	100	A	X	B	X	I	X	A	I	A	A	A	X	X	A	T
Glycerin	100	A	A	A	A	A	A	A	A	B	A	A	A	A	A	TVBNS
Glyphosate	100	A	I	I	I	I	I	I	A	I	I	I	I	I	I	I
Graffinite	100	I	X	X	X	X	A	A	X	X	I	I	I	I	I	B
Grease	100	A	X	X	X	A	A	I	X	B	A	A	A	A	A	TVB
Green Sulfate Liquor	150	A	A	A	A	I	A	A	A	A	A	A	A	X	X	TBS
H																
Heptanal	100	A	X	X	X	X	X	X	I	A	I	A	I	I	I	T B
Heptane	100	A	X	X	X	A	A	A	X	B	B	A	A	A	I	TVB

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	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
H																
Heptane Carboxylic Acid	100	A	X	B	X	A	X	A	I	A	A	A	I	I	I	T V
Hexaldehyde	100	A	X	X	X	X	X	I	X	A	B	A	A	A	I	T
Hexane	100	B	X	X	X	A	A	B	X	B	B	A	A	A	A	TVB
Hexanol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	T B
Hexyl Methyl Ketone	100	A	B	X	X	X	X	I	I	A	A	A	I	I	I	T
Hexylamine	100	A	B	X	X	X	X	B	I	A	B	A	I	I	I	T
Hexylene	100	X	X	X	X	A	A	I	X	X	I	A	I	I	I	TVB
Hexylene Glycol	150	A	A	A	A	A	A	A	I	A	A	A	A	B	A	TVBN
Hexyl-Alcohol	100	A	A	A	A	B	A	A	X	A	A	A	A	I	I	T B
Hi-Tri	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Hydrobromic Acid (37%)	150	B	A	A	A	I	X	A	A	I	A	A	X	X	X	T N
Hydrochloric Acid 38% concentrated, fuming acid	125	A	B	X	I	I	X	X	I	A	I	A	X	X	X	T
Hydrochloric Acid 37%	125	A	B	A	B	X	X	A	B	A	A	A	X	X	X	T
Hydrofluoric Acid (10%)	125	A	A	A	X	I	X	A	I	A	A	A	A	X	X	T N
Hydrofluosilicic Acid	150	B	B	A	A	I	I	A	A	I	A	A	A	X	X	T
Hydrogen Dioxide 10%	100	B	X	X	X	A	X	I	I	I	I	A	A	B	X	T V
Hydrogen Dioxide over 10%	100	B	X	X	X	I	X	I	X	I	I	A	I	I	X	T
Hydrogen Gas	100	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Hydrogen Peroxide 10% to 50%	100	B	X	X	X	A	X	A	I	I	I	A	I	B	I	TVS
Hydrogen Peroxide over 50%	100	X	X	X	X	X	X	X	X	X	I	A	A	I	X	T
I																
Iodine	100	A	I	A	I	I	I	A	I	B	I	A	I	I	X	TVB
Iron Acetate	100	A	A	A	X	X	X	I	I	A	A	A	I	I	I	TNS
Iron Hydroxide	100	A	A	B	X	X	B	I	I	A	A	A	I	I	I	T N
Iron Salts	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBN
Iron Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBN
Iron Sulfide	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Isoamyl Acetate	100	A	A	B	X	X	X	I	X	A	B	A	I	I	I	T
Isoamyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	A	TBN
Isoamyl Bromide	100	B	X	X	X	B	X	I	X	B	I	A	I	I	I	T V
Isoamyl Butyrate	100	B	X	X	X	X	X	I	I	B	B	A	I	I	I	T
Isoamyl Chloride	100	X	X	X	X	B	X	I	I	X	B	A	I	I	I	T V

GOODYEAR ENGINEERED PRODUCTS

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		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
I																
Isoamyl Ether	100	A	X	B	X	I	B	I	X	A	I	A	I	I	I	T
Isoamyl Phthalate	100	A	A	X	X	X	X	I	I	A	I	A	I	I	I	T
Isobutane	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Isobutanol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBNS
Isobutyl Acetate	100	A	A	B	X	X	X	B	X	A	B	A	A	B	I	T
Isobutyl Alcohol	100	A	A	A	A	B	X	A	A	A	A	A	A	I	I	TNS
Isobutyl Aldehyde	100	A	B	X	X	X	X	B	I	A	B	A	I	I	I	T
Isobutyl Amine	100	A	B	X	X	X	X	I	I	A	B	A	I	I	I	T
Isobutyl Bromide	100	B	X	X	X	B	X	I	X	X	I	A	I	I	I	T V
Isobutyl Carbinol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	A	TBN
Isobutyl Chloride	100	B	X	X	X	B	X	I	X	X	I	A	I	I	I	T V
Isobutyl Ether	100	A	X	B	X	I	X	I	X	A	I	A	I	I	I	T B
Isobutylene	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Isooctane	100	B	X	X	X	A	A	I	X	B	B	A	A	A	A	TVBS
Isopentane	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Isophorone	100	B	A	I	I	I	X	I	A	B	B	A	B	A	I	T
Isopropanol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TVBS
Isopropanol Amine	100	A	A	X	B	X	B	I	I	A	B	A	I	I	I	T B
Isopropyl Acetate	100	A	A	X	X	X	X	B	X	A	A	A	A	I	I	T
Isopropyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TBNS
Isopropyl Amine	100	A	B	X	X	X	X	I	I	A	B	A	I	I	I	T
Isopropyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	I	I	I	T V
Isopropyl Chloride	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Isopropyl Ether	100	A	X	B	X	I	X	I	X	A	B	A	A	I	I	T B
Isopropyl Toluene	100	A	X	X	X	A	X	I	X	A	I	A	I	I	I	T V
J																
Jet Fuels	---	SPECIAL HOSE REQUIRED											A	A	A	TVB
K																
Kerosene	100	A	X	X	X	A	A	A	X	A	A	A	A	A	I	TVB
L																
Lauryl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Lead Acetate	100	A	A	X	X	X	X	A	B	A	A	A	A	X	X	T

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		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasym™	Teflon®	316 SS	Aluminum	Brass	Gasket
	Temperature (°F)	HOSE TUBE POLYMER											METAL			
L																
Lead Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN
Ligroin	100	A	X	X	X	A	A	I	X	A	B	A	A	A	I	T V B
Linseed Oil	100	A	A	B	X	A	A	A	B	I	A	A	A	I	A	TVBNS
Liquefied Natural Gas (LNG)	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Liquefied Petroleum Gas (LPG)	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Lubricating Oils	100	A	X	X	X	A	A	I	X	A	I	A	A	A	A	T V B
M																
MIBK	100	A	X	X	X	X	X	X	X	A	B	A	X	X	X	T
M.E.K.	100	A	X	X	X	X	X	X	X	A	B	A	X	X	X	T
Magnesium Acetate	100	A	A	A	X	X	X	A	I	A	A	A	I	I	I	T
Magnesium Chloride	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBS
Magnesium Hydrate	150	A	A	B	A	B	B	I	I	A	A	A	A	X	I	T N
Magnesium Hydroxide	150	A	A	B	A	B	B	A	A	A	A	A	A	X	I	TVBN
Magnesium Sulfate	150	A	A	A	A	A	A	A	B	A	A	A	A	I	I	TVBNS
Maleic Acid	100	A	X	X	X	I	X	I	I	B	I	A	A	B	X	T V
Malic Acid	150	B	I	A	A	I	I	I	I	I	I	A	A	B	X	TVBNS
Manganese Sulfate	150	A	A	A	X	A	A	A	A	A	A	A	A	I	I	TVBN
Manganese Sulfide	150	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVB
Manganese Sulfite	150	A	A	A	X	A	A	A	A	A	A	A	I	I	I	TVB
Methanol	100	A	A	A	A	X	A	A	A	A	A	A	A	I	I	T B
Mesityl Oxide	100	A	B	X	X	X	X	B	X	A	B	A	A	I	I	T
Methallyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Methyl (Wood) Alcohol	100	A	A	A	A	X	A	A	A	A	A	A	A	I	I	TBNS
Methyl Acetate	100	A	A	B	X	X	X	A	A	A	A	A	A	I	I	T
Methyl Acetoacetate	100	A	B	X	X	X	X	A	I	A	A	A	I	I	I	T
Methyl Acetone	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Methyl Amyl Acetate	100	B	A	B	X	X	X	I	X	A	B	A	I	I	I	T
Methyl Amyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	TBN
Methyl Amyl Carbinol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Methyl Amyl Ketone	100	A	B	X	X	X	X	X	I	A	B	A	I	I	I	T
Methyl Benzene	100	A	X	X	X	A	X	X	X	A	B	A	A	A	A	T V
Methyl Butanol	100	A	A	A	A	B	A	A	I	A	A	A	A	I	A	TBN

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M	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		Fabchem™ UHMWPE	Gray Flexwing® Butyl	Yellow Flexwing Hypalon®	Tan Flexwing NR	Orange Flexwing Viton®	Flexwing Petroleum Nitrile	Brown Flexwing CPE	Purple Flexwing EPDM	Green XLPE Blue Flexwing XLPE	ChemOne™ & Viper™ Alphasyn™	HI-PER® Teflon®	Insta-Lock™ 316 SS	Insta-Lock Aluminum	Insta-Lock Brass	Insta-Lock Gasket
Methyl Butanone	100	A	B	X	X	X	X	B	B	A	B	A	I	I	I	T
Methyl Butyl Ketone	100	A	B	X	X	X	X	X	I	A	B	A	A	B	I	T
Methyl Carbitol	100	A	A	A	X	I	X	A	I	A	A	A	I	I	I	T
Methyl Cellosolve	100	A	A	A	X	I	X	A	A	A	A	A	A	B	A	T
Methyl Chloride	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Methyl Cyclohexane	100	A	X	X	X	B	X	B	X	B	I	A	I	I	I	T V
Methyl Ethyl Ketone (M.E.K.)	100	A	X	X	X	X	X	X	X	A	B	A	X	X	X	T
Methyl Hexanol	100	A	A	A	B	A	A	A	A	A	A	A	I	I	I	TVB
Methyl Hexanone	100	A	B	X	X	X	X	X	I	A	B	A	I	I	I	T
Methyl Hexyl Ketone	100	A	B	X	X	X	X	X	I	A	B	A	I	I	I	T
Methyl Isobutyl Carbinol	100	A	A	A	A	B	A	A	A	A	A	A	B	I	I	TBN
Methyl Isobutyl Ketone (MIBK)	100	A	X	X	X	X	X	X	X	A	B	A	X	X	X	T
Methyl Isopropyl Ketone	100	A	B	X	X	X	X	B	B	A	B	A	A	I	I	T
Methyl Normal Amyl Ketone	100	A	B	X	X	X	X	I	I	A	B	A	I	I	I	T
Methyl Propyl Carbinol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Methyl Propyl Ether	100	A	X	B	X	I	X	I	X	A	B	A	I	I	I	T
Methyl Propyl Ketone	100	A	B	X	X	X	X	B	I	A	B	A	I	I	I	T
Methyl Tertiary Butyl Ether (MTBE) 100% Concentratel	100	X	X	X	X	X	X	X	X	A	B	I	I	I	I	I
Methylallyl Acetate	100	A	A	B	X	X	X	I	A	A	A	A	I	I	I	T
Methylallyl Chloride	100	A	X	X	X	X	X	X	I	B	I	A	I	I	I	T
Methyldiethanolamine	100	A	X	X	X	X	A	A	X	A	A	A	I	I	I	T B
Methylene Bromide	100	B	X	X	X	B	X	I	X	B	A	A	I	I	I	T V
Methylene Chloride	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Metribuzin	100	A	I	I	I	I	I	I	A	I	I	A	I	I	I	T
Mineral Spirits	100	A	X	X	X	B	A	I	X	A	B	A	A	A	I	T B
Monochloroacetic Acid	100	A	X	X	B	I	X	A	X	A	A	A	A	X	X	T
Monochlorobenzene	100	B	X	X	X	A	X	X	X	B	B	A	A	B	B	T V
Monochlorodifluoromethane	100	I	X	X	X	X	X	I	I	I	I	A	A	I	I	T N
Monoethanol Amine	100	A	A	X	B	I	B	A	B	A	B	A	A	B	I	T N
Monoethyl Amine	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Monoisopropanol Amine	100	A	A	X	B	I	B	I	I	A	B	A	I	I	I	T B
Muriatic Acid	125	A	X	X	A	I	X	A	X	A	A	A	X	X	X	T

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		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasym™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
N																
N/Methylpyrrolidone	100	A	X	X	X	X	X	X	X	A	I	A	I	I	I	T
Naphtha	100	A	X	X	X	A	A	A	X	A	A	A	A	A	I	TVBN
Naphthalene	100	A	X	X	X	A	X	I	X	A	I	A	A	B	I	T V
Natural Gas	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Neohexane	100	A	X	X	X	A	A	B	X	A	B	A	A	A	I	TVB
Neu-Tri	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Nickel Chloride	150	A	A	A	A	A	A	A	A	A	A	A	B	X	X	TVBS
Nickel Nitrate	150	A	A	A	A	A	A	A	A	A	A	A	B	X	X	TVBN
Nickel Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Nitric Acid 25%	100	B	B	X	X	X	X	X	X	B	A	A	A	X	X	T V
Nitric Acid 37%	100	X	X	X	X	X	X	X	X	X	A	A	A	X	X	T V
Nitric Acid 40%-60%	100	X	X	X	X	X	X	X	X	X	B	A	A	X	X	T V
Nitric Acid 70%	100	X	X	X	X	X	X	X	X	X	B	A	B	X	X	T
Nitro Benzene	100	A	X	X	X	B	X	X	X	A	B	A	A	B	X	T
Nitrogen Gas	100	A	A	A	A	A	A	A	A	A	A	A	A	I	I	TVBNS
Nitrous Oxide	100	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBNS
Nonenes	100	A	X	X	X	A	A	I	X	A	B	A	I	I	I	V B
O																
Octadecanoic Acid	100	A	B	X	X	I	A	A	B	A	A	A	A	B	A	T B
Octane	100	B	X	X	X	A	A	A	X	B	B	A	B	I	B	TVB
Octanol	100	A	A	A	A	B	A	A	X	A	A	A	A	I	I	TBN
Octyl Acetate	100	A	A	A	X	X	X	X	I	A	B	A	I	I	I	T
Octyl Alcohol	100	A	A	A	A	B	A	A	X	A	A	A	A	I	I	T B
Octyl Aldehyde	100	A	X	X	X	X	X	I	I	A	I	A	I	I	I	T
Octyl Amine	100	A	B	X	X	X	X	B	I	A	B	A	I	I	I	T
Octyl Carbinol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Octylene Glycol	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Oil Petroleum	100	B	X	X	X	A	A	A	X	A	B	A	A	A	X	TVB
Oleic Acid	100	A	B	X	X	I	B	A	X	A	B	A	A	B	X	T B
Oleum	100	X	X	X	X	X	X	X	X	X	X	A	I	X	X	T V
Organic Fatty Acids	100	A	X	X	X	X	A	A	X	A	B	A	A	I	I	T B
Orthodichlorobenzene	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Orthodichlorobenzol	100	A	X	X	X	A	X	I	X	A	I	A	I	I	I	T V

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	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
O																
Orthoxylene	100	B	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Oxalic Acid	100	A	A	X	X	I	X	A	B	I	B	A	A	B	X	T S
Oxygen	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Ozone	100	A	B	B	X	I	X	A	A	I	B	A	I	I	I	T S
P																
Palmitic Acid	100	A	A	B	X	I	A	A	B	B	B	A	A	I	X	TBS
Papermakers Alum	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBN
Paradichlorobenzol	100	B	X	X	X	A	X	I	X	A	I	A	I	I	I	T V
Paraffin	150	A	B	X	X	A	A	A	X	X	I	A	A	A	A	TVB
Paraldehyde	100	A	B	X	X	X	X	I	B	A	B	A	A	A	I	T
Paraxylene	100	A	X	X	X	A	X	I	X	A	B	A	I	I	I	T V
Pelargonic Acid	100	A	A	X	X	I	A	I	I	A	I	A	I	I	I	T B
Pentachloroethane	100	A	X	X	X	A	X	I	X	A	I	A	A	B	X	T V
Pentane	100	X	X	X	X	A	A	A	X	B	X	A	B	A	A	TVB
Pentanol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	TBN
Pentanone	100	A	B	X	X	X	X	B	I	A	B	A	I	I	I	T
Perchloroethylene	100	B	X	X	X	A	X	X	X	A	B	A	A	B	X	T V
Petroleum Ether (Ligroin)	100	A	X	X	X	A	A	A	X	A	B	A	A	A	I	TVB
Petroleum - Crude	100	A	X	X	X	A	A	A	X	A	B	A	A	A	X	TVB
Petroleum Oils	100	A	X	X	X	A	A	A	X	A	B	A	A	A	X	TVB
Phenol	125	A	A	X	X	A	X	A	X	A	B	A	A	B	B	T V
Phenolsulfonic Acid	100	X	X	X	X	X	X	A	I	B	B	A	B	I	I	T
Phenyl Chloride	100	A	X	X	X	A	X	X	X	A	B	A	A	B	I	T V
Phosphoric Acid 10%	150	A	A	A	A	X	A	A	A	A	A	A	A	X	X	TVBN
Phosphoric Acid 10-85%	100	A	A	A	B	X	X	A	A	A	A	A	A	X	I	TVN
Pine Oil	100	A	X	X	X	A	X	B	X	A	B	A	A	I	X	T V
Pinene	100	A	X	X	X	A	B	B	X	A	B	A	B	I	I	T V
Polyethylene Glycol	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBN
Polypropylene Glycol	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Potassium Acetate	100	A	A	B	X	X	X	A	B	A	A	A	A	X	X	T B
Potassium Bisulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBN
Potassium Bisulfite	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBN
Potassium Carbonate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN S

GOODYEAR ENGINEERED PRODUCTS

CHEMICAL CHARTS

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GASKET

T = Teflon® **V** = Viton®
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S = Silicone

		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
	Temperature (°F)	HOSE TUBE POLYMER											METAL			
P																
Potassium Chloride	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Potassium Chromate	150	B	A	X	I	I	I	A	I	B	B	A	B	I	I	TVBN
Potassium Dichromate	150	B	A	X	I	I	I	A	I	B	B	A	A	B	X	TVBNS
Potassium Hydrate	150	A	A	B	A	X	B	A	B	A	A	A	A	X	I	T S
Potassium Hydroxide	150	B	A	B	A	X	B	A	B	A	A	A	A	X	X	T N
Potassium Nitrate	150	A	A	A	A	A	A	A	A	A	A	A	A	B	A	TVBNS
Potassium Permanganate	100	A	A	A	A	A	B	I	I	A	A	A	A	I	I	TVS
Potassium Silicate	150	A	A	A	A	A	A	A	A	A	A	A	A	I	I	TVBNS
Potassium Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	B	A	TVBNS
Potassium Sulfide	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Potassium Sulfite	150	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBNS
Propanediol	100	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVBS
Propane Gas	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Propanol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	TVB
Propyl Acetate	100	A	A	B	X	X	X	B	X	A	B	A	A	I	I	T
Propyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	A	I	I	T B
Propyl Aldehyde	100	A	B	X	X	X	X	X	I	A	B	A	I	I	I	T
Propyl Chloride	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Propylene Diamine	100	A	A	X	B	I	B	A	I	A	I	A	I	I	I	T B
Propylene Dichloride	100	B	X	X	X	B	X	X	X	B	I	A	A	X	I	T V
Propylene Glycol	100	A	A	A	A	A	A	A	A	A	A	A	A	I	I	TVBS
Propylene Tetramer	100	A	X	X	X	X	A	A	X	A	B	I	I	I	I	B
S																
Sea Water	100	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBNS
Sewage	100	A	X	A	X	I	A	A	A	A	A	A	A	X	I	TBNS
Silicate of Soda	100	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Soap	100	A	X	X	X	X	A	A	X	X	I	A	A	X	X	TBNS
Soda Ash	100	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBNS
Soda, Caustic	100	A	A	B	A	X	B	A	A	A	A	A	A	X	X	TNS
Soda, Lime	100	A	A	B	A	X	B	A	A	A	A	A	I	I	I	TVB
Soda, Niter	100	A	A	A	A	A	A	A	B	A	A	A	A	B	I	TVB
Sodium Acetate	100	A	A	A	X	X	X	A	B	B	B	A	A	I	A	TNS
Sodium Aluminate	100	A	A	A	A	A	A	A	A	A	A	A	A	I	I	TVBN

GOODYEAR ENGINEERED PRODUCTS

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S = Silicone

S	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER											FITTING — METAL			
		Fabchem™ UHMWPE	Gray Flexwing® Butyl	Yellow Flexwing Hypalon®	Tan Flexwing NR	Orange Flexwing Viton®	Flexwing Petroleum Nitrile	Brown Flexwing CPE	Purple Flexwing EPDM	Green XLPE Blue Flexwing XLPE	ChemOne™ & Viper™ Alphasyn™	HI-PER® Teflon®	Insta-Lock™ 316 SS	Insta-Lock Aluminum	Insta-Lock Brass	Insta-Lock Gasket
Sodium Bisulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Sodium Bisulfite	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Sodium Carbonate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBNS
Sodium Chloride (Brine)	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBNS
Sodium Chromate	150	X	A	X	I	I	I	A	I	X	I	A	A	A	A	TVBN
Sodium Dichromate	150	A	A	X	I	I	I	A	A	A	A	A	A	I	X	T
Sodium Hydrate	150	A	A	B	A	X	B	A	A	A	A	A	B	X	X	T N
Sodium Hydrochlorite (20%)	100	A	B	X	X	B	X	I	I	B	A	A	I	I	I	T
Sodium Hydrosulfide	100	A	X	X	X	X	A	A	X	A	I	A	I	B	I	T B
Sodium Hydroxide (50%)	150	A	A	B	A	X	B	A	A	A	A	A	A	X	X	TBN
Sodium Hypochlorite	100	B	B	X	X	B	X	A	A	X	B	A	X	X	X	TVS
Sodium Nitrate	150	A	A	A	A	A	A	A	B	A	A	A	A	B	I	TVBNS
Sodium Silicate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Sodium Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	B	X	TVBNS
Sodium Sulfide	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBN
Sodium Sulfite	150	A	A	A	A	A	A	A	B	A	A	A	A	I	I	TVBNS
Sodium Sulphydrate	100	A	X	X	X	X	A	A	X	A	B	A	I	I	I	T B
Sodium Thiosulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	I	X	TVBNS
Stannic Chloride	150	A	A	A	A	I	A	A	A	A	A	A	X	X	X	T B
Stannic Sulfide	150	A	A	A	A	I	A	A	A	A	A	A	I	I	I	TBN
Stannous Chloride	150	A	A	A	A	I	A	A	B	A	A	A	A	X	X	T B
Stannous Sulfide	150	A	A	A	A	I	A	A	A	A	A	A	I	I	I	T B
Stearic Acid	100	A	B	X	X	I	A	A	B	A	A	A	A	B	A	TVB
Stoddards Solvent	100	A	X	X	X	A	A	A	X	A	B	A	A	A	I	TVB
Styrene	100	B	X	X	X	A	X	X	X	X	I	A	A	I	I	T V
Sulfamic Acid (>10%)	100	X	A	B	B	I	B	A	I	I	I	A	I	I	I	TVN
Sulfonic Acid	100	B	X	X	X	X	X	I	I	B	I	A	I	I	I	TVN
Sulfur Dioxide (Liquid)	100	B	B	B	I	X	I	I	I	X	I	A	A	I	I	T N
Sulfuric Acid 25%	150	A	A	B	B	I	X	A	A	A	A	A	I	X	X	TVN
Sulfuric Acid 93%	100	X	X	B	X	B	X	X	B	A	A	A	I	X	X	T V
Sulfuric Acid 93-98%	100	X	X	X	X	B	X	X	X	I	B	A	I	X	X	T V
Sulfuric Acid Fuming	100	X	X	X	X	X	X	X	X	X	X	A	I	X	X	T
Sulfurous Acid 10%	150	A	A	A	A	I	X	A	A	A	A	A	I	X	X	T

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	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE — HOSE TUBE POLYMER: UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	FITTING — METAL: 316 SS	Aluminum	Brass	Gasket
S																
Sulfurous Acid 10-75%	100	A	A	A	A	I	X	A	A	A	A	A	I	X	X	T
Sulphonate	100	I	X	X	X	X	A	A	X	X	I	I	I	I	I	B
T																
Tall Oil	100	A	X	X	X	A	A	I	X	I	I	A	A	X	X	TVB
Tallow	150	A	X	X	X	I	A	A	X	I	I	A	A	I	A	TBNS
Tannic Acid	150	A	A	A	A	I	B	A	X	I	I	A	A	X	I	TVBN
Tar	---	SPECIAL HOSE REQUIRED											A	A	I	I
Tartaric Acid	150	A	A	A	A	I	A	A	A	A	A	A	A	I	A	TBN
Tergitol	100	X	I	I	I	I	I	I	I	I	I	A	I	I	I	T
Tertiary Butyl Alcohol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Tetrachlorobenzene	100	B	X	X	X	B	X	I	X	B	I	A	I	I	T	
Tetrachloroethane	100	A	X	X	X	A	X	I	X	X	I	A	A	X	X	T V
Tetrachloroethylene	100	A	X	X	X	A	X	X	X	A	B	A	A	B	X	T V
Tetrachloromethane	100	A	X	X	X	A	X	X	X	X	B	A	A	I	I	T V
Tetrachloronaphthalene	100	B	X	X	X	B	X	I	X	X	I	A	I	I	I	T
Tetradecanol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Tetraethylene Glycol	150	A	A	A	A	A	A	A	A	A	A	A	I	I	I	TVB
Tetraethylene Lead	100	X	X	X	X	A	X	X	X	X	I	A	I	I	I	T V
Tetrahydrofuran	100	B	X	X	X	X	X	X	X	B	X	A	A	B	X	T
THF	100	B	X	X	X	X	X	X	X	B	X	A	A	B	X	T
Thionyl Chloride	100	X	I	I	I	I	I	I	I	I	X	A	X	X	X	T
Tin Chloride	100	A	A	A	A	I	A	A	A	A	A	A	X	X	X	TVB
Tin Tetrachloride	150	B	A	A	A	I	A	A	A	A	A	A	X	X	X	T B
Titanium Tetrachloride	100	B	X	X	X	A	B	X	X	A	B	A	B	X	X	T V
Toluene	100	A	X	X	X	A	X	X	X	B	B	A	A	A	A	T V
Toluidine	100	X	I	I	I	I	I	I	I	I	I	A	I	I	I	T
Toluol	100	A	X	X	X	A	X	X	X	A	B	A	A	A	A	T V
Transformer Oil	100	X	I	I	I	I	I	I	I	I	I	A	A	I	I	T
Transmission Oil "A"	150	B	X	X	X	A	A	I	X	I	I	A	A	A	A	TVB
Tributoxy Ethysulphate	100	I	A	X	X	A	X	X	A	X	I	I	I	I	I	V
Tributyl Amine	100	A	A	X	B	I	B	A	I	A	A	A	I	I	I	T
Tributyl Phosphate	100	A	A	X	X	X	X	X	X	A	I	A	A	I	X	T
Trichlorobenzene	100	B	X	X	X	B	X	X	X	B	I	A	I	A	I	T

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		GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
	Temperature (°F)	UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasyn™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
T																
Trichloroethane	100	A	X	X	X	A	X	B	X	X	B	A	A	I	I	T V
Trichloroethylene	100	X	X	X	X	A	X	X	X	X	B	A	A	I	I	T V
Trichloropropane	100	A	X	X	X	A	X	I	X	A	I	A	A	X	I	T V
Tricresylphosphate	100	A	A	X	X	A	X	A	A	A	I	A	A	X	I	T V
Tridecanol	100	A	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
Triethanolamine	100	A	A	X	B	X	B	A	A	A	A	A	A	I	X	T B
Triethylamine	100	A	A	X	B	I	B	A	I	A	A	A	A	I	I	TVBN
Triethylene Glycol	150	A	A	A	A	I	A	A	I	A	A	A	A	A	I	T B
Trifluralin (Trefalin)	100	A	X	X	X	A	X	X	X	A	I	A	I	I	I	T V
Triphenyl Phosphate	100	A	A	X	X	I	X	I	I	A	I	A	A	I	I	T
Tripolyphosphate	100	X	I	I	I	I	I	I	I	I	I	A	I	I	I	T
Trisodium Phosphate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	I	TVBNS
Turpentine	100	A	X	X	X	A	A	B	X	A	X	A	A	A	A	T V B
U																
Urea	100	A	A	I	I	I	X	A	I	A	A	A	A	B	I	TVBN
Undecanol	100	B	A	A	A	B	A	A	A	A	A	A	I	I	I	T B
V																
V.M. & P. Naptha	100	A	X	X	X	A	A	I	X	A	I	A	I	I	I	TVBS
Vinyl Acetate	100	A	A	B	X	X	X	A	X	A	B	A	A	I	X	T V
Vinyl Benzene	100	A	X	X	X	A	X	X	X	A	I	A	A	I	I	T V
Vinyl Chloride	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Vinyl Ether	---	NO HOSE RECOMMENDED FOR THIS APPLICATION														
Vinyl Toluene	100	A	X	X	X	A	X	X	X	A	I	A	I	I	I	T V
Vinyl Trichloride	100	A	X	X	X	A	X	X	X	A	B	A	A	I	I	T V

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	Temperature (°F)	GOODYEAR ENGINEERED PRODUCTS CHEMICAL HOSE											FITTING			
		Fabchem™	Gray Flexwing®	Yellow Flexwing	Tan Flexwing	Orange Flexwing	Flexwing Petroleum	Brown Flexwing	Purple Flexwing	Green XLPE Blue Flexwing	ChemOne™ & Viper™	HI-PER®	Insta-Lock™	Insta-Lock	Insta-Lock	Insta-Lock
		UHMWPE	Butyl	Hypalon®	NR	Viton®	Nitrile	CPE	EPDM	XLPE	Alphasym™	Teflon®	316 SS	Aluminum	Brass	Gasket
		HOSE TUBE POLYMER											METAL			
W																
Water	180	A	A	A	A	A	A	A	A	A	A	A	A	I	I	TVBNS
Wax	100	A	X	X	X	X	A	A	X	X	X	A	A	I	I	TVBN
White Oil	100	A	X	X	X	I	A	A	X	I	I	A	I	I	I	TVB
Wood Alcohol	100	A	A	A	A	X	A	A	A	A	A	A	A	I	I	TBNS
X																
Xylene (Xylol)	100	X	X	X	X	A	X	X	X	A	B	A	A	I	I	T V
Xylidine	100	B	X	X	X	X	X	X	X	B	B	A	B	A	I	T
Z																
Zinc Carbonate	150	A	A	A	A	A	A	A	A	A	A	A	B	B	X	TVBN
Zinc Chloride	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS
Zinc Chromate	150	A	A	X	I	I	I	A	X	B	I	A	I	I	I	T
Zinc Phosphate	100	A	X	X	X	X	A	A	A	X	I	A	I	I	I	TBNS
Zinc Sulfate	150	A	A	A	A	A	A	A	A	A	A	A	A	X	X	TVBNS

SPIRAFLEX HOSE CHEMICAL RESISTANCE GUIDE

Thermoplastic Hose

A = May be used for Continuous Service
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X = Do not Use
I = Insufficient Data

A	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Acetaldehyde	70°	X	X	I	X
Acetic Acid, Conc.	70°	X	B	I	I
Acetic Acid, Dilute 10	70°	B	A	I	I
Acetic Acid, Glacial	70°	X	B	I	X
Acetic Aldehyde	70°	I	X	I	X
Acetic Anhydride	70°	X	X	X	X
Acetic Ester	70°	X	X	X	B
Acetic Ether	70°	X	X	X	I
Acetone	70°	X	X	X	B
Acetone Cyanohydrin	70°	X	X	X	I
Acetyl Acetone	70°	X	X	X	I
Acetyl Chloride	70°	X	I	X	X
Acetylene Dichloride	70°	I	X	I	X
Acetylene Tetrachloride	70°	I	X	I	I
Acrylonitrile	70°	A	A	B	I
Allyl Alcohol	70°	X	X	X	X
Allyl Bromide	70°	X	X	X	I
Allyl Chloride	70°	X	X	X	I
Alum	70°	A	A	A	B
Aluminum Acetate	70°	I	I	I	I
Aluminum Chloride	70°	A	A	A	B
Aluminum Hydroxide	70°	A	A	A	I
Aluminum Sulfate	70°	A	A	A	B
Ammonia Cupric Sulfate	70°	I	X	I	I
Ammonia Water	70°	A	A	A	A
Ammonium Chloride	70°	A	A	A	B
Ammonium Hydroxide	70°	B	B	I	B
Ammonium Nitrate	70°	A	A	A	I
Ammonium Phosphate	70°	I	I	I	B
Ammonium Sulfate	70°	A	A	A	B
Ammonium Sulfide	70°	A	A	A	I
Ammonium Sulfite	70°	A	A	A	I
Ammonium Thiosulfate	70°	A	A	I	I

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A	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Amyl Acetate	70°	X	X	X	X
Amyl Alcohol	70°	B	B	I	X
Amyl Chloride	70°	X	X	X	X
Amyl Phenol	70°	I	X	I	I
Amyl Phthalate	70°	I	X	I	I
Aniline Oils	70°	X	X	X	I
Animal Grease	70°	A	A	A	I
Animal Oils	70°	A	A	A	X
Aqua Ammonia	70°	I	B	B	I
Aromatic Tar	70°	X	X	X	I
Arsenic Acid	70°	A	A	A	I
Arsenic Chloride	70°	A	A	I	I
Arsenic Trichloride	70°	A	A	I	I
Asphalt	70°	X	X	X	X
ASTM #1 Oil	70°	A	A	A	X
ASTM #2 Oil	70°	A	A	I	X
ASTM #3 Oil	70°	A	A	B	X
B					
Barium Carbonate	70°	A	A	A	I
Barium Chloride	70°	A	A	A	I
Barium Hydroxide	70°	A	A	A	I
Barium Sulfate	70°	A	A	A	I
Barium Sulfide	70°	A	A	A	I
Benzyl Chloride	70°	I	X	I	I
Benzaldehyde	70°	X	X	X	X
Benzene (Benzol)	70°	X	X	X	X
Benzine (Ligroin)	70°	X	X	X	X
Benzine Solvent (Ligroin)	70°	X	X	X	X
Benzoic Acid	70°	B	A	A	B
Benzoic Aldehyde	70°	I	X	I	I
Benzotrichloride	70°	I	X	I	I
Benzoyl Chloride	70°	I	X	I	I
Benzyl Acetate	70°	I	X	I	I

GOODYEAR ENGINEERED PRODUCTS

SPIRAFLEX HOSE CHEMICAL RESISTANCE GUIDE

Thermoplastic Hose

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B	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Benzyl Chloride	70°	I	X	I	I
Bichromate of Soda	70°	I	A	I	I
Black Sulfate Liquor	70°	A	A	A	I
Bleach	70°	A	A	A	B
Brine	70°	A	A	A	B
Bromine	70°	X	X	X	X
Bromo Benzene	70°	I	X	I	X
Bromo Toluene	70°	I	X	I	I
Bromochloromethane	70°	I	X	I	X
Butanol	70°	I	X	I	B
Butyl (Normal) Alcohol	70°	I	X	X	B
Butyl (Secondary) Alcohol	70°	I	X	X	B
Butyl Acetate	70°	X	X	I	X
Butyl Acetoacetate	70°	I	X	I	I
Butyl Acrylate	70°	I	X	I	I
Butyl Alcohol	70°	A	A	A	B
Butyl Benzene	70°	I	X	I	I
Butyl Benzl Phthalate	70°	I	X	I	I
Butyl Bromide	70°	I	X	I	I
Butyl Butyrate	70°	I	X	I	I
Butyl Chloride	70°	I	X	I	I
Butyl Phthalate	70°	I	X	I	X
Butyric Acid	70°	I	X	B	I
C					
Cadmium Acetate	70°	I	A	I	I
Calcium Acetate	70°	I	A	I	I
Calcium Aluminate	70°	I	A	I	I
Calcium Bichromate	70°	I	A	I	I
Calcium Bisulfate	70°	I	A	B	I
Calcium Bisulfite	70°	A	A	A	I
Calcium Carbonate	70°	A	A	A	I
Calcium Chloride	70°	A	A	A	I
Calcium Hydroxide (Caustic Lime)	70°	A	A	A	I

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C	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Calcium Hypochlorite	70°	A	A	I	I
Calcium Nitrate	70°	A	A	I	I
Calcium Silicate	70°	A	A	I	I
Calcium Sulfate	70°	A	A	A	I
Calcium Sulfide	70°	A	A	I	I
Calcium Sulfite	70°	A	A	I	I
Carbolic Acid, Phenol	70°	X	X	X	X
Carbon Dioxide	70°	A	A	A	B
Carbon Disulfide	70°	X	X	X	X
Carbon Monoxide	70°	A	A	A	B
Carbon Tetrachloride	70°	X	X	X	X
Carbonic Acid	70°	I	A	A	I
Casinghead Gasoline	70°	I	X	X	X
Caster Oil (Castor Oil)	70°	A	A	A	I
Caustic Potash	70°	A	A	A	A
Caustic Soda	70°	A	A	A	B
Chlorinated Solvents	70°	I	X	I	I
Chlorine (Dry)	70°	A	A	A	B
Chlorine (Wet)	70°	B	X	I	B
Chloroacetone	70°	I	X	I	I
Chlorobenzene	70°	X	X	X	X
Chlorobutane	70°	I	X	I	I
Chloroethylbenzene	70°	I	X	I	I
Chloroform	70°	X	X	X	X
Chloropentane	70°	I	X	I	X
Chlorophenol	70°	I	X	I	I
Chloropropanone	70°	I	X	I	I
Chlorosulfonic Acid	70°	I	B	I	X
Chlorothene	70°	I	X	I	X
Chlorotoluene	70°	X	X	X	X
Chromic Acid	70°	B	B	B	B
Copper Chloride	70°	A	A	A	B
Copper Hydrate	70°	I	A	I	I

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Copper Hydroxide	70˚	I	A	I	I
Copper Nitrate	70˚	A	A	A	I
Copper Nitrite	70˚	A	A	A	I
Copper Sulfate	70˚	A	A	A	I
Copper Sulfide	70˚	B	A	B	I
Creosol	70˚	X	X	X	X
Creosote	70˚	X	X	X	X
Crude Oil	70˚	B	A	B	X
Cupric Carbonate	70˚	I	A	I	I
Cupric Chloride	70˚	A	A	I	I
Cupric Nitrate	70˚	A	A	I	I
Cupric Nitrite	70˚	A	A	I	I
Cupric Sulfate	70˚	A	A	A	I
Cyclohexane	70˚	X	X	X	X
Cyclohexanol	70˚	X	X	X	X
Cyclohexanone	70˚	X	X	X	X
Cyclopentane, methyl	70˚	I	A	I	I
Cyclopentanol	70˚	I	A	I	I
Cyclopentanone	70˚	I	A	I	I
D					
D.D.T.	70˚	I	A	I	I
D.D.T. in Kerosene	70˚	X	X	X	X
Decalin	70˚	I	B	I	I
Decanol	70˚	I	B	I	I
Decyl Alcohol	70˚	I	A	I	I
Decyl Butyl Phthalate	70˚	X	X	X	X
Denatured Alcohol	70˚	I	A	B	I
Diacetone Alcohol	70˚	B	A	B	B
Diamyl Phenol	70˚	X	X	X	X
Dibromobenzene	70˚	I	X	I	I
Dibutyl Amine	70˚	I	X	I	I
Dibutyl Phthalate	70˚	X	X	X	X
Dibutyl Sebacate	70˚	I	X	I	I

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D	Temperature (˚F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Dicalcium Phosphate	70˚	B	A	B	I
Dichlorobenzene	70˚	X	X	X	X
Dichlorobutane	70˚	I	X	I	I
Dichlorodiboromethane	70˚	X	X	X	X
Dichloroethane	70˚	I	X	I	I
Dichloroethyl Ether	70˚	I	X	I	X
Dichloroethylene	70˚	I	X	I	X
Dichlorohexane	70˚	I	X	I	X
Dichloromethane	70˚	I	X	I	X
Dichloropentane	70˚	I	X	I	X
Dichloropropane	70˚	I	X	I	X
Diesel Oil	70˚	I	B	X	X
Diethylamine	70˚	I	I	I	I
Diethyl Benzene	70˚	I	X	I	X
Diethyl Ketone	70˚	I	X	I	I
Diethyl Oxalate	70˚	I	X	I	I
Diethyl Phthalate	70˚	I	X	I	I
Diethyl Sebacate	70˚	I	X	I	I
Diethylene Glycol	70˚	I	B	I	I
Diisobutyl Ketone	70˚	I	X	I	I
Diisoctyl Adipate	70˚	I	X	I	I
Diisoctyl Phthalate	70˚	I	X	I	I
Diisodecyl Adipate	70˚	I	X	I	I
Diisopropyl Amine	70˚	I	X	I	I
Diisopropyl Ketone	70˚	I	X	I	I
Dimethyl Amine	70˚	I	X	I	I
Dimethyl Benzene	70˚	I	X	I	I
Dimethyl Ketone	70˚	I	X	I	I
Dimethyl Phthalate	70˚	I	X	I	I
Dinitrobenzene	70˚	I	X	I	I
Dioctyl Adipate	70˚	I	X	I	I
Dioctyl Phthalate	70˚	X	X	X	X
Dioctyl Sebacate	70˚	I	X	I	I

GOODYEAR ENGINEERED PRODUCTS

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D	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Diphenyl Phthalate	70°	I	X	I	I
Dipropyl Ketone	70°	I	X	I	I
Disodium Phosphate	70°	A	A	A	B
Divinyl Benzene	70°	I	X	I	I
Dodecyl Benzene	70°	I	X	I	I
E					
Ethanol	70°	A	A	A	A
Ethanol Amine	70°	B	A	B	I
Ethyl Acetate	70°	X	X	X	B
Ethyl Acetoacetate	70°	I	X	I	I
Ethyl Acrylate	70°	X	X	X	I
Ethyl Alcohol	70°	A	A	A	A
Ethyl Benzene	70°	I	X	I	X
Ethyl Butanol	70°	I	A	I	I
Ethyl Butyl Acetate	70°	I	X	I	I
Ethyl Butyl Alcohol	70°	I	A	I	I
Ethyl Butyl Ketone	70°	I	X	I	I
Ethyl Chloride	---	X	X	X	X
Ethyl Dichloride	70°	X	X	X	X
Ethyl Ether	---	X	X	X	X
Ethyl Formate	70°	I	X	I	I
Ethyl Hexyl Acetate	70°	I	X	I	I
Ethyl Hexyl Alcohol	70°	I	A	I	I
Ethyl Iodide	70°	X	X	X	X
Ethyl Isobutyl Ether	70°	I	X	I	I
Ethyl Methyl Ketone	70°	X	X	X	X
Ethyl Oxalate	70°	I	X	I	I
Ethyl Phthalate	70°	I	X	I	I
Ethyl Propyl Ether	70°	I	X	I	I
Ethyl Propyl Ketone	70°	X	X	X	I
Ethylene Bromide	70°	X	X	X	X
Ethylene Chloride	70°	X	X	X	X
Ethylene Dibromide	70°	X	X	X	X

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E	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Ethylene Dichloride	70°	X	X	X	X
Ethylene Glycol	70°	A	A	A	A
F					
Ferric Bromide	70°	A	A	A	B
Ferric Chloride	70°	A	A	A	A
Ferric Sulfate	70°	A	A	A	A
Ferrous Acetate	70°	A	A	A	I
Ferrous Chloride	70°	A	A	A	B
Ferrous Hydroxide	70°	I	A	A	I
Ferrous Sulfate	70°	A	A	A	A
Fluorine	70°	X	X	X	X
Fluosilicic Acid	70°	A	A	A	B
Formaldehyde	70°	X	X	B	A
Formalin	70°	I	I	A	A
Formic Acid (less than 50%)	70°	B	B	A	A
Formic Acid (more than 50%)	70°	B	X	X	B
Freon® 12	70°	B	B	B	X
Freon® 22	70°	X	X	X	X
Fuel A (ASTM)	70°	A	B	B	I
Fuel B (ASTM)	70°	A	B	X	X
Fuel Oil	70°	A	B	B	X
Furfural	70°	X	X	X	X
G					
Gasoline	70°	X	X	X	X
Glacial Acetic Acid	70°	X	B	I	I
Glycerin	70°	A	A	A	B
Grease	70°	A	A	A	B
H					
Heptane	70°	A	A	X	X
Hexane	70°	A	A	B	X
Hexanol	70°	B	A	B	B
Hexyl Methyl Ketone	70°	I	X	I	I
Hexylene Glycol	70°	I	B	I	I

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	Temperature (˚F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
H					
Hexyly-Alcohol	70˚	I	A	I	I
Hydrobromic Acid	70˚	A	A	B	B
Hydrochloric Acid	70˚	A	B	A	A
Hydrofluoric Acid	70˚	A	B	A	B
Hydrofluosilicic Acid	70˚	B	B	I	I
Hydrogen Dioxide 10%	70˚	I	A	A	I
Hydrogen Dioxide (over 10%)	70˚	I	A	A	I
Hydrogen Gas	70˚	X	X	X	B
Hydrogen Peroxide 10%	70˚	A	A	A	B
Hydrogen Peroxide (over 10%)	70˚	A	A	A	B
I					
Iodine	70˚	X	X	X	X
Iron Acetate	70˚	I	A	I	I
Iron Hydroxide	70˚	I	A	A	I
Iron Salts	70˚	I	A	A	B
Iron Sulfate	70˚	I	A	A	A
Iron Sulfide	70˚	I	A	I	I
Isoamyl Acetate	70˚	I	X	I	I
Isoamyl Alcohol	70˚	I	A	I	I
Isoamyl Bromide	70˚	X	X	X	I
Isoamyl Butyrate	70˚	I	X	I	I
Isoamyl Chloride	70˚	I	X	I	I
Isoamyl Ether	70˚	I	X	I	I
Isoamyl Phthalate	70˚	I	X	I	I
Isobutanol	70˚	I	A	I	A
Isobutyl Acetate	70˚	I	X	I	I
Isobutyl Alcohol	70˚	I	A	I	A
Isooctane	70˚	I	B	X	I
Isopentane	---	I	B	I	I
Isopropanol	70˚	I	A	I	A
Isopropyl Acetate	70˚	X	X	X	I
Isopropyl Alcohol	70˚	A	A	B	B
Isopropyl Benzene	70˚	I	X	I	X

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	Temperature (˚F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
I					
Isopropyl Chloride	---	I	X	I	I
J					
Jet Fuels	---	X	X	X	X
K					
Kerosene	70˚	X	B	X	X
Ketones	70˚	X	X	X	X
L					
Lead Acetate	70˚	A	A	A	B
Lead Sulfate	70˚	I	X	I	I
Linseed Oil	70˚	A	A	A	X
Lubricating Oils	70˚	A	B	B	I
M					
MIBK	70˚	I	X	I	X
M.E.K.	70˚	X	X	B	X
Magnesium Acetate	70˚	I	A	I	I
Magnesium Chloride	70˚	A	A	A	A
Magnesium Hydrate	70˚	I	A	A	B
Magnesium Hydroxide	70˚	A	A	A	A
Magnesium Sulfate	70˚	A	A	A	A
Malic Acid	70˚	B	A	B	B
Manganese Sulfate	70˚	I	A	I	I
Manganese Sulfide	70˚	I	A	I	I
Manganese Sulfite	70˚	I	A	I	I
Methanol	70˚	A	A	A	A
Methallyl Alcohol	70˚	I	A	I	I
Methyl (Wood) Alcohol	70˚	B	B	A	A
Methyl Acetate	70˚	X	X	X	X
Methyl Acetoacetate	70˚	I	X	I	I
Methyl Acetone	70˚	I	X	I	X
Methyl Amyl Acetate	70˚	X	X	X	X
Methyl Amyl Alcohol	70˚	I	A	I	I
Methyl Amyl Ketone	70˚	I	X	A	I
Methyl Benzene	70˚	I	X	I	X

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M	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Methyl Butanol	70°	I	B	I	X
Methyl Butyl Ketone	70°	I	X	I	I
Methyl Cellosolve	70°	I	B	I	I
Methyl Chloride	---	X	X	X	X
Methyl Ethyl Ketone	70°	X	X	X	X
Methyl Hexyl Ketone	70°	X	X	X	X
Methyl Isobutyl Ketone	70°	X	X	X	X
Methyl Isopropyl Ketone	70°	X	X	X	X
Methyl Normal Amyl Ketone	70°	X	X	X	X
Methylallyl Chloride	70°	X	X	X	X
Methyl Propyl Ether	70°	I	I	A	I
Methyl Propyl Ketone	70°	I	X	I	I
Methylallyl Acetate	70°	I	X	I	I
Methylene Bromide	70°	X	X	X	I
Methylene Chloride	---	X	X	X	X
Mineral Spirits	70°	I	B	I	I
Monochlorobenzene	70°	X	X	X	X
Monochlorodibluoromethane	70°	I	X	I	I
Muriatic Acid	70°	I	B	A	B
N					
Naphtha	70°	B	B	B	X
Naphthalene	70°	B	X	B	X
Natural Gas	No hose is recommended for this service				
Nickel Chloride	70°	A	A	A	B
Nickel Nitrate	70°	A	A	A	B
Nickel Sulfate	70°	A	A	A	A
Nitric Acid 10%	70°	A	A	A	B
Nitric Acid 20%	70°	A	B	A	B
Nitric Acid 30%	70°	B	B	A	B
Nitric Acid 30-70%	70°	X	X	X	X
Nitro Benzene	70°	X	X	X	X
Nitrogen Gas	70°	A	A	A	A
Nitrous Oxide	70°	A	A	A	B

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O	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Octanol	70°	I	A	I	B
Octyl Acetate	70°	I	X	I	I
Oil Petroleum	70°	A	B	A	I
Oleic Acid	70°	B	B	B	B
Oleum	70°	X	X	X	X
Orthodichlorobenzene	70°	I	X	I	I
Orthodichlorobenzol	70°	I	X	I	I
Oxalic Acid	70°	A	A	A	A
Oxygen	No hose is recommended for this service				
Ozone	70°	B	B	B	B
P					
Palmitic Acid	70°	B	B	B	B
Papermakers Alum	70°	I	A	I	I
Paradichlorobenzol	70°	I	X	I	I
Paraffin	70°	B	A	B	I
Pentachloroethane	70°	I	I	X	I
Pentane	70°	B	B	I	X
Pentanol	70°	I	A	I	I
Perchloroethylene	70°	X	X	X	X
Petroleum Ether (Ligroin)	70°	A	B	I	X
Petroleum - Crude	70°	A	B	X	X
Petroleum Oils	70°	A	B	X	X
Phenol	70°	X	X	X	X
Phenolsulfonic Acid	70°	I	X	I	I
Phenyl Chloride	70°	I	I	X	X
Phosphoric Acid 10%	70°	A	A	A	A
Phosphoric Acid 10%-85%	70°	B	B	A	B
Polyethylene Glycol	70°	B	B	A	B
Polypropylene Glycol	70°	B	B	A	B
Potassium Acetate	70°	I	A	A	B
Potassium Bisulfate	70°	A	A	A	B
Potassium Bisulfite	70°	A	A	A	B
Potassium Carbonate	70°	A	A	A	A

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P	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Potassium Chloride	70°	A	A	A	A
Potassium Chromate	70°	A	A	A	B
Potassium Dichromate	70°	A	A	A	B
Potassium Hydrate	70°	I	A	I	B
Potassium Hydroxide	70°	B	A	A	B
Potassium Nitrate	70°	A	A	A	B
Potassium Silicate	70°	I	A	I	B
Potassium Sulfate	70°	A	A	A	B
Potassium Sulfide	70°	A	A	A	B
Potassium Sulfite	70°	A	A	A	B
Propanediol	70°	I	A	I	B
Propanol	70°	I	A	I	B
Propyl Acetate	70°	I	X	I	I
Propyl Alcohol	70°	A	A	B	B
Propyl Chloride	---	X	X	X	X
Propylene Dichloride	70°	X	X	X	X
Propylene Glycol	70°	A	I	A	A
S					
Sea Water	70°	A	A	A	A
Silicate of Soda	70°	I	B	A	A
Soda Ash	70°	A	A	A	A
Soda, Caustic	70°	A	B	A	A
Soda, Lime	70°	I	B	A	I
Soda, Niter	70°	I	B	I	A
Sodium Acetate	70°	A	B	A	B
Sodium Aluminate	70°	I	A	A	B
Sodium Bisulfate	70°	A	A	A	A
Sodium Bisulfite	70°	I	A	A	A
Sodium Carbonate	70°	A	A	A	A
Sodium Chloride (brine)	70°	A	A	A	A
Sodium Chromate	70°	I	A	I	I
Sodium Dichromate	70°	A	A	A	B
Sodium Hydrate	70°	I	A	I	I

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S	Temperature (°F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Sodium Hydrochlorite	70°	A	A	B	B
Sodium Hydroxide	70°	A	A	A	A
Sodium Hypochlorite	70°	A	A	A	A
Sodium Nitrate	70°	A	A	A	A
Sodium Silicate	70°	A	A	A	A
Sodium Sulfate	70°	A	A	A	A
Sodium Sulfide	70°	A	A	A	A
Sodium Sulfite	70°	A	A	A	A
Sodium Thiosulfate	70°	A	A	A	A
Stannic Chloride	70°	A	A	A	B
Stannic Sulfide	70°	I	A	I	I
Stannous Chloride	70°	I	A	I	I
Stannous Sulfide	70°	I	A	I	I
Stearic Acid	70°	A	A	A	A
Sulfonic Acid	70°	I	B	I	I
Sulfur Dioxide (Liquid)	70°	X	X	X	X
Sulfuric Acid (Dry)	70°	A	A	A	A
Sulfuric Acid 25%	70°	A	A	A	A
Sulfuric Acid 25-50%	70°	A	A	A	A
Sulfuric Acid 50-96%	70°	X	X	B	B
Sulfuric Acid Fuming	70°	X	X	X	X
Sulfurous Acid 10%	70°	B	B	B	A
Sulfurous Acid 10-75%	70°	X	X	X	X
T					
Tannic Acid	70°	B	B	B	A
Tar	---	I	X	I	I
Tartaric Acid	70°	A	A	A	A
Tertiary Butyl Alcohol	70°	B	B	B	I
Tetrachlorobenzene	70°	I	X	I	I
Tetrachloroethane	70°	I	X	X	X
Tetrachloroethylene	70°	I	X	X	X
Tetraethylene Glycol	70°	I	B	I	I
Tetrachloromethane	70°	I	X	I	X

GOODYEAR ENGINEERED PRODUCTS

SPIRAFLEX HOSE CHEMICAL RESISTANCE GUIDE

Thermoplastic Hose

A = May be used for Continuous Service
B = May be used for Intermittent Service
X = Do not Use
I = Insufficient Data

T	Temperature (˚F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Tetrachloronaphthalene	70˚	I	X	I	X
Tetrahydrofuran	70˚	X	X	X	X
Tin Chloride	70˚	B	B	B	B
Tin Tetrachloride	70˚	B	B	B	B
THF	70˚	I	X	I	X
Toluene	70˚	X	X	X	X
Toluidine	70˚	I	X	I	I
Toluol	70˚	X	X	X	X
Transmission Oil “A”	70˚	A	B	I	I
Tributyl Phosphate	70˚	X	X	X	X
Trichlorobenzene	70˚	X	X	X	X
Trichloroethane	70˚	I	X	X	X
Trichloroethylene	70˚	X	X	X	X
Trichloropropane	70˚	I	I	X	X
Triethanolamine	70˚	B	B	B	I
Triethylene Glycol	70˚	I	B	I	B
Triphenyl Phosphate	70˚	B	X	I	I
Trisodium Phosphate	70˚	B	B	A	A
Turpentine	70˚	B	B	A	X

Thermoplastic Hose

A = May be used for Continuous Service
B = May be used for Intermittent Service
X = Do not Use
I = Insufficient Data

U	Temperature (˚F)	Polyurethane/Spirathane	PVC/Pliovic Plus	TPE/Arvac SW	TPR/Green Hornet XF
Urea	70˚	A	A	A	A
Undecanol	70˚	I	A	I	I
V					
V.M. & P. Naptha	70˚	I	B	I	I
Vinyl Acetate	70˚	I	X	I	X
Vinyl Benzene	70˚	I	X	I	X
Vinyl Chloride	---	X	X	X	X
W					
Water	70˚	A	A	A	A
Wood Alcohol	70˚	B	B	B	A
X					
Xylene (Xylol)	70˚	X	X	X	X
Xylidine	70˚	I	X	I	I
Z					
Zinc Carbonate	70˚	I	A	A	B
Zinc Chloride	70˚	A	A	A	B
Zinc Chromate	70˚	A	A	A	I
Zinc Sulfate	70˚	A	A	A	B

GENERAL INFORMATION

CHEMICAL PROPERTIES OF FLUROETHYLENEPROPYLENE (FEP)

AS STATED BY E.I. DU PONT DE NEMOURS

FEP fluorocarbon resins are attacked by certain halogenated complexes containing fluorine including: chlorine trifluoride, bromine trifluoride, iodine pentafluoride and fluorine itself.

FEP is also attacked by such metals as sodium or potassium, especially in their molten states. Great care should be used when mixing finely divided fluorocarbon polymers with finely divided metals, such as aluminum, magnesium or barium, since these can react violently if ignited or heated to a high temperature. Certain complexes of these metals with ammonia or naphthalene (in either solvent) also attack the products. Certain metal hydrides such as boranes, aluminum chloride and certain amines have also been observed to attack fluorocarbon resins at elevated temperatures.

The following materials are inert to FEP:

- Alcohols
- Aliphatic Hydrocarbons
- Aromatics
- Esters
- Fluorocarbons
- Inorganic Oxidizing Agents
- Organic Acids
- Strong Mineral Acids
- Aldehydes
- Anhydrides
- Chlorocarbons
- Ethers
- Inorganic Bases
- Ketones
- Salt Solutions

FEP is a registered trademark of E.I. du Pont de Nemours.

METHOD FOR STEAM CLEANING GOODYEAR ENGINEERED PRODUCTS (CHEM ONE, VIPER, FABCHEM AND FABCHEM ARC)

5 IMPORTANT REQUIREMENTS

1) Hose must be **open-ended** during steam cleaning.
2) Temperature of Steam–**Maximum 288˚F**.
3) Length of Cleaning Time–**5 to 10 minutes**...Not more than 15 minutes.
4) Care must be taken **not to score** the tube (liner) with the nozzle or wand end.
5) Prolonged steam jet contact on a specific area of the tube (liner) **could cause tube damage**.

U.S.A.
1-800-BELT-USA or 1-800-235-8872
FAX 1-800-329-2358

CANADA
1-800-263-7788
FAX 1-800-939-9919

GOODYEAREP.COM/HOSE

09GHOS051 - 5/09

Ball Valve and Hose Adapter

(Grainger)

EnSol, Inc.

GRAINGER
FOR THE ONES WHO GET IT DONE

printed May 20, 2013

Adapter, Male, 3 In, 316 SS

Cam And Groove Coupling, Size 3 In, Male Adapter x FNPT Connection, Max Working Pressure 125 PSI, Material of Construction 316 Stainless Steel

Grainger Item #	3LX43
Price (ea.)	**$126.15**
Brand	GRAINGER APPROVED VENDOR
Mfr. Model #	3LX43
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	1.8
Availability	Typically in Stock
Catalog Page No.	4066

Price shown may not reflect your price. Log in or register.

Additional Info

Aluminum and Stainless Steel

- Max. pressure: 250 psi (up to 2"); 125 psi (3"); 100 psi (4") Temp. range: -40° to 212°F Interchangeable with all product produced to MIL-C-27487F Buna N gasket

Cam and Groove Couplings

Couplings have Buna N seals and stainless steel pins. Pull rings and locking pins are plated carbon steel.

Meet ASTMC 38000 and MIL-C-27487F specifications.

Tech Specs

Item: Adapter
Type: A
Size: 3"
Connection: Male Adapter x FNPT
Max. Working Pressure (PSI): 125
Material of Construction: 316 Stainless Steel

Notes & Restrictions

There are currently no notes or restrictions for this item.

MSDS

This item does not require a **Material Safety Data Sheet (MSDS).**

Required Accessories

There are currently no required accessories for this item.

Optional Accessories

Dust Cap, 3 In, 316 SS

Item #: 3LX51
Brand: GRAINGER APPROVED VENDOR
Usually Ships: Typically in Stock
Price (ea): $143.25

Coupler, Female, 3 In, 316 SS

Item #: 3LX49
Brand: GRAINGER APPROVED VENDOR
Usually Ships: Typically in Stock
Price (ea): $245.00

Cap with Handle, 3 In, Polypropylene

Item #: 4YLL5
Brand: GRAINGER APPROVED VENDOR
Usually Ships: Typically in Stock
Price (ea): $66.95

Alternate Products

There are currently no alternate products for this item.

Repair Parts

A Repair Part may be available for this item. Visit our Repair Parts Center or contact your local branch for more information.

GRAINGER
FOR THE ONES WHO GET IT DONE

printed February 8, 2013

Ball Valve, Two Piece, 2 In, 316 SS Body

Two Piece Ball Valve, FNPT Connection, Max. Pressure 1000 psi WOG, Full Port, Material of Construction 316 Stainless Steel, Seats PTFE, Ball Material 316 Stainless Steel, Stem Material 316 Stainless Steel, Stem Blowout Proof, Handle Stainless Steel, Lockable, With Vinyl Grip, Standards -

Grainger Item #	1WMY7
Price (ea.)	**$202.00**
Brand	GRAINGER APPROVED VENDOR
Mfr. Model #	1WMY7
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	5.5
Availability	Ready to Ship
Catalog Page No.	4364

Price shown may not reflect your price. Log in or register.

Additional Info

316 Stainless Steel Ball Valves with Handle Options

Stainless steel handle with vinyl grip. Bottom-loaded stem resists blowout. 2-pc. valves with PTFE seats and FNPT connections. Vacuum service to 29" Hg. For use with water, oil, and gas in most corrosive industrial environments.

- Rated: 1000 psi; 150 psi WSP Temp. range: -25° to 450°F

Tech Specs

Item: Ball Valve
Type: Two Piece
Connection: FNPT
Max. Pressure: 1000 psi WOG
Pipe Size: 2"
Port: Full
Material of Construction: 316 Stainless Steel
Seats: PTFE
Ball Material: 316 Stainless Steel
Stem Material: 316 Stainless Steel
Stem: Blowout Proof
Handle: Stainless Steel, Lockable, With Vinyl Grip
Temp. Range (F): -25 to 450 Degrees
Overall Length (In.): 4-29/32

Notes & Restrictions

There are currently no notes or restrictions for this item.

MSDS

This item does not require a **Material Safety Data Sheet (MSDS).**

Required Accessories

There are currently no required accessories for this item.

Optional Accessories

There are currently no optional accessories for this item.

Alternate Products

Ball Valve, Two Piece, 2 In, 316 SS Body

Item #: 1WNA7
Brand: GRAINGER APPROVED VENDOR
Usually Ships: Ready to Ship
Price (ea): $207.75

Repair Parts

A Repair Part may be available for this item. Visit our Repair Parts Center or contact your local branch for more information.

HDPE Pipe Data

(Chevron Phillips)

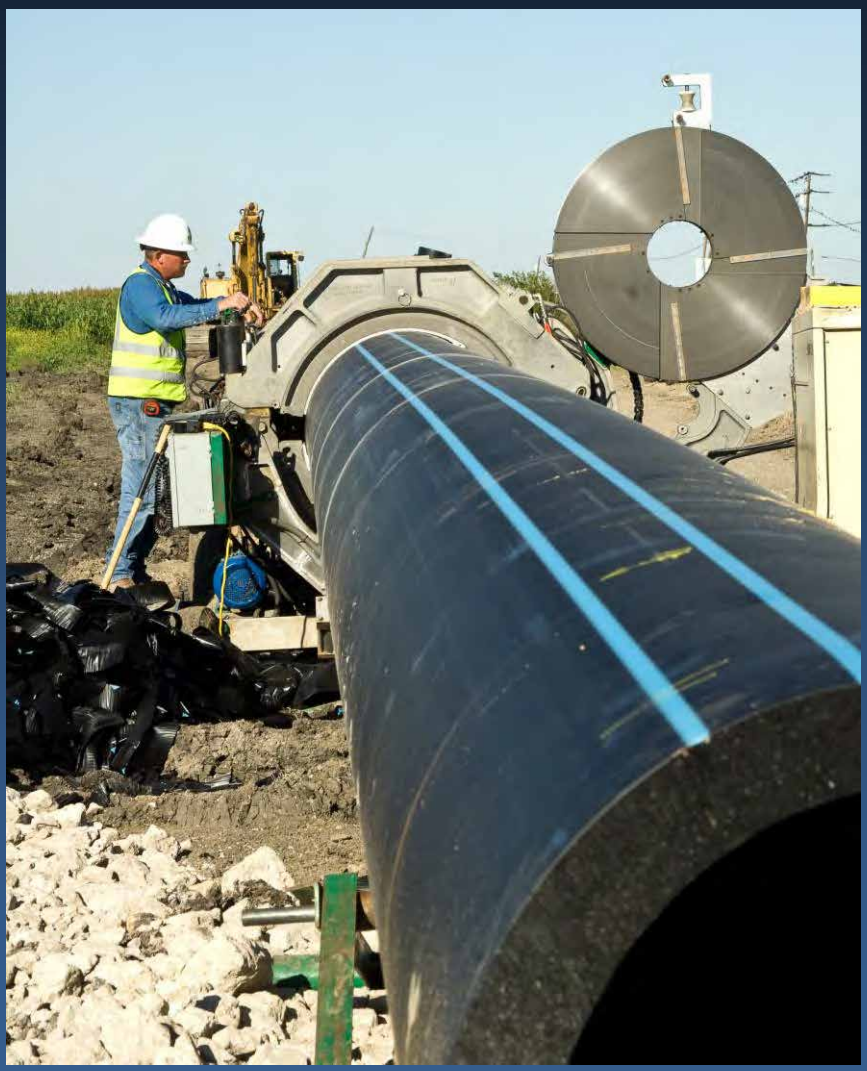
EnSol, Inc.

PERFORMANCE PIPE
A Division of Chevron Phillips Chemical Company LP

PERFORMANCE PIPE DRISCOPLEX® 4000/4100 Pipe

Water and Wastewater Piping Systems

- Corrosion Resistant
- Leak Proof Fused Joints
- Ideal for Trenchless Applications
- Flexible
- Hydraulically Efficient ID
- Will Not Tuberculate
- Reduces Surge Pressure
- Outstanding Resistance to Fatigue
- Excellent Impact Strength
- Thrust Blocks Not Needed
- Resistant to Sewer Gas
- Less Maintenance
- Mechanical Fittings Available for Transitions and Repairs
- Environmentally Friendly



When Performance Matters
Rely on Us!

ASCE Report Card

The American Society for Civil Engineers (ASCE) issues a "report card" on the condition of America's infrastructure about once every five years. In the 2009 report they gave water and wastewater infrastructure a grade of D minus. EPA has identified the two biggest problems facing America's infrastructure as corrosion and leakage. DriscoPlex® 4000 and 4100 High Density Polyethylene (HDPE) pipes offer a solution. HDPE pipes do not undergo galvanic corrosion and are suited for "aggressive soils." They do not rust, rot, corrode, tuberculate, or support biological growth. DriscoPlex® 4000 and 4100 pipes are joined by heat fusion which means the pipes are essentially a continuous pipe without gasket joints to leak. The heat-fused joint is as strong as the pipe itself and fully restrained requiring no thrust blocks.

The Future for Water and Wastewater Piping

Polyethylene pipe's wide acceptance and use for natural gas distribution is the strongest statement that can be made about polyethylene pipe's corrosion resistance and leak-tight nature. Polyethylene pipe has been used for gas distribution pipe since the early 1960's. More than 95% of new gas distribution piping is polyethylene. By 2008, over 577,000 miles of polyethylene natural gas pipe and 39.6 million polyethylene pipe services were installed in the United States. Natural gas service is the most safety critical usage of piping in a municipality. Leakage cannot be tolerated. In addition to the excellent record in gas distribution, polyethylene pipe has been used for water in Europe and North America for 50 years. Recognizing these successes, more and more water and wastewater utilities are turning to polyethylene pipe for both trenchless construction and open-cut applications. For municipal usage, DriscoPlex® pipe is manufactured to ASTM F714, AWWA C901 and AWWA C906 standards. It meets the requirements of NSF/ANSI-61 (NSF/ANSI-14 where noted) and comes in either Iron Pipe Sizes or Ductile Iron Pipe Sizes, i.e. the outside diameter (OD) matches the OD of iron pipe or ductile iron pipe, respectively. In addition to pipe, standard products such as heat-fusion and electrofusion saddles, flanges, mechanical-joint adapters are available for hot tapping and connecting to pumps, hydrants or valves. Mechanical connections and hot taps requiring no fusion are available as well.

Performance Pipe Means the Highest Quality

Performance Pipe is a name you can trust in water and sewer piping. Performance Pipe has produced quality polyethylene piping products for fifty years. Our internal QA/QC requirements meet or exceed those required by industry standards. Each production line is continuously monitored throughout the manufacturing cycle to ensure that the product adheres to all internal quality control specifications and the manufacturing standard.

All nine of Performance Pipe's manufacturing facilities and our headquarters are certified in accordance with the latest edition of ISO 9001:2000. Certificates of Conformance are available through our website. Performance Pipe produces all pipe and molded fittings products in the United States. These products are compliant with the Buy American requirement of the 2009 American Recovery and Reinvestment Act.

When you select Performance Pipe DriscoPlex® 4000 and 4100 pipe and fittings, in addition to receiving quality products, you also gain access to our team of experts for technical support, sales and assistance. Our territory sales teams are dedicated to the municipal piping industry and are active

Performance Pipe, a division of Chevron Phillips Chemical Company LP | 5085 W. Park Blvd | Suite 500 | Plano, TX 75093 | Phone: 800-527-0662 | Fax: 972-599-7348

members of the ASTM International, Plastics Pipe Institute, American Water Works Association (AWWA) and many other industry associations. As a company we provide technical expertise and service to these organizations on an ongoing basis.

The unmatched quality and performance of Performance Pipe's polyethylene piping products is further enhanced and strengthened by more than five decades of quality polyolefin plastic resin production from our parent company Chevron Phillips Chemical Company LP.

Polyethylene Resin Continues to Improve

DriscoPlex® pipe and fittings for M&I applications are made from polyethylene materials that are engineered for high density, extra high molecular weight, and broad molecular weight distribution. These characteristics give DriscoPlex® products strength, flexibility, toughness and durability. Since the introduction of polyethylene piping materials in the 1950's, polyethylene resin manufacturers have worked continually to improve their resins. In 2005 "High Performance" polyethylene pipe materials were adopted in U.S. ASTM standards. The most improved of the new materials has a designation code of PE4710. Compared to PE3408 (now PE3608) materials, PE4710 resins have increased density, higher tensile strength and higher resistance to slow crack growth. These increased properties allow the pipe to meet higher performance requirements.

Performance Pipe manufactures pipe and fittings of high performance PE4710. Performance Pipe's PE4710 materials are listed in PPI TR-4 with a Hydrostatic Design Stress of 1000 psi at 73°F. Where specifications and standards permit, PE4710 materials can be operated at higher pressures than PE3408 materials due to the higher Hydrostatic Design Stress rating at 73°F. PE4710 materials meet or exceed all of the requirements of the former PE3408 resin.

For a more detailed explanation of PE4710 materials and information regarding temperature, design factors and calculation of pressure rating, see PP 816-TN *PE3608 and PE4710 Materials Designation Codes and Pipe Pressure Ratings.* All Performance Pipe documents may be found at www.performancepipe.com.

Cell Classification for PE4710 Material

ASTM D3350, *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials,* identifies polyethylene materials for pipe and fittings according to a cell classification system. Performance Pipe's DriscoPlex® 4000 and 4100 series pipe cell classification is listed in Table 1. For specific material properties see PP101, *"DriscoPlex® 4000 (DIPS)/4100 (IPS) Water, Wastewater and Industrial".*

Table 1: Cell Classifications

Performance Pipe Product Series	Material Designation Code (MDC)		ASTM D3350 Cell Classification
	Present	Past	
DRISCOPLEX® 4000/4100 Pipe	PE4710	PE3408	445574C

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PE Durability and Disinfectants in Potable Water Applications

HDPE pipes are used extensively in municipal water applications throughout Europe and the United Kingdom – boasting the lowest failure rates of any piping material. HDPE pipes contain additives which protect the pipe from the oxidizing effects of disinfectants. At Performance Pipe, our HDPE water pipes meet AWWA requirements and are evaluated to the toxicological requirements of NSF/ANSI 61. A recent study by Jana Laboratories examined the projected lifespan of polyethylene pipe under typical operating conditions at utilities in Indiana, Florida, North Carolina, and California. Their findings indicate a life expectancy greater than 100 years. Read Jana Laboratories' report, *Impact of Potable Water Disinfectants on PE Pipe*.

DriscoPlex® Piping Products for Municipal Applications

Performance Pipe offers pipe for municipal applications that are manufactured to both ASTM and AWWA standards simultaneously. Performance Pipe standard products are generally stocked by distributors and, for many sizes and DR's, are readily available. Specialty products are available but generally not stocked and thus have to be produced at Performance Pipe manufacturing plants. Table 2 lists the various products, applicable standards, and the pipe material designation code. DriscoPlex® pipes series are identified by a four digit number code. For example, DriscoPlex® 4000 pipe.

Table 2. DriscoPlex® Pipes

DriscoPlex® Municipal Water and Wastewater Pipe				
DriscoPlex® Pipe Series	**Features**	**Size Range**	**Applicable Standards**	**Pipe Materials Designation Codes Available (PPI TR-4)**
4000 (DIPS) Municipal potable water, raw water, process water, sewer	Black w/ blue stripes	4" through 42" DIPS	AWWA C906 & ASTM F714 (4" to 42") NSF/ANSI 61	**PE4710**
4100 (IPS) Municipal potable water, raw water, process water, sewer	Black pipe is standard	1-1/2" through 54" IPS	AWWA C901 & ASTM D3035 (3" & smaller) ASTM F714 & AWWA C906 (4" to 54") and NSF/ANSI 61	**PE4710**

For ¾" through 2" SIDR and CTS and for ¾" through 3" IPS for municipal potable water service lines consider 5100 Ultraline®. See PP410,"DriscoPlex® 5100 Series Ultraline® HDPE Water Service Pipe & Tubing".

DriscoPlex® Pipe is Manufactured to Both ASTM F714 and AWWA C906

DriscoPlex® 4000/4100 pipe meets or exceeds the requirements of ASTM F714 and AWWA C906. ASTM F714 designates a "Pressure Rating (PR)" whereas AWWA C906 designates a "Pressure Class, PC." Currently these are not calculated the same way and therefore are not equal. ASTM F714 recognizes PE4710 material, whereas AWWA C906 is being updated but currently treats PE4710 material as having the same PC as the former PE3408 material. For AWWA C906 ratings, see Appendix 1.

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The pressure rating of PE pipe varies with the pipe's Dimension Ratio (DR). The DR is equal to the average pipe outside diameter (OD) divided by the minimum wall thickness. The Plastics Pipe Institute's *Handbook of Polyethylene Pipe* gives the method for calculating the pressure rating. The pressure ratings for DriscoPlex® 4000/4100 pipe allowed by ASTM F714 are given in Table 3.

Water and force main sewer lines have frequent and recurring surges. The designer will consider both the pipe's working or pumping pressure and the total pressure (pumping pressure plus surge pressure) when determining an application's DR. Rating for both are given in Table 3 for easy comparison with design flow conditions.

Table 3 DriscoPlex® 4000 and 4100 Pipe Pressure Ratings per ASTM F714 at 80°F

PE4710 Pipe Pressure Ratings Per ASTM F714[1]			
Dimension Ratio	**Working Pressure Rating (psi)**	**Allowable Total Pressure During Recurring Surge (psi)**	**Allowable Total Pressure During Occasional Surge (psi)**
9	**250**	**375**	**500**
11	**200**	**300**	**400**
13.5	**160**	**240**	**320**
14.3	**150**	**225**	**300**
17	**125**	**185**	**250**
21	**100**	**150**	**200**
26	**80**	**120**	**160**

[1]For Pressure Class and Working Pressure Ratings per AWWA C906, see Appendix 1. Ratings are for water and can vary for other fluids and temperature. Table 3 Working Pressure Ratings may be used with AWWA C901 pipe.

The temperature range for polyethylene pipe is -40°F to 140°F for pressure pipe and -40°F to 180°F for non-pressurized pipe, e.g. gravity flow. When DriscoPlex® pipe operates at a temperature above 80°F the Pressure Rating and Pressure Class of the pipe are decreased. The PR/PC for temperatures above 80°F may be determined by multiplying the PC in Table 3 by the temperature factor from Table 4.

Table 4: Service Temperature Design Factor

Service Temperature Design Factor, F_T[1]							
Service Temperature, °F (°C)	≤80 (27) (1)	≤90 (32)	≤100 (38)	≤110 (43)	≤120 (49)	≤130 (54)	≤140 (60)
	1.0	0.9	0.8	0.71	0.63	0.57	0.50

[1]Use 80°F (27°C) service factor for service temperatures below 80°F (27°C). F_T for temperatures below 100°F are from AWWA M-55. F_T for temperatures above 100°F found by interpolation.

***PPI Design & Engineering Calculator for PE Pipe* is available on the Performance Pipe website.**

DriscoPlex®4000/4100 Pipe Common Sizes

Tables 5 and 6 give dimensions and weights for commonly used DR's in the water and wastewater industry. For other available DR's, see PP152 and PP153, *Size and Dimension Sheets*. All pipes of a given nominal size are made to the same OD regardless of DR. Therefore, the average inside diameter (ID) varies with the pipe wall thickness. DriscoPlex® 4000/4100 pipe is available in 40 or 50 foot lengths and is also available in coils through 6" DIPS. *Packaging and Loading* information is available on our website.

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Table 5 DriscoPlex® 4000 DIPS Pipe Sizing System

Common Dimension Ratio's for DriscoPlex® 4000 DIPS Pipe (Custom DR's available. Contact Performance Pipe)													
DIPS		DR 21			DR 14.3			DR 11			DR 9		
ASTM F714 PR		PR = 100 psi			PR = 150 psi			PR = 200 psi			PR = 250 psi		
AWWA C906 PC		PC = 80 psi			PC = 120 psi			PC = 160 psi			PC = 200 psi		
Pipe Size, in.	OD, in.	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft
4	4.80	0.229	4.315	1.45	0.336	4.088	2.07	0.436	3.876	2.62	0.533	3.670	3.13
6	6.90	0.329	6.203	2.99	0.483	5.877	4.27	0.627	5.571	5.42	0.767	5.274	6.47
8	9.05	0.431	8.136	5.13	0.633	7.708	7.35	0.823	7.305	9.33	1.006	6.917	11.13
10	11.10	0.529	9.979	7.73	0.776	9.454	11.06	1.009	8.961	14.03	1.233	8.486	16.74
12	13.20	0.629	11.867	10.93	0.923	11.243	15.64	1.200	10.656	19.84	1.467	10.090	23.67
14	15.30	0.729	13.755	14.68	1.070	13.032	21.01	1.391	12.351	26.65	1.700	11.696	31.80
16	17.40	0.829	15.643	18.98	1.217	14.820	27.17	1.582	14.046	34.47	1.933	13.302	41.13
18	19.50	0.929	17.531	23.84	1.364	16.609	34.12	1.773	15.741	43.30	2.167	14.906	51.66
20	21.60	1.029	19.419	29.25	1.510	18.398	41.87	1.964	17.436	53.13	2.400	16.512	63.38
24	25.80	1.229	23.195	41.73	1.804	21.975	59.73	2.345	20.829	75.77	2.867	19.722	90.43
30	32.00	1.524	28.769	64.18	2.238	27.256	91.89	2.909	25.833	116.58			
†36	38.30	1.824	34.433	91.93	2.678	32.622	131.63	3.482	30.918	167.02			
†42	44.50	2.119	40.008	124.09	3.112	37.903	177.70						

Average inside diameter is calculated using Nominal OD and Minimum Wall plus 6% for use in estimating fluid flow. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimensions and tolerances in the applicable pipe manufacturing specification. †OD available upon special request.

Table 6 DriscoPlex® 4100 IPS Pipe Sizing System

Common Dimension Ratio's for DriscoPlex® 4100 IPS Pipe (Custom DR's available. Contact Performance Pipe)																
IPS		DR 21			DR 17			DR 13.5			DR 11			DR 9		
ASTM F714 PR		PR = 100 psi			PR = 125 psi			PR = 160 psi			PR = 200 psi			PR = 250 psi		
AWWA C906 PC		PC = 80 psi			PC = 100 psi			PC = 130 psi			PC = 160 psi			PC = 200 psi		
Pipe Size in.	OD, in.	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. lbs/ft	Min. Wall, in.	Avg. ID, in.	Wgt. Lbs/ft
2	2.375				0.140	2.078	0.43	0.176	2.002	0.53	0.216	1.917	0.64	0.264	1.815	0.77
3	3.500				0.206	3.063	0.94	0.259	2.951	1.16	0.318	2.826	1.39	0.389	2.675	1.66
4	4.500	0.214	4.046	1.27	0.265	3.938	1.55	0.333	3.794	1.92	0.409	3.633	2.31	0.500	3.440	2.75
6	6.625	0.315	5.957	2.75	0.390	5.798	3.36	0.491	5.584	4.15	0.602	5.349	5.00	0.736	5.065	5.96
8	8.625	0.411	7.754	4.66	0.507	7.550	5.69	0.639	7.270	7.04	0.784	6.963	8.47	0.958	6.594	10.11
10	10.750	0.512	9.665	7.24	0.632	9.410	8.83	0.796	9.062	10.93	0.977	8.679	13.16	1.194	8.219	15.70
12	12.750	0.607	11.463	10.19	0.750	11.160	12.43	0.944	10.749	15.38	1.159	10.293	18.51	1.417	9.746	22.08
14	14.000	0.667	12.586	12.28	0.824	12.253	14.98	1.037	11.802	18.54	1.273	11.301	22.32	1.556	10.701	26.63
16	16.000	0.762	14.385	16.04	0.941	14.005	19.57	1.185	13.488	24.22	1.455	12.915	29.15	1.778	12.231	34.78
18	18.000	0.857	16.183	20.30	1.059	15.755	24.77	1.333	15.174	30.65	1.636	14.532	36.89	2.000	13.760	44.02
20	20.000	0.952	17.982	25.07	1.176	17.507	30.58	1.481	16.860	37.84	1.818	16.146	45.54	2.222	15.289	54.34
22	22.000	1.048	19.778	30.33	1.294	19.257	37.00	1.630	18.544	45.79	2.000	17.760	55.10	2.444	16.819	65.75
24	24.000	1.143	21.577	36.10	1.412	21.007	44.03	1.778	20.231	54.49	2.182	19.374	65.58	2.667	18.346	78.25
26	26.000	1.238	23.375	42.36	1.529	22.759	51.67	1.926	21.917	63.95	2.364	20.988	76.96	2.889	19.875	91.84
28	28.000	1.333	25.174	49.13	1.647	24.508	59.93	2.074	23.603	74.17	2.545	22.605	89.26	3.111	21.405	106.51
30	30.000	1.429	26.971	56.40	1.765	26.258	68.80	2.222	25.289	85.14	2.727	24.219	102.47	3.333	22.934	122.27
32	32.000	1.524	28.769	64.17	1.882	28.010	78.28	2.370	26.976	96.87	2.909	25.833	116.58	3.333	22.934	122.27
34	34.000	1.619	30.568	72.44	2.000	29.760	88.37	2.519	28.660	109.36	3.091	27.447	131.61			
36	36.000	1.714	32.366	81.21	2.118	31.510	99.07	2.667	30.346	122.60	3.273	29.061	147.55			
42	42.000	2.000	37.760	110.54	2.471	36.761	134.84	3.111	35.405	166.88						
48	48.000	2.286	43.154	144.38	2.824	42.013	176.12									
54	54.000	2.571	48.549	182.73	3.176	47.266	222.90									

For pipe smaller than 2" see PP415, DriscoPlex® 5100 Water Service Pipe and Tubing.
Average inside diameter is calculated using Nominal OD and Minimum Wall plus 6% for use in estimating fluid flow. Actual ID will vary. When designing components to fit the pipe ID, refer to pipe dimensions and tolerances in the applicable pipe manufacturing specification.

PERFORMANCE ADVANTAGES OF DRISCOPLEX® 4000/4100 PIPE

Stripes

Stripes allow easy field identification of pipe. DriscoPlex® 4000 (DIPS) pipe comes standard with three pairs of blue stripe, but lavender, green, and no stripes is optional. The standard DriscoPlex® 4100 (IPS) is black, but blue, lavender and green striping is optional with 4 single stripes at 90 degrees apart.

Flow

DriscoPlex® 4000/4100 pipes are characterized as hydraulically smooth and typically have an absolute surface roughness (ε) of 0.000005 ft. The Hazen-Williams Friction Factor (C) equals 150 to 155 for polyethylene pipes. Even though the inside diameter of polyethylene pipe may be smaller for the same nominal size as metallic or concrete pipes, flow is often equal or greater through polyethylene pipe. For example, an 8" DR17 DriscoPlex® 4000 pipe has a lower pressure drop per given flow rate than an 8" CL350 concrete lined DI pipe (C equals 120). For gravity flow, the n-factor in the Manning equation is typically taken as 0.009 for clear water and 0.010 for sanitary sewer. For design information, see the *Handbook of Polyethylene Pipe*, Chapter 6.

Surge Pressure

When it comes to surges, polyethylene has two advantages over most piping materials. 1) As Table 3 shows, it has the capacity to handle surge pressures significantly in excess of its pressure rating. 2) It also has the lowest surge pressure of all common water pipes. For example, a 5 ft/sec velocity change in a DR17 Polyethylene pipe will produce a 56 psi surge, in a DR18 PVC pipe the surge is 88 psi, and in a Class 50 DI pipe the surge is 268 psi. Thus, with polyethylene pipe there are lower surge pressures and less wear and tear on valves, hydrants, and other system components and, when surges occur, HDPE pipes may be quite capable of handling them with a lower Pressure Class (PC) than required for other materials.

Fatigue

Repeated surges will cause fatigue stress in pipelines. This is particularly significant in certain thermoplastic pipes, excluding polyethylene. Fortunately, polyethylene has an excellent resistance to fatigue. The projected design life for DriscoPlex® 4000/4100 pipes exceeds 100 years for pipe operating at a velocity of 4 fps with a surge frequency of 4 times per hour continuously. See Bulletin PP-402, *Working Pressure Rating and Fatigue Life*.

Comparison with Other Piping Products

Polyethylene's superior performance is due to its fused joint, toughness, and flexibility. Comparisons of polyethylene to other piping materials based on PC alone can lead to costly over-designs, since the definition of "Pressure Class" varies from material to material (see AWWA C906, C905, etc). When correctly incorporating HDPE's lower surge magnitudes, higher surge allowances, and greater fatigue strength into the design, the PC required for HDPE may be much lower than the PC required for other pipe materials.

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Impact Resistance

Polyethylene pipe is routinely used in mining applications above the Arctic Circle and can withstand water freezing internally. A product that can be handled in these extreme conditions has to have excellent impact resistance. The Izod Impact Strength of high density polyethylene using ASTM D256 Method A is 4 to 5 ft-lbs/in at 73^{o}F, again a value significantly greater than other plastic pipe materials.

Rapid Crack Propagation

Impact damage, fatigue, or joint failure in metal or thermoplastic pipes under certain operating conditions can lead to long, running cracks that will propagate through fused joints and can travel hundreds of feet. This cracking is referred to as Rapid Crack Propagation (RCP). One published report cites an 1100 ft long crack that occurred in a fusion joined PVC pipeline. Polyethylene pipe has excellent resistance to RCP. In fact, laboratory testing has shown that RCP cannot occur in a water filled polyethylene pipe. PP838, *Preventing RCP in Fused Water Pipelines* indicates that the best way to avoid this type of cracking is to specify polyethylene pipe as opposed to other thermoplastic pipes.

INSTALLATION ADVANTAGES OF DRISCOPLEX® 4000/4100 PIPE

Heat Fusion of Polyethylene Pipe

Heat fusion of polyethylene pipe is proven, reliable, and time-tested, with over 50 years of success. The procedure is standardized, published in ASTM F2620, and there are thousands of trained operators around the nation. Compared to fusing other types of thermoplastic pipes, the process for polyethylene pipe is easier to learn, more forgiving, and results in higher productivity rates. Joints have the same tensile strength as the pipe and no thrust blocks or restraints are required at fittings and bends. Polyethylene pipe can be fused and installed in subfreezing weather. See PP750, *Heat Fusion Joining Procedures and Qualification Guide*.

Exceptional for Trenchless Installations

DriscoPlex® pipe is flexible and tough. As a result, polyethylene pipes are well-suited for horizontal directional drilling, plowing, river and water crossings, pipe bursting and sliplining. Installers like the fact that polyethylene pipe is tough enough to stand up to rigors of field handling with higher impact resistance, greater ductility, more flexibility, and higher resistance to RCP than its closest thermoplastic competitor. There is a wealth of technical publications for trenchless usage of polyethylene pipe including the *Handbook of Polyethylene Pipe*. See Chapter 11 “Pipeline Rehabilitation by Sliplining with PE Pipe,” Chapter 12, “Horizontal Directional Drilling,” and Chapter 16, “Pipe Bursting.”

Small Bend Radius; Big Installation Advantage

Installers often choose DriscoPlex® 4000/4100 pipe because of its flexibility and tight bend radius. The bend radius is the smallest radius to which a pipe can be bent without causing permanent damage. In open-cut and above-grade applications pipe may be strung around corners or over swales often eliminating fittings. Polyethylene water mains can typically be laid around a cul-de-sac without the use of fittings. In trenchless applications, a more flexible pipe results in shorter insertions pits and reduced costs.

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For horizontal directional drilling, a tight bend radius greatly reduces laydown space, the area where pipe is placed prior to pullback. In tight suburban right-of-ways, it is often necessary to string pipe around corners or bends while awaiting pullback. Flexibility facilitates this and polyethylene pipe can be curved to a radius 1/10th of that of its closest thermoplastic pipe competitor. Thus, it is more convenient for the installer and less disruptive to the public by eliminating inconvenient street closures. In addition, this extra flexibility provides a safety factor against damage during pullback as the polyethylene pipe will almost always have a tighter bending radius than the drill rod used to install it. Thus, polyethylene pipe is protected from over-bending unlike other fused thermoplastic pipes.

Bend radius should not be confused with the length of the pipe required to make a specific turn. Table 7 gives both the bend radius and the length required to make a 90^{o} bend. For additional information on bending see PP407, "*Small Bend Radius Big Installation Advantage"* and PP819, "*Field Bending of PE Pipe".*

Table 7. DriscoPlex® 4000/4100 Minimum Bend Radius

DriscoPlex® 4000/4100 Minimum Bend Radius														
4100 IPS Size (in)	Minimum Bend Radius (ft)			Length of Pipe Required to Make a 90° Bend (ft)			4000 DIPS Size (in)	Minimum Bend Radius (ft)			Length of Pipe Required to Make a 90° Bend (ft)		
	DR 9	DR 11 DR 13.5	DR 17 DR 21	DR 9	DR 11 DR 13.5	DR 17 DR 21		DR 9	DR 11 DR 14.3	DR 21	DR 9	DR 11 DR 14.3	DR 21
2	4.0	4.9	5.3	6.2	7.8	8.4	---		---	---		---	---
3	5.8	7.3	7.9	9.2	11.5	12.4	---		---	---		---	---
4	7.5	9.4	10.1	11.8	14.7	15.9	**4**	8.0	10.0	10.8	12.6	15.7	17.0
6	11.0	13.8	14.9	17.3	21.7	23.4	**6**	11.5	14.4	15.5	18.1	22.6	24.4
8	14.4	18.0	19.4	22.6	28.2	30.5	**8**	15.1	18.9	20.4	23.7	29.6	32.0
10	17.9	22.4	24.2	28.1	35.2	38.0	**10**	18.5	23.1	25.0	29.1	36.3	39.2
12	21.3	26.6	28.7	33.4	41.7	45.1	**12**	22.0	27.5	29.7	34.6	43.2	46.7
14	23.3	29.2	31.5	36.7	45.8	49.5	**14**	25.5	31.9	34.4	40.1	50.1	54.1
16	26.7	33.3	36.0	41.9	52.4	56.5	**16**	29.0	36.3	39.2	45.6	56.9	61.5
18	30.0	37.5	40.5	47.1	58.9	63.6	**18**	32.5	40.6	43.9	51.1	63.8	68.9
20	33.3	41.7	45.0	52.4	65.5	70.7	**20**	36.0	45.0	48.6	56.5	70.7	76.3
22	36.7	45.8	49.5	57.6	72.0	77.8	---		---	---		---	---
24	40.0	50.0	54.0	62.8	78.5	84.8	**24**	43.0	53.8	58.1	67.5	84.4	91.2
28	46.7	58.3	63.0	73.3	91.6	99.0	---		---	---		---	---
30	50.0	62.5	67.5	78.5	98.2	106.0	**30**		66.7	72.0		104.7	113.1
32		66.7	72.0		104.7	113.1	---		---	---		---	---
34		70.8	76.5		111.3	120.2	---		---	---		---	---
36		75.0	81.0		117.8	127.2	**36**		79.8	86.2		125.3	135.4
42		87.5	94.5		137.4	148.4	**42**		92.7	100.1		145.6	157.3
48			108.0			169.6	---		---	---		---	---
54			121.5			190.9	---		---	---		---	---
When fittings or flanges are present the bend radius is normally taken as 100 times the pipe diameter.													

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Safe Pull Strength

Most all trenchless methods using polyethylene pipe are pull-in or pullback techniques. Pull-in distance is often proportional to the pipe's safe pull strength, which is the maximum tensile force that can be applied to the pipe with adequate assurance that the pipe will not be damaged or changed in any way that could affect its long term performance. The maximum safe tensile stress in DriscoPlex® PE4710 pipe for a 10 hour pull is 1300 psi. Table 8 lists the safe pull strength for DriscoPlex® 4000/4100 pipe.

Table 8. Safe Pull Strength for DriscoPlex® 4000/4100

Safe Pull Strength for DriscoPlex® 4000/4100 (PE4710)										
4100 IPS Nom. Size (in)	Safe Pull Strength (lbs)					4000 DIPS Nom. Size (in)	Safe Pull Strength (lbs)			
	DR 9	DR 11	DR 13.5	DR 17	DR 21		DR 9	DR 11	DR 14.3	DR 21
2	2,275	1,904	1,580	1,275	1,045	--	--	--	--	--
3	4,941	4,135	3,431	2,770	2,269	--	--	--	--	-
4	8,168	6,835	5,672	4,579	3,751	4	9,294	7,777	6,120	4,267
6	17,704	14,814	12,294	9,924	8,129	6	19,204	16,070	12,647	8,818
8	30,007	25,109	20,838	16,820	13,779	8	33,037	27,644	21,756	15,170
10	46,614	39,005	32,371	26,130	21,404	10	49,699	41,587	32,728	22,821
12	65,572	54,869	45,536	36,757	30,110	12	70,282	58,811	46,283	32,273
14	79,060	66,155	54,903	44,317	36,303	14	94,424	79,012	62,181	43,358
16	103,262	86,407	71,709	57,884	47,416	16	122,123	102,190	80,422	56,077
18	130,691	109,359	90,757	73,259	60,011	18	153,380	128,345	101,005	70,430
20	161,346	135,011	112,046	90,443	74,088	20	188,194	157,477	123,931	86,416
22	195,229	163,363	135,576	109,436	89,646	--	--	--	--	--
24	232,339	194,416	161,346	130,238	106,686	24	268,496	224,672	176,813	123,289
28	316,239	264,621	219,610	177,269	145,212	--	--	--	--	--
30	363,029	303,775	252,104	203,497	166,697	30	--	345,628	272,003	189,664
32	--	345,628	286,838	231,535	189,664	--	--	--	--	--
34	--	390,182	323,813	261,381	214,113	--	--	--	--	--
36	--	437,435	363,029	293,036	240,044	36	--	410,898	389,647	271,696
42	--	--	494,123	398,855	326,726	42	--	--	526,010	366,780
48	--	--	--	520,953	426,745	--	--	--	--	--
54	--	--	--	--	540,099	--	--	--	--	--

Horizontal Directional Drilling Resources

In developing plans for a directional drilling project, the designer must determine what DR to use. In addition to working-pressure considerations, DR selection depends on how much force will be required to pull the pipe back into the bore and on how much external force will be applied to the pipe during and afterward from the drilling slurry, soil and groundwater. Several resources are available to help the designer select an appropriate DR. Some of these resources offer additional and important information for planning a crossing. Resources include the following: ASTM F1962, a standard guide for the design

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of a directional drilled crossing with polyethylene pipe; the PPI *Handbook of Polyethylene Pipe*, Chapter 12; ASCE MOP 108, *Pipeline Design for Installation by Horizontal Directional Drilling*; and the Plastics Pipe Institute's Technical Report 46, *Guidelines for Use of Mini-Horizontal Directional Drilling for Placement of Polyethylene Pipe*. In addition, the PPI ***BoreAid*** program is useful for making a preliminary evaluation of the DR requirements and the anticipated pullback force. A link to PPI BoreAid can be found on the Performance Pipe website on the Engineering Information page.

Burial in Open-Cut Trenching

The PPI *Handbook of Polyethylene Pipe*, Chapter 6, gives design guidance for open-cut trench installations of polyethylene pipes. HDPE pipe has been placed in landfills with cover depths well in excess of 100 ft. However, most municipal applications are significantly shallower. For the convenience of the designer, AWWA M-55, *PE Pipe—Design and Installation*, offers a safe design window. Pipe within the window meets the design deflection limits of M-55 and provide at least a 2:1 Safety Factor against buckling. For deeper depths or heavier loading, calculations are required.

Table 9. AWWA M-55 Minimum and Maximum Depths without doing calculations

AWWA M-55 Design Window	
DriscoPlex® 4000/4100 Pipe DR7.3 through DR21	
Minimum Cover Depth with no surface load	2 feet
Minimum Cover Depth with H20 truck load	3 feet
Maximum Cover Depth	25 feet
Requirements Minimum E' of native soil of 1000 psi. Maximum backfill weight of 120 pcf. No water above ground surface. Granular embedment soil around pipe with a minimum density of 85% Standard Proctor. Pipe installed per ASTM D2774 and PP-901.	

Like all piping materials, HDPE piping must be properly installed. DriscoPlex® 4000/4100 pipe should be installed in accordance with ASTM D 2774 *Standard Practice for Underground Installation of Thermoplastic Pressure Piping* and Performance Pipe's PP-901, *Field Handbook*. HDPE is a flexible piping material that works together with its soil embedment to sustain the earth and live loads above it. Suitable embedment is required to provide support around the pipe, and embedment materials must be placed so that the pipe is properly surrounded. Under roadways, compacted coarse sands and gravels are preferred, but other materials may be used under the direction of the design engineer. For more information on installation of 12" and smaller diameter DriscoPlex® pipe see the Plastics Pipe Institute's *Polyethylene Piping Systems Field Manual for Municipal Water Applications*. For installation by plowing and planting see the special underground installation techniques section of PP-901.

Ground Movement and Seismic Resistance

A large number of water main breaks occur every year due to soil settlement, freeze/thaw cycles, and shrinking or swelling of expansive soils, not to mention the occasional widespread damage that accompanies earthquakes. Polyethylene's flexibility and its fusion joints make it considerably less susceptible to damage from ground movement. California gas utilities recognize polyethylene's excellent record in enduring seismic events without damage.

Poisson Effect

When polyethylene pipe connects to a gasket jointed pipeline, the polyethylene pipe must be anchored or the gasket joints upstream (or downstream) from the transition must be restrained to prevent pullout of the gasket joints. See PP813, *Poisson Effect*.

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Above Grade and Aerial Installation

Performance Pipe black polyethylene pipe contains carbon black allowing indefinite above grade storage and use. For details on above grade applications see PP814, *Thermal Effects* and PP815, *Above Grade Pipe Supports*.

Vacuum Resistance (External Pressure)

Many pipelines operate under full or partial vacuum or experience negative internal pressures when subject to pressure surges. External pressure exceeding the internal pressure (external differential pressure) creates the same effect. Pipelines may be subject to external pressure during installation, submergence, grouting of sliplined pipe, or directional drilling. All pipes have a limit to the amount of external differential pressure (or vacuum) they can withstand. Exceeding that limit will cause the pipe to collapse. Table 10 gives the allowable external differential pressure based on Equation 3-39 in Chapter 6 of the *Handbook of Polyethylene Pipe* with a safety factor of two against collapse and with 3% ovality in the pipe. Higher resistance to collapse can be achieved by embedding the pipe in soil, flowable fill, grout, or concrete. For additional temperatures, see PP-901, *Field Handbook*.

Table 10. DriscoPlex® 4000/4100 Collapse Resistance (Vacuum Resistance)

DriscoPlex® 4000/4100 External Pressure Resistance PE4710									
Service Temperature	Pipe DR	External Differential Pressure or Vacuum Resistance 3% ovality with 2:1 safety factor[1] (psi)							
		50 yr	10 yr	1 yr	1000 hr	100 hr	10 hr	0.5 hr	Short-Term
Modulus Value (psi)		*29000*	*34000*	*40000*	*46000*	*55000*	*65000*	*82000*	*130000*
73°F	9	54.0	63.3	74.5	85.6	102.4	121.0	152.6	242.0
	11	27.6	32.4	38.1	43.8	52.4	61.9	78.1	123.9
	13.5	14.1	16.6	19.5	22.4	26.8	31.7	40.0	63.4
	14.3	11.7	13.8	16.2	18.6	22.3	26.3	33.2	52.7
	17	6.7	7.9	9.3	10.7	12.8	15.1	19.1	30.2
	21	3.5	4.1	4.8	5.5	6.6	7.7	9.8	15.5
120°F	9	31.3	36.7	43.2	49.7	59.4	70.2	88.5	140.3
	11	16.0	18.8	22.1	25.4	30.4	35.9	45.3	71.9
	13.5	8.2	9.6	11.3	13.0	15.6	18.4	23.2	36.8
	14.3	6.8	8.0	9.4	10.8	12.9	15.3	19.3	30.5
	17	3.9	4.6	5.4	6.2	7.4	8.8	11.1	17.5
	21	2.0	2.3	2.8	3.2	3.8	4.5	5.7	9.0

[1]Gray shading indicates value equals or exceeds full vacuum of 14.7 psi.

Fittings

Performance Pipe manufactures HDPE molded *Fittings* including tees and elbows in sizes through 8" diameter. Flange adapters for flange connections are available through 24" diameter. MJ Adapters for both DriscoPlex® 4000 and 4100 pipe are available through 12" diameter. Larger fittings are available through third party fabricators.

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Transition to Non-Polyethylene Pipes

Polyethylene pipe can be conveniently connected to metallic valves, pumps and even pipe. Normally the connection is made using a polyethylene Van Stone style Flange Adapter with a metallic backup ring which mates to a metallic flange or using a polyethylene Mechanical Joint (MJ) Adapter which mates to a DI mechanical joint bell. The MJ Adapter works with both IPS and DIPS polyethylene pipe. Acceptable methods also include metallic transition couplings that slide on, seal, and grip the polyethylene pipe or metallic transition couplings that slide on and seal but require additional external restraint rings. These types of couplings may require the use of an insert stiffener in the polyethylene pipe. DriscoPlex® 4000 pipe may be inserted directly into an MJ Bell. This requires placing an insert stiffener inside the end of the DriscoPlex® pipe and restraining the connection with an external ring or clamp on the DriscoPlex® pipe. When selecting mechanical couplings or components for use with DriscoPlex® pipe, make sure the mechanical coupling manufacturer recommends the particular part for HDPE pipe. For additional information on HDPE to non-HDPE pipe transitions, see the Plastics Pipe Institute's TN-36, *General Guidelines for Connecting Potable Water HDPE Pressure Pipes to DI and PVC Piping Systems* and *Polyethylene Piping Systems Field Manual for Municipal Water Applications.*

Tapping

A variety of heat fusion and mechanical fittings make hot or cold tapping a straightforward process. Heat fusion jointed products include saddle fusion tapping tees, electrofusion tapping tees, and branch-saddles. A number of manufacturers produce metallic full body tapping saddles and sleeves for polyethylene pipe. Performance Pipe recommends that the manufacturer be contacted to make sure their saddles work with polyethylene pipes. Service saddles are available as well. These may come with double or extra wide straps, with spring washers, or with both.

Repair

Polyethylene pipe has an excellent field record. However, circumstances may arise where repair is necessary. The most likely form of damage is impact or an underground strike which is usually localized. A variety of repair clamps (both mechanical and electrofusion) and tapping saddles are available. If a section of pipe has to be removed, a new pup piece can be inserted using mechanical couplings, polyethylene flange adapters, or electrofusion couplings.

Leak Testing

Polyethylene pipe may be hydrostatically tested to determine system integrity for leaks. When testing is required, observe all safety measures. See Performance Pipe PP 802, *Leak Testing of Polyethylene Pipe*. Typically, HDPE pipe is leak tested to 1.5 times its Pressure Rating (PR). See Tables 5 and 6.

Water Quality

Water utilities aim to maintain a high standard of water quality and to protect public drinking water from any internal and external contaminates. All piping systems have some potential for contamination from external agents through permeation of gaskets, jointed connections, or permeation through the pipe wall. Literature suggests that permeation of organic chemicals and hydrocarbons through polyethylene pipe is possible, while actual cases of soil contaminated hydrocarbon permeation are extremely rare.

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Hydrocarbons do not degrade polyethylene but can diffuse through the wall of the pipe in areas of gross contamination. The exterior contact may affect sidewall fusions and or butt fusions; thus, after polyethylene pipes have been exposed to grossly contaminated soils, mechanical connections may be preferred.

There are several ways to address gross hydrocarbon contamination of soil surrounding the pipe including removal and replacement of the contaminated soil with good clean soil of Class I or Class II materials, sleeving the pipe, and rerouting the pipe around the contaminated area.

Safety

Polyethylene piping has been safely used in thousands of applications. However, there are general precautions that should be observed when using any product. In this respect, polyethylene piping is no different. Performance Pipe's recommends the following reading for a more detailed list of cautions and safety features.

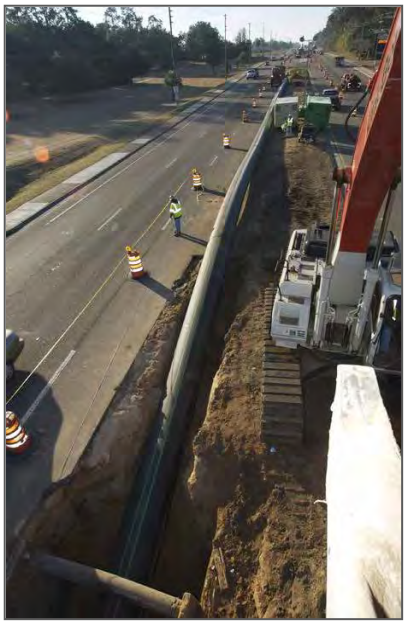
1. The Plastic Pipe Institute Handbook of Polyethylene Pipe, Chapter 2. *Inspections, Tests and Safety Features*.

2. *The Performance Pipe Field Handbook*.

3. *Pipe Loading/Unloading-Truck Driver Safety Video*

Technical Information

A large body of technical information related to the design and installation of polyethylene pipe is available at the Plastics Pipe Institute's website, www.plasticpipe.org and on Performance Pipe's website, www.performancepipe.com. Additional information on polyethylene pipe including case history information is available at the PE Alliance site, www.pepipe.org.



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APPENDIX A. PRESSURE CLASS SELECTION PER AWWA C906

Selecting the right Pressure Class for High Density Polyethylene pipe in accordance with AWWA C906 is easy. Just two steps! AWWA C906 takes into account the continuous pumping and transient (surge) pressures that occur in municipal water pipes.

Step 1. Compare the pipeline working pressure with the pipe's Pressure Class.

AWWA C906 defines working pressure as "the maximum anticipated, sustained **operating pressure applied to the pipe exclusive of transient pressures".** The maximum working pressure for a pipe must be less than or equal to the pipe's Pressure Class. Table A-1 gives Pressure Class for standard Dimension Ratio's (DR) HDPE pipe made from PE3608 material.

Table A-1: Maximum Allowable Pressures for HDPE Pipe (PE3608) at 80°F[1] (Per AWWA C906)

	Pressure Class/ Maximum Working Pressure (psi)	Maximum Total Pressure[2] Allowed During Recurring Surge (psi)	Maximum Total Pressure[2] Allowed During Occasional Surge (psi)	Maximum Test Pressure Allowed per AWWA Manual M55 (psi)
Pipe DR 7.3	254	380	510	380
Pipe DR 9	200	300	400	300
Pipe DR 11	160	240	320	240
Pipe DR 13.5	128	185	250	185
Pipe DR 17	100	150	200	150
Pipe DR 21	80	120	160	120

[1]Pressures above 80°F require derating. See Table 4.

[2]Total pressure equals the combined pumping (working) pressure plus surge pressure. Recurring surges are frequently occurring surges inherent to the design and operation of the system. Occasional surges are caused by emergency operations such as fire flows.

Step 2. Compare the peak pipeline pressure during surge with the pipe's allowable Maximum Total Pressure.

Peak pressure during a surge is equal to the sum of the pumping pressure and the transient surge pressure. Transient surge pressure depends on the instantaneous change in flow velocity. Maximum transient pressure due to an instantaneous change in flow velocity is given in Table A-2. Peak pressure may be obtained by adding the surge pressure at the design velocity from Table A-2 to the pumping pressure. Peak pressure is compared with the Maximum Total Pressure Allowed During Surge in Table A-1. The Maximum Total Pressure Allowed equals 1.5 times the pipe's Pressure Class for recurring surge and 2.0 times the pipe's Pressure Class for occasional surge.

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Note: *The surge pressure occurring in HDPE pipe is significantly lower than surge pressures occurring in cast or ductile iron pipe and is lower than that in PVC pipe of the same DR. For example, a 4 fps instantaneous velocity change in HDPE DR17 pipe results in a 45.0 psi surge whereas for DI pipe the surge is 200 psi and for PVC DR18 pipe the surge is 69.6 psi. When HDPE pipe is connected to DI pipe the surge pressure is dampened by the HDPE pipe.*

Table A-2. Surge Pressure at 80°F for Sudden Velocity Change, psi (Per AWWA M-55)

		Surge Pressure, psi							
		1 fps	2 fps	3 fps	4 fps	5 fps	6 fps	7 fps	8 fps
Pipe DR	7.3	18.4	36.8	55.2	73.6	92.0	110.4	128.8	147.2
	9	16.2	32.4	48.5	64.7	80.9	97.1	113.2	129.4
	11	14.4	28.7	43.1	57.5	71.9	86.2	100.6	115.0
	13.5	12.8	25.6	38.4	51.2	63.9	76.7	89.5	102.3
	17	11.3	22.5	33.8	45.0	56.3	67.5	78.8	90.0
	21	10.0	20.1	30.1	40.1	50.2	60.2	70.2	80.3

Working Pressure and Surge Pressure Example:

An engineer is designing a water system that operates at 85 psi and has some runs in it where the flow velocity is 4 fps. In addition, his/her state requires a 150 psi test for the pipeline. What DR pipe does the engineer use?

Step 1. Compare the pumping pressure, 85 psi, with the available Pressure Classes in Table A-1. DR17 has a PC of 100 psi>85 psi. The test pressure of DR17 is also 150 psi, which meets the specified test pressure.

Step 2. The anticipated peak pressure in the pipeline is found by adding the pumping pressure of 85 psi to the surge pressure of 45.0 psi (given in Table A-2 for a 4 fps velocity). The sum equals 130.2 psi and is less than the Maximum Total Pressure Allowed for Recurring Surge for DR17 pipe of 150 psi. DR17 pipe is O.K. A similar comparison can be made for peak pressure during fire flow where velocity may reach 8 fps. In this case add 90.0 psi (from Table A-2) to 85 psi to obtain a peak pressure during occasional surge of 175 psi. Compare with the Maximum Total Pressure Allowed for Occasional Surge for DR17 of 200 psi. DR17 pipe is O.K.

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When Performance Matters Rely on Performance Pipe

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Chemical Resistance of Thermoplastics Piping Materials

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CHEMICAL RESISTANCE OF THERMOPLASTICS PIPING MATERIALS

Foreword

This report was developed and published with the technical help and financial support of the members of the PPI (Plastics Pipe Institute, Inc.). The members have shown their interest in quality products by assisting independent standards-making and user organizations in the development of standards, and also by developing reports on an industry-wide basis to help engineers, code officials, specifying groups, and users.

The purpose of this technical report is to provide information on the transport of various chemicals using thermoplastic piping materials.

This report has been prepared by PPI as a service of the industry. The information in this report is offered in good faith and believed to be accurate at the time of its preparation, but is offered without any warranty, expressed or implied, including WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Consult the manufacturer for more detailed information about the particular weathering package used for its piping products. Any reference to or testing of a particular proprietary product should not be construed as an endorsement by PPI, which do not endorse the proprietary products or processes of any manufacturer. The information in this report is offered for consideration by industry members in fulfilling their own compliance responsibilities. PPI assumes no responsibility for compliance with applicable laws and regulations.

PPI intends to revise this report from time to time, in response to comments and suggestions from users of the report. Please send suggestions of improvements to the address below. Information on other publications can be obtained by contacting PPI directly or visiting the web site.

The Plastics Pipe Institute
469-499-1044
www.plasticpipe.org

September 2007

This report has been developed as an informative guide on resistance of thermoplastic piping materials to chemical attack. It is divided into two main sections: (1) a discussion of chemical resistance and general considerations for end use applications and (2) a listing of chemical resistance data (table) for several thermoplastic piping materials applicable to *non-pressure* applications. Determination of suitability for specific applications under stress (pressurized service) is beyond the scope of this report.

SECTION I: CHEMICAL RESISTANCE IN GENERAL

Thermoplastic materials generally are resistant to attack from many chemicals which makes them suitable for use in many process applications. The suitability for use in a particular process piping application is a function of:

I. Material
   - A. The specific plastic material: ABS, CPVC, PP, PVC, PE, PB, PVDF, PEX[1], PA11, PK
   - B. The specific plastic material physical properties as identified by its cell classification according to the appropriate ASTM material specification.

II. Product and Joint System
   - A. Piping product dimensions, construction, and composition (layers, fillers, etc.).
   - B. Joining system. Heat fusion and solvent cementing do not introduce different materials into the system. Mechanical joints can introduce gaskets such as elastomers, or other thermoplastic or non-thermoplastic materials used as mechanical fitting components.
   - C. Other components and appurtenances in the piping system.

III. Use Conditions - Internal and External
   - A. Chemical or mixtures of chemicals, and their concentrations.
   - B. Operating temperature — maximum, minimum, and cyclical variations.
   - C. Operating pressure or applied stress — maximum, minimum and cyclical variations.
   - D. Life-cycle information — such as material cost, installation cost, desired service life, maintenance, repair and replacement costs, etc.

[1] Once cross-linked, PEX is no longer considered a thermoplastic material, however, it is included in this report as convenience for the reader.

Types of Chemical Attack on Plastics

In general, chemicals that affect plastics do so in one of two ways. One effect is chemical solvation or permeation; the other is direct chemical attack.

Chemical Solvation or Permeation

In the case of solvation or permeation, physical properties may be affected, but the polymer molecule structure itself is not chemically changed, degraded or destroyed. In solvation or permeation, gas, vapor or liquid molecules pass through the polymer, typically without damaging the plastic material itself. If the solvating chemical can be removed completely, the plastic is generally restored to its original condition. However, removal of the chemical is not always possible, and, in such cases, these chemical solvation effects may be permanent.

Sometimes the polymer itself may not be soluble, but it may contain a soluble compounding ingredient that may be extracted from the polymer compound. This is rare because such extractable ingredients are either not used in pipe compounds, or they are chemically bonded to the molecular polymer matrix and in such small amounts that they cannot be leached out to any significant extent.

Permeation may do little if any harm to the material, but it may have application-related effects. The permeating chemical may transfer into a fluid on the other side of the pipe. In general, thermoplastic pipes should not be used where a permeating chemical in the environment surrounding the pipe could compromise the purity of a fluid, such as potable water inside the pipe (See also PPI *Statement N* on Pipe Permeation). In gas or vapor transmission service, there may be a very slight loss of contents through the pipe wall. Lastly, a permeating chemical entrained in the material may be released when heat fusion or solvent cement joining is performed. Thus, heat fusion or solvent cement joining may be unreliable if performed on permeated pipes.

Direct Chemical Attack

Direct chemical attack occurs when exposure to a chemical causes a chemical alteration of the polymer molecules by chain scission, crosslinking, oxidation or substitution reactions. Direct chemical attack may cause profound, irreversible changes that cannot be restored by removal of the chemical. Examples of this type of attack are 50% chromic acid at 140 °F on PVC, aqua regia on PVC at 73 °F, 95% sulfuric acid at 73 °F on PE and wet chlorine gas on PVC and PE. Direct chemical attack frequently causes a severe reduction of mechanical physical properties such as tensile strength, ductility, and impact resistance, and susceptibility to cracking from applied stress (stress cracking).

Chemical resistance may vary greatly from one plastic material to another (i.e., PVC, ABS, PE, etc.), and also among different cell classifications of the same plastic type (e.g. PVC 1120 to PVC 2110, PE 3608 to PE 4710, etc.). There may also be slight variations among commercial products having the same cell classification.

The chemical resistance of plastic piping is basically a function of the chemical resistance of the thermoplastic material, in addition to additives and other ingredients in the final compound. In general, the less inert compounding ingredients used the better the chemical resistance. Thermoplastic pipes with significant filler percentages may be susceptible to chemical attack where an unfilled material may be affected to a lesser degree or not at all.

Other Considerations

Chemical Families

While the effect of each individual chemical is specific, some chemicals can be grouped into general categories based on similarities in chemical characteristics (acids, bases, alcohols, etc.). For example, water-based (aqueous) solutions of neutral inorganic salts generally have the same effect on thermoplastic piping materials as water alone; thus, sodium chloride, potassium alum, calcium chloride, copper sulfate, potassium sulfate and zinc chloride solutions have the same effect as water. However, at elevated temperatures and/or high concentrations, some oxidizing salt solutions may attack some plastic materials.

Further, with organic chemicals in a specific series such as alcohols, ketones, or acids, etc., as the molecular weight of the organic chemical series increases, the chemical resistance of a particular plastic material to members of the specific organic chemical series frequently also increases. Thus, while one type of polyvinyl chloride at 73 °F is not suitable for use with ethyl acetate, it is suitable for the higher molecular weight butyl acetate.

Accelerating factors (concentration, temperature, stress)

Generally, the resistance of a particular plastic to a specific chemical decreases with an increase in concentration. For example, at 73°F polyethylene pipe can be used to carry 70% sulfuric acid but is not satisfactory for 95% sulfuric acid.

Also, the resistance of a particular plastic to a specific chemical generally decreases as temperature increases, generally decreases with increasing applied stress, and generally decreases where temperature or applied stress are varied or cycled. These effects can be greater overall in combination.

Combinations of Chemicals

In some cases, combinations of chemicals may have a synergistic effect on a thermoplastic material where the individual chemicals do not. It cannot be

assumed that an individual chemical's lack of effect would apply for combinations that include several chemicals. When the possible combined effect of several chemicals is unknown, the material should be tested in the complete chemical mixture(s) in question.

Multi-Layered (Composite) Piping

Some piping products utilize a multi-layered (*composite*) construction, in which the pipe wall is constructed of layers of different materials. The layers may consist of both thermoplastic and non-thermoplastic – for example, PE/AL/PE and PEX/AL/PEX pipes, which contain a mid-wall aluminum layer. An all-thermoplastic composite pipe may contain PVC, ABS, and PVC layers. Layered composite material pipes may have chemical resistance that differs from the chemical resistance of the individual materials.

Rate of Chemical Attack

Chemicals that attack plastics do so at a certain rate, some slowly and some more quickly. But usually, any chemical attack is increased when temperature or stress are increased, or when temperature or stress are varied. The particular rate must be taken into consideration in the life-cycle evaluation for a particular application. It has been observed in some chemical plants that while a particular application may have a relatively short service life, the overall life-cycle cost may be economically feasible and justifiable. Each combination of material cost, installation cost and service life must be evaluated and judged on its own merits.

In some cases involving a slow rate of chemical attack, particularly when the application will be pressurized, simple immersion data, like that represented in the following resistance tables, may not adequately characterize performance throughout the intended design life. Longer-term testing to replicate service conditions is advisable to fully measure the effects of these chemicals.

SECTION 2: CHEMICAL RESISTANCE DATA FOR THERMOPLASTIC PIPING IN *NON-PRESSURE* APPLICATIONS AND DATA TABLE

When thermoplastic pipes come into contact with chemical agents, it is important to know how the pipe may be affected. For gravity flow or non-pressure applications, where the pipe is not subject to continuous internal pressure or thermal stress, chemical immersion test data may provide suitable information. The pipe manufacturer may have additional data from similar tests, or information on previous installations under similar field conditions.

The following table provides resistance data, with the following cautions:

I. *Data Sources.* The following chemical resistance information has been obtained from numerous sources. The data are based primarily on plastic material test specimens that have been immersed in the chemical, and to a lesser degree, on field-experience. In most cases, detailed information on the test conditions (such as exposure time), and on test results (such as change in weight, change in volume, and change in strength) was not available. Therefore, this information is best used only for comparison of different thermoplastic materials.

II. *Combinations of Chemicals.* . Chemicals that individually do not have an effect may affect the pipe if combined with certain other chemicals. The listings that follow do not address chemical combinations.

III. *Composite Piping.* Layered composite piping may have chemical resistance that differs from that of the individual materials in the layers. The listings that follow are not applicable to layered composite piping products.

IV. *Applicability to fiberglass, filled materials.* The listings that follow are not applicable to composite piping products such as reinforced epoxy resin (fiberglass) pipes, or to thermoplastic pipes containing significant percentages of filler materials.

V. *Concentrations.* Where no concentrations are given, the relatively pure material is indicated, except in the case of solids where saturated aqueous solutions are indicated.

NOTE: *Even though indicated as acceptable with certain temperature limitations, the use of PVC piping with liquid hydrocarbons such as gasoline and jet fuels should be limited to short-term exposure such as secondary containment systems. This piping is not recommended for long-term exposure to liquid hydrocarbons.*

Resistance Codes

The following code is used in the data table:

Code	Meaning	Typical Result
140	Plastic type is generally resistant to temperature (°F) indicated by code.	Swelling < 3% or weight loss < 0.5% and elongation at break not significantly changed.
R to 73	Plastic type is generally resistant to temperature (°F) indicated by code and may have limited resistance at higher temperatures.	Swelling < 3% or weight loss < 0.5% and elongation at break not significantly changed.
C to 73	Plastic type has limited resistance to temperature (°F) indicated by code and may be suitable for some conditions.	Swelling 3-8% or weight loss 0.5-5% and/or elongation at break decreased by < 50%.
N	Plastic type is not resistant.	Swelling > 8% or weight loss > 5% and/or elongation at break decreased by > 50%.
—	Data not available.	

Plastic Materials Identification

ABS	acrylonitrile-butadiene-styrene
CPVC	chlorinated polyvinyl chloride
PP	polypropylene
PVC	polyvinyl chloride
PE	polyethylene
PB	polybutylene
PVDF	poly vinylidene fluoride
PEX	crosslinked polyethylene
PA11	polyamide 11
PK	polyketone

CHEMICALS THAT DO NOT NORMALLY AFFECT THE PROPERTIES OF AN UNSTRESSED THERMOPLASTIC MAY CAUSE COMPLETELY DIFFERENT BEHAVIOR (SUCH AS STRESS CRACKING) WHEN UNDER THERMAL OR MECHANICAL STRESS (SUCH AS CONSTANT INTERNAL PRESSURE OR FREQUENT THERMAL OR MECHANICAL STRESS CYCLES). UNSTRESSED IMMERSION TEST CHEMICAL RESISTANCE INFORMATION IS APPLICABLE ONLY WHEN THE THERMOPLASTIC PIPE WILL NOT BE SUBJECT TO MECHANICAL OR THERMAL STRESS THAT IS CONSTANT OR CYCLES FREQUENTLY.

WHEN THE PIPE WILL BE SUBJECT TO A CONTINUOUS APPLIED MECHANICAL OR THERMAL STRESS OR TO COMBINATIONS OF CHEMICALS, TESTING THAT DUPLICATES THE EXPECTED FIELD CONDITIONS AS CLOSELY AS POSSIBLE SHOULD BE PERFORMED ON REPRESENTATIVE SAMPLES OF THE PIPE PRODUCT TO PROPERLY EVALUATE PLASTIC PIPE FOR USE IN THIS APPLICATION.

May not be fully applicable to pressurized applications

Plastics at Maximum Operating Temperature (F)

Chemical (Formula)	Concentration	ABS	CPVC	PP	PVC	PE	PB	PVDF	PEX	PA 11	PK
Acetaldehyde CH_3CHO	--	—	N	140	N	C to 73	C to 73	---	C to 140	C to 176	R to 73
	Aq. Of 40%	—	N	—	C to 73	R to 73	---	N	R to 73	---	---
Acetamide CH_3CONH_2	5%	120	—	140	---	140	—	---	140	---	---
Acetic Acid CH_3COOH	vapor	120	180	180	140	140	140	---	140	---	---
	5%	—	—	—	—	---	---	—	—	—	R to 176
	10%	—	---	---	—	—	---	R to 248	140	R to 176	—
	25%	N	180	180	140	140	140	---	140	---	---
	40%	—	—	---	---	—	—	R to 140	R to 176	---	---
	50%	---	---	---	—	—	---	R to 140	R to 176	C to 68	—
	60%	N	N	180	73	73	73	R to 104	73	---	---
	80%	—	---	---	---	—	—	R to 104	---	---	—
	85%	N	N	120	73	73	73	---	73	—	—
	glacial	N	N	120	73	73	73	R to 104	R to 68	---	---
Acetic Anhydride $(CH_3CO)_2O$	---	N	N	73	N	73	140	N	73	C to 68	—
Acetone CH_3COCH_3	5%	N	N	73	N	C to 73	140	R to 212	C to 73	C to 140	—
	10%	---	—	—	—	---	---	R to 122	—	—	---
	100%	—	—	---	---	---	—	—	---	---	R to 73 C to 122
Acetophenone $C_6H_5COCH_3$	—	N	---	120	—	73	—	R to 68	73	—	—
Acetyl Chloride CH_3COCl	—	N	N	—	N	—	---	N	—	—	—
Acetylene $HC{\equiv}CH$	gas 100%	73	N	73	N	73	C to 73	—	73	140	---
Acetylnitrile	—	—	N	---	N	---	---	—	---	---	—
Acrylic Acid $H_2C{=}CHCOOH$	97%	—	N	—	N	140	---	—	140	—	—

May not be fully applicable to pressurized applications

Plastics at Maximum Operating Temperature (F)

Chemical (Formula)	Concentration	ABS	CPVC	PP	PVC	PE	PB	PVDF	PEX	PA 11	PK
Xylene (Xylol) $C_6H_4(CH_3)_2$	–	N	N	N	N	N	N	C to 140	N	C to 194	—
Zinc Acetate $Zn(CH_3COO)_2o2H_2O$	–	---	180	—	---	—	---	---	—	—	---
Zinc Carbonate $ZnCO_3$	--	—	180	140	—	140	---	R to 212	140	---	---
Zinc Chloride $ZnCl_2$	--	120	180	180	140	140	---	---	140	---	---
	50%	---	—	---	---	---	—	---	---	C to 73	---
	Sat'd	---	---	---	—	---	—	R to 212	---	---	---
Zinc Nitrate $Zn(NO_3)_2o6H_2O$	--	160	180	180	140	140	140	—	140	---	—
	Sat'd	---	---	—	---	---	—	R to 212	---	—	---
Zinc Oxide ZnO	--	---	---	—	---	---	—	R to 212	---	---	---
Zinc Stearate $(CH_3(CH_2)_{16}COO)_2Zn$	--	---	---	—	---	—	---	R to 122	---	---	---
Zinc Sulfate $ZnSO_4o7H_2O$	–	160	180	212	140	140	140	---	140	—	---
	Sat'd	---	---	---	---	—	---	R to 212	—	---	—

Flange Gaskets

(Durlon)

EnSol, Inc.

SPECIFICATION
SHEET
September 2006

DURLON® 8300

Carbon Fiber with NBR Rubber Binder
COMPRESSED SHEET GASKET MATERIAL
ASTM F104: F712120-A9B3E22K5L311M5

APPLICATION:

DURLON® 8300 is premium grade compressed sheet gasket material that is excellent in steam and hydrocarbon services in the refining, petrochemical and power generation industries. Other applications include oil, water, mild alkalis, mild acids, and solvents.

COMPOSITION:

DURLON® 8300 contains high-strength carbon fibers bonded with nitrile (NBR) synthetic rubber. A release agent on both sides provides good anti-stick properties.

ANTI-STICK PROPERTIES:

Much effort has gone into improving the anti-stick release agents of all compressed DURLON® products. All DURLON® compressed gasket materials have passed the MIL-G-24696B Navy Adhesion Test (366°F/48 hrs).

TYPICAL PROPERTIES:

Color:	Black, branded
Fiber:	Carbon
Binder:	Nitrile (NBR)
Fluid Services:	Saturated Steam, Oils, Dilute Acids & Alkalis, Hydrocarbons, Solvents
Density:	1.6 g/cm^3 (100 lbs./ft^3)
Tensile Strength, ASTM F152:	1,800 psi (12.4 MPa)
Compressibility, ASTM F36:	8 to 16%
Recovery ASTM F36:	50%
Temperature Range: Continuous, max:	 -100 to 800°F (-73 to 427°C) 600°F (315°C)
Pressure, max:	1500 psig (103 bar)
Fluid Resistance - ASTM F146 IRM 903 oil, 5 h/300°F (149°C) Thickness Increase: Weight Increase: ASTM Fuel B 5 h/70°F (21°C) Thickness Increase: Weight Increase:	 0 to 10% 10% 0 to 10% 12%
Sealability ASTM F37 (Fuel A): ASTM F37 (Nitrogen):	 0.03 mL/hr 0.4 mL/hr
Volume Resistivity, ASTM D257:	5 x 10^9 ohm-cm
Dielectric Breakdown, ASTM D149:	0.04 kV/mm (1 V/mil)
DIN 3535 Gas Permeability:	0.05 cc/min
Creep Relaxation ASTM F38:	18%
Flexibility, ASTM F147:	10x

Note: ASTM properties based on 1/16" sheet thickness except ASTM F38, which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties but should not be used to establish specification limits nor used alone as the basis of design.

*For applications above Class 300, consult your representative.

M&Y AND PROPOSED ASTM GASKET CONSTANTS:

THICKNESS	1/16"	1/8"
M	3.7	3.0
Y psi (MPa)	3515 (24.24)	4014 (27.68)
Gasket Constants		
Gb psi (MPa)	512 (3.5)	1716 (11.8)
a	0.355	0.209
Gs psi (MPa)	13 (0.09)	70 (0.48)
*Gasket Constants based on proposed ASTM Draft 10.01		

AVAILABLE SHEET SIZES:

Nominal Thickness	Sheet Sizes inches	Sheet Sizes mm	Order Code	Sheets Per Roll	Approx. Weight/Sheet lbs (kg)
1/64" 0.4mm	60 x 63 60 x 126	1524 x 1600 1254 x 3200	DC05-060-063 DC05-060-126	20 10	4 (1.81) 7 (3.18)
1/32" 0.8mm	60 x 63 60 x 126	1524 x 1600 1254 x 3200	DC08-060-063 DC08-060-126	20 10	7 (3.18) 14 (6.35)
1.0mm	60 x 63 60 x 126 120 x 126	1524 x 1600 1254 x 3200 3048 x 3200	DC10-060-063 DC10-060-126 DC10-120-126	20 10 2	11 (5.00) 22 (9.98) 44 (19.96)
1/16" 1.5mm	60 x 63 60 x 126 120 x 126	1524 x 1600 1254 x 3200 3048 x 3200	DC15-060-063 DC15-120-126 DC15-120-126	10 5 2	14 (6.35) 28 (12.70) 55 (24.95)
2.0mm	60 x 63 60 x 126 120 x 126	1524 x 1600 1254 x 3200 3048 x 3200	DC20-060-063 DC20-060-126 DC20-120-126	10 5 2	22 (9.98) 44 (19.96) 88 (39.92)
3/32" 2.5mm	60 x 63 60 x 126	1524 x 1600 1254 x 3200	DC25-060-063 DC25-060-126	8 4	25 (11.34) 49 (22.23)
1/8" 3.0mm	60 x 63 60 x 126 120 x 126	1524 x 1600 1254 x 3200 3048 x 3200	DC30-060-063 DC30-120-126 DC30-120-126	8 4 1	27 (12.25) 54 (24.50) 108 (49.00)

Note: Please inquire about availability of 4.0mm and 5.0mm thicknesses and other sizes not listed.

GASKET RESOURCES INC.

CONTACT INFORMATION:	Phone:	Fax:	E-mail
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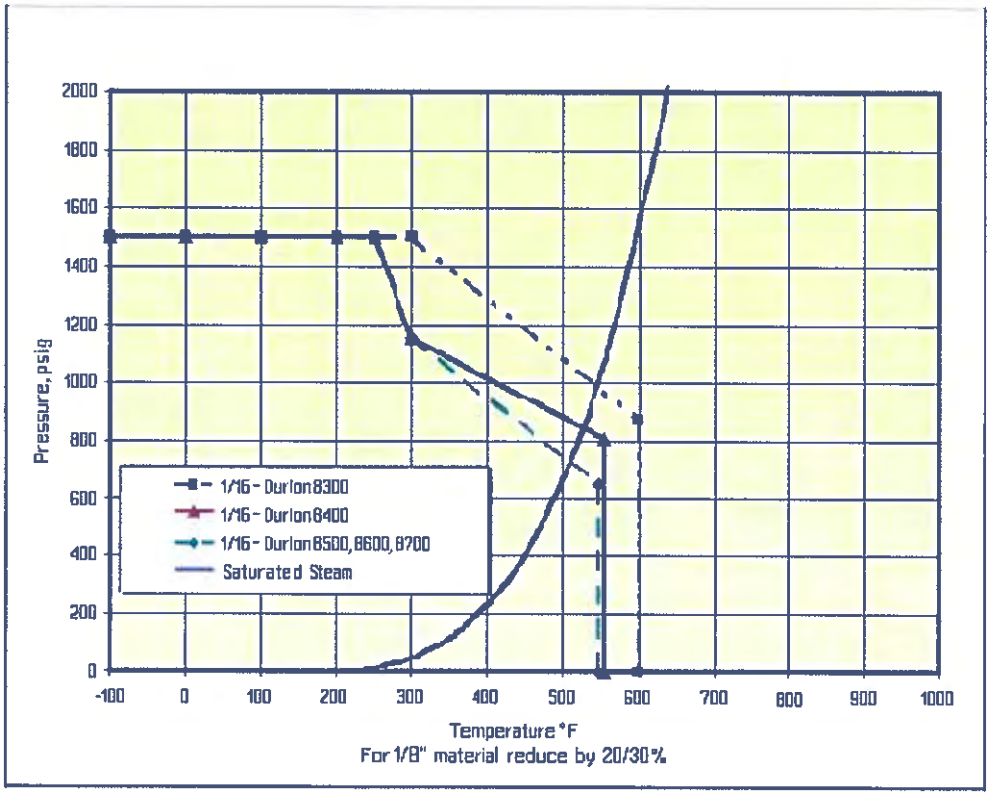
INTERNATIONAL	(613) 966-1442	(613) 966-1572	intl@durlon.com

Gasket Resources Inc

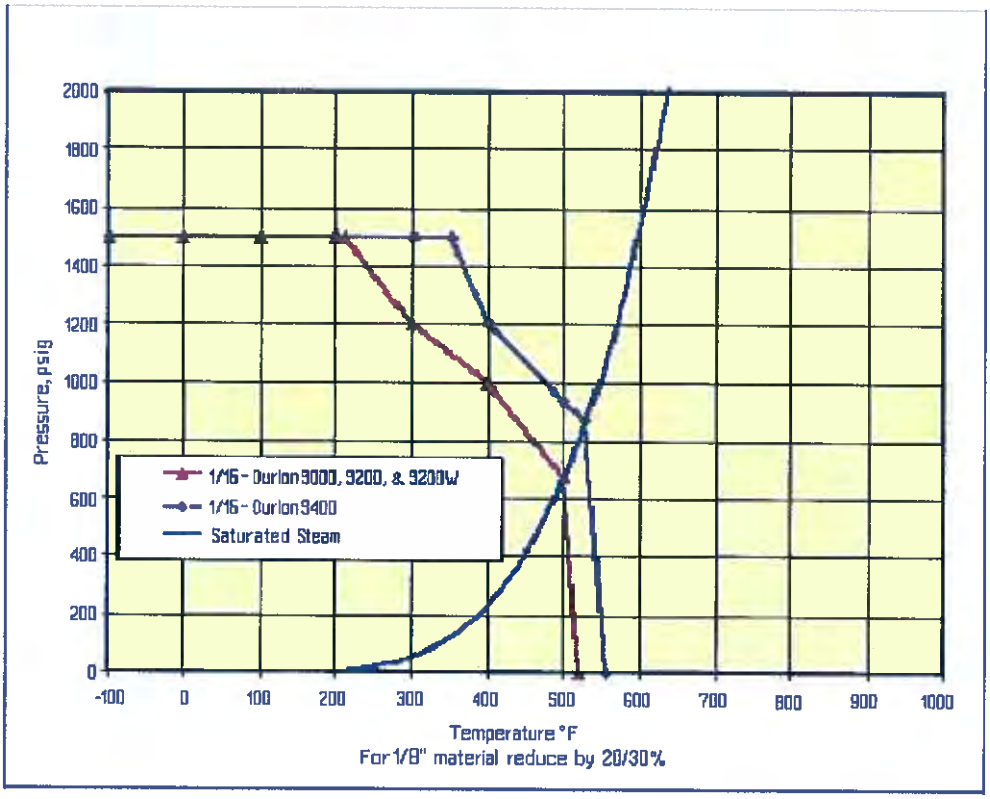
DURLON® Pressure - Temperature Chart

Durlon® Compressed Sheet Gasketing



To the left of the saturated steam curve (blue line) is hot water; while to the right of this curve is superheated steam.

Durlon® Filled PTFE Sheet Gasketing



Hydroxide, Vinyl Chloride, Ethylene Dichloride, Sulfuric Acid and Oxygen making it the clear Chlor-Alkali Industry choice

Print Page

CHEMICAL RESISTANCE CHART - A

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Acetaldehyde	NS	C	C	C	C	A	A	A	A	A	A	A
Acetic Acid, Glacial	C	C	C	C	C	A	A	A	A	A	A	A
Acetic Acid, 37%	A	A	A	A	A	A	A	A	A	A	A	A
Acetic Anhydride	A	C	C	C	C	A	A	A	A	A	A	A
Acetone	C	C	C	C	C	A	A	A	A	A	A	A
Acetonitrile	NS	NS	NS	NS	C	A	A	A	A	NS	NS	NS
Acetylene	A	A	A	C	A	A	A	A	A	A	A	A
Acrolein	C	C	C	NS	C	A	A	A	A	NS	NS	NS
Acrylic Acid	NS	NS	NS	NS	NS	A	A	A	A	A	NS	NS
Acrylonitrile	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Air	A	A	A	A	A	A	A	A	A	A	A	A
Alum	A	A	A	A	A	A	A	A	A	A	A	A

Related Links >

CHEMICAL RESISTANCE CHART - A
CHEMICAL RESISTANCE CHART - B
CHEMICAL RESISTANCE CHART - C
CHEMICAL RESISTANCE CHART - D-F
CHEMICAL RESISTANCE CHART - G-L
CHEMICAL RESISTANCE CHART - M-O
CHEMICAL RESISTANCE CHART - P
CHEMICAL RESISTANCE CHART - R
CHEMICAL RESISTANCE CHART - S
CHEMICAL RESISTANCE CHART - T-Z

find it fast >

Chemical Resistance
Product Literature
Gasket Fundamentals

Aluminum Acetate	A	A	A	A	A	A	A	A	A	C	C	C
Aluminum Hydroxide	A	A	A	A	A	A	A	A	A	A	NS	NS
Aluminum Nitrate	C	C	C	C	C	A	A	NS	A	C	C	C
Aluminum Sulfate	A	A	A	A	A	A	A	A	A	A	NS	NS
Amines	C	C	C	A	C	A	A	A	A	A	A	A
Ammonia, Gas<150°F	A	A	A	A	A	A	A	A	A	A	C	C
Ammonia, Liquid, Anhydrous	A	A	A	C	A	A	A	A	A	A	A	A
Ammonium Bisulfite	A	A	A	C	A	A	A	A	A	NS	NS	NS
Ammonium Chloride	A	A	A	A	A	A	A	A	A	A	A	A
Ammonium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A
Ammonium Nitrate	C	C	C	C	C	A	A	NS	A	A	A	A
Amyl Chloride	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Aniline, Aniline Oil	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Aqua Regia	NS	NS	NS	NS	NS	A	A	NS	A	NS	NS	NS
Arsenic Acid	A	A	A	A	A	A	A	A	A	A	A	A
Asphalt	A	A	A	NS	NS	A	A	A	A	A	A	A
Aviation Fuels	A	A	A	NS	C	A	A	A	A	A	A	A

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Call GRI™ Technical Services at 1-713-856-9445 for specific recommendations

Sales:

140 Sheree Blvd
P.O. Box 565
Exton, PA 19341-0565

phone. **(866) 707.7300**
phone. **(610) 363.5800**
fax. **(610) 363.5881**
email. **sales@durlon.com**

Technical:

Houston, Texas

phone. **(713) 856.9445**
email. **tech@durlon.com**

joint failure analysis

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CHEMICAL RESISTANCE CHART - B

A - Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG FGL316	FGT316
Baking Soda	A	A	A	A	A	A	A	A	A	A	A	A
Barium Chloride	A	A	A	A	A	A	A	A	A	A	A	A
Beer	A	A	A	A	A	A	A	A	A	A	A	A
Benzaldehyde	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Benzene (Benzol)	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Benzoic Acid	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Benzoyl Chloride	NS	NS	NS	NS	NS	A	A	A	A	C	NS	NS
Benzyl Alcohol	NS	NS	NS	NS	C	A	A	A	A	A	C	C
Benzyl Chloride	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Biodiesel, B100 (methyl esters from oils and fats; RME, FAME)	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Biodiesel Blend, B5 (5% biodiesel / 95% petrodiesel)	A	A	A	C	C	A	A	A	A	A	A	A

Related Links >

CHEMICAL RESISTANCE CHART - A
CHEMICAL RESISTANCE CHART - B
CHEMICAL RESISTANCE CHART - C
CHEMICAL RESISTANCE CHART - D-F
CHEMICAL RESISTANCE CHART - G-L
CHEMICAL RESISTANCE CHART - M-O
CHEMICAL RESISTANCE CHART - P
CHEMICAL RESISTANCE CHART - R
CHEMICAL RESISTANCE CHART - S
CHEMICAL RESISTANCE CHART - T-Z

find it fast >

Chemical Resistance
Product Literature
Gasket Fundamentals

Biodiesel Blend, B20 (20% biodiesel / 80% petrodiesel)	C	C	C	NS	NS	A	A	A	A	A	A	A
Black Sulfate Liquor<350°F	NS	A	A	C	C	A	A	A	A	C	C	C
Black Sulfate Liquor >350°F	NS	C	NS	NS	NS	A	A	A	A	NS	NS	NS
Bleach Solutions	C	A	C	C	C	A	A	A	A	C	NS	NS
Boiler Feed Water	A	A	A	A	A	A	A	A	A	A	A	A
Borax	A	A	A	A	A	A	A	A	A	A	A	A
Boric Acid	A	A	A	A	A	A	A	A	A	A	A	A
Brine	A	A	A	A	A	A	A	A	A	A	C	C
Butadiene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Butane	A	A	A	NS	C	A	A	A	A	A	A	A
2-Butanone	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Butyl Acetate	NS	C	NS	NS	NS	A	A	A	A	A	A	A
Butyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A
n-Butyl Amine	C	C	C	NS	NS	A	A	A	A	A	A	A
tert-Butyl Amine	C	C	C	NS	NS	A	A	A	A	A	A	A
Butyl Methacrylate	NS	NS	NS	NS	NS	A	A	A	A	C	NS	NS
Butylene (butene)	A	A	A	NS	C	A	A	A	A	A	A	A
Butyric Acid	A	A	A	C	C	A	A	A	A	A	A	A

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Technical:

Houston, Texas

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Gasket Resources Inc

CHEMICAL RESISTANCE CHART - C

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Calcium Bisulfite	A	A	A	NS	C	A	A	A	A	A	A	A
Calcium Carbonate	A	A	A	A	A	A	A	A	A	A	A	A
Calcium Chloride	A	A	A	A	A	A	A	A	A	A	A	A
Calcium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A
Calcium Hypochlorite	C	A	C	C	C	A	A	A	A	A	A	A
Calcium Nitrate	C	C	C	C	C	A	A	NS	A	A	A	A
Caprolactam	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
Carbon Dioxide, dry	A	A	A	C	C	A	A	A	A	A	A	A
Carbon Dioxide, wet	A	A	A	C	C	A	A	A	A	A	A	A
Carbon Disulfide	NS	C	NS	NS	NS	A	A	A	A	A	A	A
Carbon Monoxide	A	A	A	NS	NS	A	A	A	A	A	A	A
Carbon Tetrachloride	NS	C	C	NS	NS	A	A	A	A	A	A	A
Caustic Soda (NaOH)	NS	A	C	C	NS	A	A	A	A	C	C	C
Chlorine, gas (dry) *	C	NS	NS	NS	NS	A	A	A	A	A	C	C
Chlorine, liquid (dry) *	NS	NS	NS	NS	NS	A	A	A	A	A	C	C
Chlorine (wet) *	NS	C	NS	NS	NS	A	A	A	A	A	NS	NS
Chlorine Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	C	NS	NS
Chlorobenzene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A

Chloroethane	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Chloroethylene	NS	NS	NS	NS	NS	A	A	A	A	A	C	C
Chloroform	C	A	C	NS	NS	A	A	A	A	A	A	A
Chromic Acid	NS	NS	NS	NS	NS	A	A	NS	A	A	A	A
Citric Acid	A	A	A	A	A	A	A	A	A	A	A	A
Coal Gas	NS	NS	NS	NS	C	A	A	A	A	A	A	A
Copper Sulfate	A	A	A	A	A	A	A	A	A	A	A	A
Corn Oil	A	C	C	NS	C	A	A	A	A	A	A	A
Cotton Seed Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Creosote (Coal Tar)	A	A	A	NS	NS	A	A	A	A	A	A	A
Cresol	C	A	C	NS	NS	A	A	A	A	A	A	A
Crude Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Cumene	NS	NS	NS	NS	C	A	A	A	A	NS	NS	NS
Cyclohexane	A	A	C	NS	C	A	A	A	A	A	A	A
Cyclohexanone	NS	NS	NS	NS	NS	A	A	A	A	A	A	A

* Durlon® 9000/9000N is listed as an acceptable gasket material for dry chlorine service in Pamphlet 95 of The Chlorine Institute. Gaskets must be cleaned for chlorine service before installation.

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Gasket Resources Inc

CHEMICAL RESISTANCE CHART - D-F

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE			FLEXIBLE GRAPHITE			
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Detergent Solutions	A	A	A	A	A	A	A	A	A	A	A	A
Diacetone Alcohol	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Diazomethane	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
Dibenzyl Ether	NS	C	C	NS	NS	A	A	A	A	A	NS	NS
Dibutylamine	C	C	C	NS	C	A	A	A	A	C	C	C
1,4-Dichlorobenzene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
3,3-Dichlorobenzidene	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
Dichlorobenzidene	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
1,1-Dichloroethylene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Dichloroethyl Ether	NS	NS	NS	NS	NS	A	A	A	A	C	NS	NS
Dichloromethane	NS	NS	NS	NS	NS	A	A	A	A	A	NS	NS
Diesel Fuel	A	A	A	C	C	A	A	A	A	A	A	A
Diethyl Carbonate	NS	NS	NS	NS	NS	A	A	A	A	A	NS	NS
Dimethyl Acetamide	NS	C	NS	NS	NS	A	A	A	A	C	C	C
Dimethylformamide (DMF)	NS	C	NS	NS	NS	A	A	A	A	NS	NS	NS
Dioxane	NS	NS	NS	NS	NS	A	A	A	A	A	C	C
Dowtherm A, E	NS	C	C	NS	NS	A	A	A	A	A	A	A
Epichlorohydrin	NS	NS	NS	NS	NS	A	A	A	A	A	C	C

Ethane	A	A	A	C	C	A	A	A	A	A	A	A
Ethyl Acetate	C	C	C	C	NS	A	A	A	A	A	A	A
Ethyl Alcohol (Ethanol)	A	A	A	A	A	A	A	A	A	A	A	A
Ethanol Fuel Blends, E15-E85	A	A	A	NS	C	A	A	A	A	A	A	A
Ethanol + Denaturants												
Saturated Hydrocarbons (gasoline boiling range)	A	A	A	NS	C	A	A	A	A	A	A	A
Raffinate (fuel)	A	A	A	NS	C	A	A	A	A	A	A	A
Benzene	C	C	C	NS	C	A	A	A	A	A	A	A
Naphtha	A	A	A	NS	C	A	A	A	A	A	A	A
Toluene	C	C	C	NS	C	A	A	A	A	A	A	A
Ethylbenzene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Ethylchloride	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Ethylene	A	A	A	NS	C	A	A	A	A	A	A	A
Ethylene Dichloride (EDC)	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Ethylene Glycol	A	A	A	A	A	A	A	A	A	A	A	A
Ethyl Ether	C	C	C	NS	C	A	A	A	A	A	A	A
Ethylene Oxide	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Fatty Acids	A	A	A	NS	C	A	A	A	A	A	A	A
Ferric Chloride	A	A	A	A	A	A	A	A	A	A	NS	NS
Ferrous Chloride	A	A	A	A	A	A	A	A	A	A	NS	NS
Fluorine (Gas, Liquid)	NS	NS	NS	NS	NS	NS	NS	NS	NS	C	NS	NS
Formaldehyde	A	C	A	C	C	A	A	A	A	A	A	A

Formic Acid	NS	NS	NS	C	A	A	A	A	A	A	A	A
Freon (See Refrigerants)	-	-	-	-	-	-	-	-	-	-	-	-
Fuel Oil	A	A	A	NS	C	A	A	A	A	A	A	A

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Gasket Resources Inc

CHEMICAL RESISTANCE CHART - G-L

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Gas – Natural	A	A	A	NS	A	A	A	A	A	A	A	A
Gasoline	A	A	A	NS	NS	A	A	A	A	A	A	A
Glucose	A	A	A	A	A	A	A	A	A	A	A	A
Glycerin (Glycerol)	A	A	A	A	A	A	A	A	A	A	A	A
Green Sulfate Liquor	C	C	C	NS	C	A	A	A	A	C	C	C
Glycol	A	A	A	A	A	A	A	A	A	A	C	C
Heptane	A	A	A	NS	C	A	A	A	A	A	A	A
Hexane	A	A	A	NS	C	A	A	A	A	A	A	A
Hydraulic Oil (mineral)	A	A	A	C	C	A	A	A	A	A	A	A
Hydraulic Oil (phosp. ester)	C	C	C	NS	NS	A	A	A	A	A	A	A
Hydrazine	C	C	C	C	C	A	A	A	A	A	A	A
Hydrochloric Acid, 30%	NS	C	NS	NS	NS	A	A	A	A	A	NS	NS
Hydrochloric Acid, Conc	NS	C	NS	NS	NS	A	A	A	A	A	NS	NS
Hydrofluoric Acid<150°F	NS	NS	NS	NS	NS	NS	A	A	A	A	NS	NS
Hydrofluoric Acid>150°F	NS	NS	NS	NS	NS	NS	NS	A	A	A	NS	NS
Hydrogen	A	A	A	A	A	A	A	A	A	A	A	A
Hydrogen Chloride, (dry)	A	NS	NS	NS	NS	A	A	A	A	A	NS	NS
Hydrogen Fluoride (HF)	NS	NS	NS	NS	NS	NS	NS	A	A	A	NS	NS

Hydrogen Peroxide, 10%	C	C	C	C	C	A	A	A	A	C	C	C
Hydrogen Sulfide (dry)	A	A	C	C	A	A	A	A	A	A	A	A
Hydrogen Sulfide, (wet)	C	C	C	NS	C	A	A	A	A	A	A	A
Hydroquinone	NS	NS	NS	C	NS	A	A	A	A	A	A	A
Iodine	A	A	A	A	NS	A	A	A	A	NS	NS	NS
Isobutane	A	A	A	NS	C	A	A	A	A	A	C	C
Isooctane	A	A	A	NS	C	A	A	A	A	A	A	A
Isopropyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A
Jet Fuel	A	A	A	NS	C	A	A	A	A	A	A	A
Kerosene	A	A	A	NS	C	A	A	A	A	A	A	A
Lacquer Solvents	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Lactic Acid	A	A	A	A	A	A	A	A	A	A	A	A
Linseed Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Lubricating Oil	A	A	A	NS	C	A	A	A	A	A	A	A

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Gasket Resources Inc

CHEMICAL RESISTANCE CHART - M-O

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Magnesium Chloride	A	A	A	A	A	A	A	A	A	A	NS	NS
Magnesium Hydroxide	A	A	A	A	A	A	A	A	A	A	A	A
Magnesium Sulfate	A	A	A	A	A	A	A	A	A	A	A	A
Maleic Acid	A	A	A	C	NS	A	A	A	A	A	A	A
Maleic Anhydride	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
Mercuric Chloride	A	A	A	A	C	A	A	A	A	NS	NS	NS
Mercury	A	A	A	A	A	A	A	A	A	C	C	C
Methane	A	A	A	NS	C	A	A	A	A	A	A	A
Methylacrylic Acid	C	C	C	C	C	A	A	A	A	C	NS	NS
Methyl Alcohol	A	A	A	A	A	A	A	A	A	A	A	A
Methylene Chloride	NS	NS	NS	NS	NS	A	A	A	A	A	NS	NS
Methyl Ethyl Ketone, MEK	C	C	C	NS	C	A	A	A	A	A	A	A
Methyl Isobutyl Ketone	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Methyl Isocyanate	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
Methyl Methacrylate	NS	NS	NS	NS	NS	A	A	A	A	NS	NS	NS
Milk	A	A	A	A	A	A	A	A	A	A	A	A
Mineral Oil	A	A	A	NS	C	A	A	A	A	A	A	A

Muriatic Acid	NS	C	NS	NS	NS	A	A	A	A	A	NS	NS
Naphtha	A	A	A	C	NS	A	A	A	A	A	A	A
Naphthalene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Natural Gas	A	A	A	NS	A	A	A	A	A	A	A	A
Nickel Sulfate	A	A	A	A	A	A	A	A	A	A	A	A
Nitric Acid, < 20%	NS	NS	NS	NS	NS	A	A	NS	A	A	A	A
Nitric Acid, 50%	NS	NS	NS	NS	NS	A	A	NS	A	NS	NS	NS
Nitrogen	A	A	A	A	A	A	A	A	A	A	A	A
Nitrogen Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	NS	NS	NS
Nitrogen Tetroxide	NS	NS	NS	NS	NS	A	A	NS	A	NS	NS	NS
Octane	A	A	A	NS	C	A	A	A	A	A	A	A
Oil, Crude	A	A	A	NS	C	A	A	A	A	A	A	A
Oil, Mineral	A	A	A	NS	C	A	A	A	A	A	A	A
Oleic Acid	C	C	C	NS	C	A	A	A	A	A	A	A
Oleum, fuming H2SO4	NS	NS	NS	NS	NS	A	NS	NS	A	NS	NS	NS
Oxalic Acid	A	A	C	NS	C	A	A	A	A	A	A	A
Oxygen, gas	NS	NS	NS	NS	NS	A	A	A	A	A	NS	A
Oxygen, liquid*	NS	NS	NS	NS	NS	A	A	A	A	A	NS	A
Ozone	NS	NS	NS	NS	NS	A	A	C	A	NS	NS	NS

*Must be cleaned for oxygen before installation.

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This Chemical Resistance Chart supersedes and obsoletes all previously issued charts.

Gasket Resources Inc

CHEMICAL RESISTANCE CHART - P

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Paraffin	A	A	A	C	C	A	A	A	A	A	A	A
Pentane	A	A	A	NS	C	A	A	A	A	A	C	C
Perchloroethylene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Petroleum	A	A	A	NS	C	A	A	A	A	A	A	A
Phenol	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Phosphoric Acid, <40%	C	C	C	NS	C	A	A	A	A	A	C	C
Phthalic Acid	NS	NS	NS	NS	A	A	A	A	A	A	A	A
Phthalic Anhydride	NS	NS	NS	NS	A	A	A	A	A	A	A	A
Polyacrylonitrile	A	A	A	A	A	A	A	A	A	A	A	A
Potash	A	A	A	A	A	A	A	A	A	A	A	A
Potassium Chloride	A	A	A	A	A	A	A	A	A	A	A	A
Potassium Dichromate	A	A	A	C	C	A	A	A	A	A	A	A
Potassium Hydroxide	C	A	C	C	C	A	A	A	A	C	C	C
Potassium Nitrate	C	C	C	C	C	A	A	C	A	A	A	A
Potassium Sulfate	A	A	A	A	A	A	A	A	A	A	A	A
Propane	A	A	A	NS	C	A	A	A	A	A	A	A
Propylene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Pydrauls, Skydrols	C	C	C	NS	NS	A	A	A	A	C	C	C

Pyridine	NS	NS	NS	NS	NS	A	A	A	A	A	A	A

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Call GRI Technical Services at 1-713-856-9445 for specific recommendations

Gasket Resources Inc

CHEMICAL RESISTANCE CHART - R

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Red Sulfite Liquor	NS	NS	NS	NS	NS	A	A	A	A	C	C	C
Red Sulfite Liquor>380°F	NS	NS	NS	NS	NS	C	C	C	C	NS	NS	NS
Refrigerant R-11 **	A	A	A	NS	NS	A	A	A	A	A	A	A
Refrigerant R-12 **	A	A	A	C	A	A	A	A	A	A	C	C
Refrigerant R-22 **	C	C	C	C	A	A	A	A	A	A	A	A
Refrigerant R-113 **	A	A	A	C	A	A	A	A	A	C	C	C
Refrigerant HCFC 123 **	NS	C	C	NS	C	A	A	A	A	-	-	-
Refrigerant HCFC 124 *	NS	C	C	NS	A	A	A	A	A	-	-	-
Refrigerant HFC 125 *	C	C	C	NS	A	A	A	A	A	-	-	-
Refrigerant HFC 134a *	A	A	A	C	A	A	A	A	A	-	-	-
Refrigerant HCFC 141b	A	A	A	NS	A	A	A	A	A	-	-	-
Refrigerant HFC 236fa	A	A	A	NS	A	A	A	A	A	-	-	-
Refrigerant Blend HP 62*	A	A	A	NS	A	A	A	A	A	-	-	-
Refrigerant Blend HP 80	C	C	C	NS	A	A	A	A	A	-	-	-
Refrigerant Blend HP 81	C	C	C	NS	A	A	A	A	A	-	-	-
Refrigerant Blend 404a*	A	A	A	NS	A	A	A	A	A	-	-	-

* With Polyol Ester Oil ** With Mineral Oil

The properties or applications shown are typical. Your specific application should not be undertaken without independent study and evaluation for suitability. For specific application recommendations or for unusual conditions of fluid

Gasket Resources Inc

CHEMICAL RESISTANCE CHART - S

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE			FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Sea Water	A	A	A	A	A	A	A	A	A	A	NS	NS
Silver Nitrate	C	A	C	C	C	A	A	A	A	A	A	A
Soap Solutions	A	A	A	A	A	A	A	C	A	A	A	A
Soda Ash	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Bicarbonate	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Bisulfite	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Carbonate	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Chloride	A	A	A	A	A	A	A	A	A	A	A	A
Sodium Hydroxide	C	A	C	C	NS	A	A	A	A	C	C	C
Sodium Hypochlorite	NS	NS	NS	C	C	A	A	C	A	C	NS	NS
Sodium Nitrate	A	A	A	C	C	A	A	A	A	C	C	C
Sodium Silicate	A	A	A	A	A	A	A	A	A	A	C	C
Sodium Sulfate	A	A	A	A	A	A	A	A	A	A	A	A
Sour Crude Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Soybean Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Steam, Saturated to 150 psig	A	A	A	C	C	A	A	A	A	A	A	A
Steam, Superheated	NS	NS	NS	NS	NS	NS	NS	NS	NS	A	A	A

Stearic Acid	A	A	A	C	A	A	A	A	A	A	A	A
Stoddard Solvent	A	A	A	NS	C	A	A	A	A	A	A	A
Styrene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Sulfite Liquors	C	A	C	C	C	A	A	A	A	A	C	C
Sulfur (molten)	C	C	C	NS	C	A	A	A	A	A	A	A
Sulfur Dioxide	NS	C	NS	NS	NS	A	A	A	A	A	A	A
Sulfuric Acid, 20%	C	NS	NS	NS	NS	A	A	A	A	A	NS	NS
Sulfuric Acid, Conc	NS	NS	NS	NS	NS	A	C	A	A	NS	NS	NS
Sulfuric Acid,Conc>200°F	NS	NS	NS	NS	NS	A	NS	NS	A	NS	NS	NS
FumingSulfuric Acid, Oleum	NS	NS	NS	NS	NS	A	NS	NS	A	NS	NS	NS

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Call GRI Technical Services at 1-713-856-9445 for specific recommendations

Gasket Resources Inc
CHEMICAL RESISTANCE CHART - T-Z

A -Acceptable
C - Caution, depends on operating conditions
NS - Not Suitable

	COMPRESSED					PTFE				FLEXIBLE GRAPHITE		
FLUID	8300	8400	79XX 8500	8600	8700	9000	9200W	9400	9600	FGS95	CFG, FGL316	FGT316
Tar	A	A	A	C	C	A	A	A	A	A	A	A
Tetrachloroethane	C	C	C	NS	NS	A	A	A	A	A	A	A
Tetrahydrofuran (THF)	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Toluene	NS	NS	NS	NS	C	A	A	A	A	A	A	A
Transformer Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Transmission Fluid	A	A	A	NS	C	A	A	A	A	A	A	A
1,1,2-Trichloroethane	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Trichloroethylene	C	C	C	NS	NS	A	A	A	A	A	A	A
Triethanolamine	C	C	C	C	A	A	A	A	A	C	C	C
Turpentine	A	A	A	NS	C	A	A	A	A	A	A	A
Urea	A	A	A	A	A	A	A	A	A	A	A	A
Varsol	A	A	A	NS	NS	A	A	A	A	A	A	A
Vegetable Oil	A	A	A	NS	C	A	A	A	A	A	A	A
Vinegar	A	A	A	C	A	A	A	A	A	A	A	A
Vinyl Acetate	C	C	C	NS	C	A	A	A	A	A	A	A
Vinyl Chloride	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Water	A	A	A	A	A	A	A	A	A	A	A	A
Whiskey and Wines	A	A	A	A	A	A	A	A	A	A	A	A

White Sulfate Liquor	A	A	A	A	A	A	A	A	A	A	A	A
White Spirit	A	A	A	C	C	A	A	A	A	A	A	A
Xylene	NS	NS	NS	NS	NS	A	A	A	A	A	A	A
Zinc Chloride	A	A	A	A	A	A	A	A	A	A	A	A
Zinc Nitrate	C	C	C	C	C	A	A	C	A	A	C	C
Zinc Sulfate	A	A	A	A	A	A	A	A	A	A	A	A

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Roller Cut Sheet

(OMC)

EnSol, Inc.

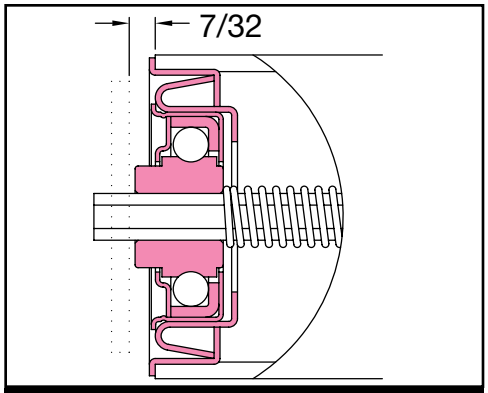
STRAIGHT ROLLERS

3 1/2 in. O.D. x 7 Ga. Rollers

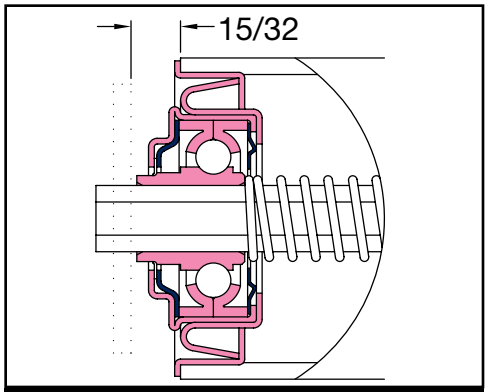
Roller Part Number		Tube Material	Axle	Drive Options	Bearing Part Number
Spring Retained	Pin Retained				
45262	45263	Mild Steel	7/16 Hex	Gravity	45173-GP
28540	28541	Mild Steel	5/8 Hex	Gravity	45207-GP
13948	13947	Mild Steel	11/16 Hex	Gravity	31439
44882	44883	Mild Steel	11/16 Hex	Gravity	44881-GP
Upon Request	40810	Mild Steel	11/16 Hex	Gravity	45208-GP
Upon Request	45260	Mild Steel	3/4 Dia.	Gravity	45171-GP

Roller Capacity Chart (lbs.)*

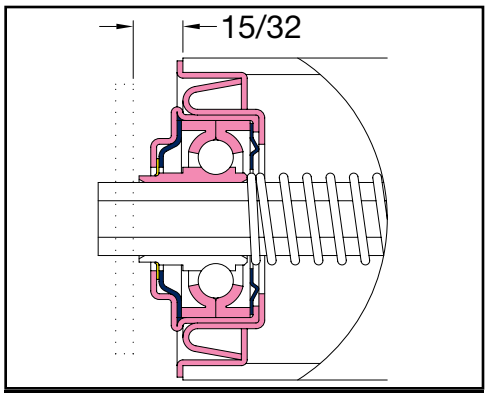
Between Frame (BF) Inches	Bearing Part Number				
	45173-GP	45207-GP	31439 45208-GP	44881-GP	45171-GP
6	504	847	847	1997	847
12	499	844	844	1994	844
18	394	841	841	1991	841
24	282	838	838	1906	838
30	212	719	835	1491	834
36	163	578	831	1208	831
42	125	474	714	998	828
48	93	393	599	832	825
54	66	326	504	695	804
60	41	268	424	576	684
66	N/A	217	354	470	580
72	N/A	170	291	373	485
78	N/A	126	232	282	399
84	N/A	84	177	196	318
90	N/A	44	125	111	241
96	N/A	N/A	74	N/A	167
102	N/A	N/A	N/A	N/A	95
108	N/A	N/A	N/A	N/A	N/A
114	N/A	N/A	N/A	N/A	N/A
120	N/A	N/A	N/A	N/A	N/A
126	N/A	N/A	N/A	N/A	N/A
132	N/A	N/A	N/A	N/A	N/A
138	N/A	N/A	N/A	N/A	N/A
144	N/A	N/A	N/A	N/A	N/A



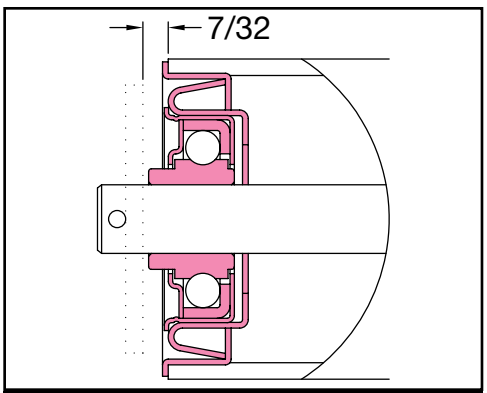
45173-GP Unground Press Fit



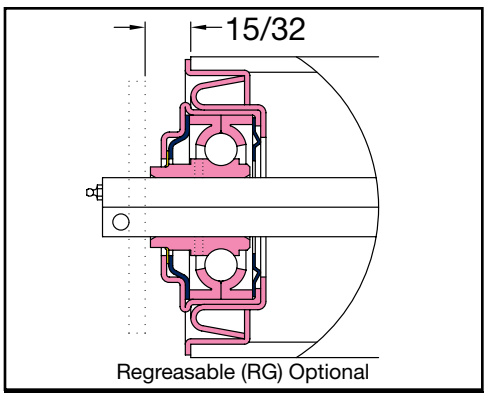
45207-GP Unground Press Fit



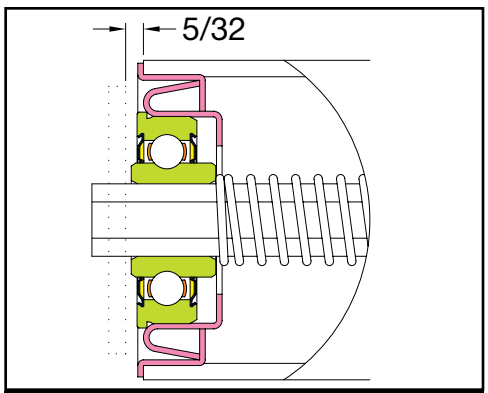
31439 Unground Press Fit



45171-GP Unground Press Fit



45208-GP Unground Press Fit



44881-GP All Metal Precision

*The dimension above include 1/16" clearance between the extension on the bearing and the side frame at each end.

***Larger Between Frames and higher capacities may be achieved with a center support puck.**
***Roller Between Frame lengths available between values shown in the table.**
***Roller Between Frames can be shorter than values shown utilizing pin retention.**

Standard Part Numbering System

Example: 27369 - 17
Roller Part Number | BF

Unground | Unground Stainless Steel | Semi-Precision | Semi-Precision Stainless Steel | Precision | Precision Stainless Steel | Plastic | Seals | Shields | Ball Retainer (Cage) | Keeper Bar

Rupture Disk

(BS & B)

EnSol, Inc.

BS&B SAFETY SYSTEMS, L.L.C.
BS&B SAFETY SYSTEMS LTD

SAF-T-GRAF

Saf-T-Graf graphite disks are impermeable to process gases and fluids

SAF-T-GRAF® FEATURES

- Offers superior sealing characteristics to process gases and fluids
- Corrosion resistant (except free fluorine)
- Burst pressures from 0.02 bar (0.25 psig) to 69 bar (1000 psig)
- Higher operating temperature than other impregnated graphite disks up to 205°C (400°F)
- Full bore opening
- Sizes from 15 to 600 mm (0.5" to 24" and larger)
- Extended service life for operating pressures up to 80% of the disk marked pressure in a static environment - Lower operating ratios can be expected in a cyclic environment
- Suitable for gas service and liquid service
- Supplied with gaskets attached for immediate installation.
- Resists full vacuum (vacuum support required below 1.52 bar (22 psig) burst pressure)
- Optional PTFE coating to reduce product build-up
- Graphite impregnation is environmentally safe
- Patent pending
- ASME code, UD stamp above 15 psig (1.03barg) available

SAF-T-GRAF® System

Armor

Armor is recommended for all graphite disks for added safety, easier installation and elimination of breakage during installation. Armor reduces the possibility of a premature burst due to uneven or excessive torqueing of the flange studs.

Armor is standard on disks with burst pressures in excess of 150 psig or to fit ANSI Class 300/600 flanges. Carbon steel armor is standard with 304/316 Stainless Steel as an option.

Saf-T-Graf monobloc impregnated graphite disks. Vacuum supports are designed utilizing the latest computer software to maximize venting capacities while maintaining structural strength. Armor ring around disk's circumference shown left.

Disks for Immediate Shipment

In order to provide the best possible service, BS&B stocks monobloc disks in the following sizes: 25, 40, 50, 80, 100, 150 and 200 mm (1", 1.5", 2", 3", 4", 6", 8").
Stocked Burst Pressures:
10-15-20-25-30-40-50-75-100-125-150 psig
All disks must be for 150 ANSI flange ratings.

Flange Ratings

Saf-T-Graf disks can be supplied to fit flange ratings ANSI, DIN, JIS, BS, AFNOR etc. Please specify flange rating when ordering

Gaskets

BS&B Safety Systems, L.L.C. stocks gaskets in the materials below:

- Garlock® or Klinger®-Sil (standard)

Optional Materials:

- GRAFOIL®
- Neoprene
- PTFE solid

Please specify your gasket material when ordering.

Sensors

A GAS™ (Graphite Alert Sensor) is available to provide warning of a burst graphite disk

Installations

The Saf-T-Graf disk is designed to permit direct installation between ANSI, DIN, JIS, BS, AFNOR pipe flanges and to locate between the flange bolts.

Operating Ratio

Up to 80% operating pressure to burst pressure ratio in a static environment. Lower operating ratios can be expected in a cyclic environment.

Monobloc

Model MBV (with bar) and MB.

Model MB™

Monobloc disks fit most applications where a graphite disk is needed.

When using a monobloc disk in application:

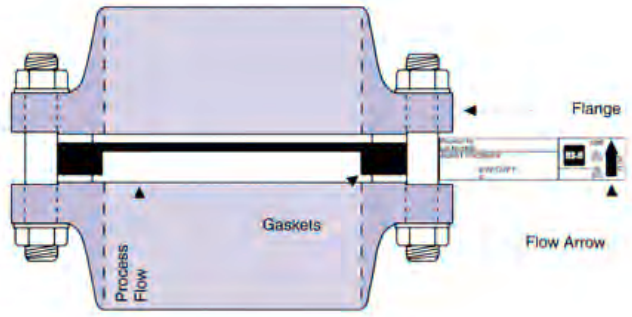
- Vacuum supports are needed for disks rated below 1.52 bar (22 psig) and where a vacuum condition exists. Model MBVTM.
- Vacuum supports are not needed for sizes 15 and 20 mm (0.5", .75").
- Temperature ranges -730 C to 205ºC (-100ºF to 400ºF).
- Armoring is recommended for all graphite disks for added safety, easier installation and elimination of breakage during installation
- Armor reduces the possibility of a premature burst due to uneven or excessive torqueing of the flange studs

MB™ Specifications

Nominal Size		Burst Ratings Barg		Burst Ratings PSIG		Internal Diameter		Disk Thickness	
mm	in	Min	Max	Min	Max	mm	in	mm	in
15	0.5	1.73	10.3	25	150	15.9	0.625	16	0.625
20	0.75	1.73	10.3	25	150	21	0.825	16	0.625
25	1	0.69	10.3	10	150	27.2	1.07	22	0.875
40	1.5	0.49	10.3	7	150	41.1	1.62	22	0.875
50	2	0.14	10.3	2	150	52.6	2.07	22	0.875
80	3	0.069	10.3	1	150	78.0	3.07	22	0.875
100	4	0.069	10.3	1	150	103.4	4.07	22	0.875
150	6	0.069	10.3	1	150	154.2	6.07	22	0.875
200	8	0.035	10.3	0.5	150	205.0	8.07	29	1.125
250	10	0.0173	8.6	0.25	125	255.8	10.07	38	1.50
300	12	0.0173	8.6	0.25	125	306.6	12.07	51	2.00
350	14	0.0173	6.89	0.25	100	336.5	13.25	57	2.25
400	16	0.0173	6.89	0.25	100	387.4	15.25	64	2.50
450	18	0.0173	6.89	0.25	100	438.2	17.25	70	2.75
500	20	0.0173	3.4	0.25	50	489.0	19.25	76	3.00
600	24	0.0173	3.4	0.25	50	590.6	23.25	76	3.00

For other disk thickness, contact BS&B Safety Systems, L.L.C. or BS&B Safety Systems LTD.

MB



MB monobloc disks are available in size from 15mm to 600 mm (0.5" to 24") with a temperature range to 205º C (400ºF).

(For Venting Capacities Chart please refer to page 5.)

Inverted Monobloc

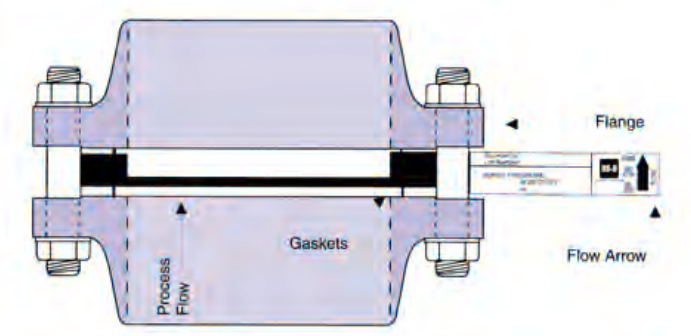
Model IMB™

Inverted monobloc disks are available to fit ANSI Class 150, Class 300 and Class 600 flanges.

When using an inverted monobloc disk in application:

- If a vacuum support is required, Model MBV™ disks must be specified.
- Temperature ranges -73°C to 200°C (-100°F to +400°F.)
- Armoring is recommended for all graphite disks for adde safety, easier installation and elimination of breakage during installation.
- Armor reduces the possibility of a premature burst due to uneven or excessive torqueing of the flange studs.

IMB



Inverted monobloc disks are supplied for ANSI Class 150, Class 300 and Class 600 flanges and in higher burst pressures than Model MB disks.

(For Venting Capacities Chart please refer to page 5.)

IMB Specifications

Nominal Size		Burst Ratings Barg		Burst Ratings PSIG		Internal Diameter		Disk Thickness	
mm	in	Min	Max	Min	Max	mm	in	mm	in
15	0.5	1.73	17.2	25	250	15.9	0.625	16	0.625
20	0.75	1.73	17.2	25	250	21.0	0.825	16	0.625
25	1	0.69	17.2	10	250	27.2	1.07	22	0.875
40	1.5	0.49	17.2	7	250	41.1	1.62	22	0.875
50	2	0.21	17.2	3	250	52.6	2.07	22	0.875
80	3	0.14	17.2	2	250	78.0	3.07	22	0.875
100	4	0.104	17.2	1.5	250	103.4	4.07	22	0.875
150	6	0.069	11.7	1	170	154.2	6.07	22	0.875
200	8	0.035	11.7	0.5	170	205.0	8.07	29	1.125
250	10	0.0173	10.3	0.25	150	255.8	10.07	38	1.50
300	12	0.0173	10.3	0.25	150	306.6	12.07	51	2.00
350	14	0.0173	10.3	0.25	150	336.5	13.25	57	2.25
400	16	0.0173	10.3	0.25	150	387.4	15.25	64	2.50
450	18	0.0173	10.3	0.025	150	438.2	17.25	70	2.75
500	20	0.0173	10.3	0.25	150	489.0	19.25	76	3.00
600	24	0.0173	10.3	0.25	150	590.6	23.25	76	3.00
15	0.5	1.73	68.9	25	1000	15.9	0.625	16	0.625
20	0.75	1.73	68.9	25	1000	21.0	0.825	16	0.625
25	1	0.69	68.9	10	1000	27.2	1.07	25	1.00
40	1.5	0.49	68.9	7	1000	41.1	1.62	25	1.00
50	2	0.21	34.4	3	500	52.6	2.07	25	1.00
80	3	0.14	34.4	2	500	78.0	3.07	32	1.25
100	4	0.10	34.4	1.5	500	103.4	4.07	32	1.25
150	6	0.069	31	1	450	154.2	6.07	44	1.75
200	8	0.035	31	0.5	450	205.0	8.07	57	2.25

For other disk thickness, contact BS&B Safety Systems, L.L.C. or BS&B Safety Systems LTD.

Inverted Monobloc with Liner

Model IMBL™

Inverted monobloc with liner extends corrosion resistance and resists product build-up with the use of a PTFE liner.

When using an inverted monobloc disk with liner in application:

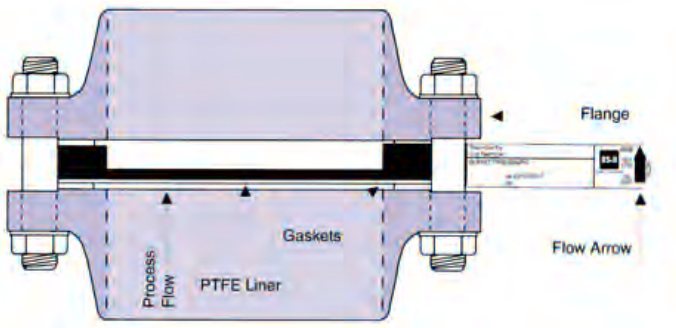
- If a vacuum support is required, Model MBV™ disks must be specified; with PTFE coating if required.
- Temperature ranges -73° C to 205° C (-100°F to 400°F).
- Armoring is recommended for all graphite disks for added safety, easier installation and elimination of breakage during installation
- Armor reduces the possibility of a premature burst due to uneven or excessive torqueing of the flange studs
- Corrosion resistant (except free fluorine)

IMBL Specifications

Nominal Size		Burst Ratings Barg		PSIG		Internal Diameter		Disk Thickness	
mm	in	Min	Max	Min	Max	mm	in	mm	in
15	0.5	1.73	17.2	25	250	15.9	0.625	16	0.625
20	0.75	1.73	17.2	25	250	21.0	0.825	16	0.625
25	1	0.69	17.2	10	250	27.2	1.07	22	0.875
40	1.5	0.49	17.2	7	250	41.1	1.62	22	0.875
50	2	0.21	17.2	3	250	52.6	2.07	22	0.875
80	3	0.14	17.2	2	250	78.0	3.07	22	0.875
100	4	0.104	17.2	1.5	250	103.4	4.07	22	0.875
150	6	0.069	11.7	1	170	154.2	6.07	22	0.875
200	8	0.035	11.7	0.5	170	205.0	8.07	29	1.125
250	10	0.0173	10.3	0.25	150	255.8	10.07	38	1.50
300	12	0.0173	10.3	0.25	150	306.6	12.07	51	2.00
350	14	0.0173	10.3	0.25	150	336.5	13.25	57	2.25
400	16	0.0173	10.3	0.25	150	387.4	15.25	64	2.50
450	18	0.0173	10.3	0.25	150	438.2	17.25	70	2.75
500	20	0.0173	10.3	0.25	150	489.0	19.25	76	3.00
600	24	0.0173	10.3	0.25	150	590.6	23.23	76	3.00
15	0.5	1.73	68.9	25	1000	15.9	0.625	16	0.625
20	0.75	1.73	68.9	25	1000	21.0	0.825	16	0.625
25	1	0.69	68.9	10	1000	27.0	1.07	25	1.00
40	1.5	0.49	68.9	7	1000	41.1	1.62	25	1.00
50	2	0.21	34.4	3	500	52.6	2.07	25	1.00
80	3	0.14	34.4	2	500	78.0	3.07	32	1.25
100	4	0.104	34.54	1.5	500	103.4	4.07	32	1.25
150	6	0.069	31	1	450	154.2	6.07	44	1.75
200	8	0.035	31	0.5	450	205.0	8.07	57	2.25

For other disk thickness, contact BS&B Safety Systems, L.L.C. or BS&B Safety Systems LTD.

IMBL



Inverted monobloc disks with liner extends corrosion resistance to practically all corrosives except free fluorine.

(For Venting Capacities Chart please refer to page 5.)

Venting Capacities

Venting capacities are expressed below in standard cubic feet per minute of air x 1000 at standard conditions. Adjustments must be made when utilizing vacuum supports.

Vacuum Example: An 8" Monobloc disk @ 10 psig utilizing a bar type of vacuum support, reduces the original capacity by a factor of .80 . Example: 19.5 x .80 = 15.6 x 1000 SCFM air

Venting capacities are based upon ASME VIII UG 131, using a 0.62 coefficient of discharge*, ratio of specific heats of 1.4 and a "Z" (compressibility) of 1.0 which simulates an entry into a vent system from a process vessel. Below 15 psig the flow becomes subcritical and appropriate corrections have been made to the venting capacities (calculated according to API guidelines).

Alternately the low K_R values for graphite disks can be used for the determination of vent system campacity. This may permit the use of a smaller size of graphite disk.

Disk Diameter (in/mm)

Burst Rating psig	1/2 15	3/4 20	1 25	1 1/2 40	2 50	3 80	4 100	6 150	8 200	10 250	12 300	14 350	16 400	18 450	20 500	24 600
1/4	-	-	-	-	-	-	-	-	-	3.71	5.34	7.26	9.49	12.0	14.8	21.3
1/2	-	-	-	-	-	-	-	-	3.35	5.24	7.54	10.3	13.4	16.9	20.9	30.2
1	-	-	-	-	-	0.666	1.18	2.66	4.73	7.40	10.7	14.5	18.9	24.0	29.6	42.6
1 1/2	-	-	-	-	-	0.814	1.45	3.26	5.79	9.05	13.0	17.7	23.2	29.3	36.2	52.1
2	-	-	-	-	0.417	0.939	1.67	3.76	6.68	10.4	15.0	20.4	26.7	33.8	41.7	60.1
3	-	-	-	-	0.510	1.15	2.04	4.59	8.15	12.7	18.3	24.9	32.6	41.3	50.9	73.4
4	-	-	-	-	0.587	1.32	2.35	5.28	9.39	14.7	21.1	28.8	37.6	47.5	58.7	84.5
5	-	-	-	-	0.655	1.47	2.62	5.89	10.5	16.4	23.6	32.0	41.9	53.0	65.5	94.3
6	-	-	-	-	0.715	1.61	2.86	6.44	11.4	17.9	25.7	35.0	45.8	57.9	71.5	103
7	-	-	-	0.433	0.771	1.73	3.08	6.93	12.3	19.3	27.7	37.8	49.3	62.4	77.0	111
8	-	-	-	0.462	0.822	1.85	3.29	7.39	13.1	20.5	29.6	40.3	52.6	66.6	82.2	118
9	-	-	-	0.489	0.869	1.96	3.48	7.82	13.9	21.7	31.3	42.6	55.6	70.4	86.9	125
10	-	-	0.229	0.514	0.914	2.06	3.66	8.23	14.6	22.9	32.9	44.8	58.5	74.0	91.4	132
15	-	-	0.279	0.627	1.11	2.51	4.46	10.0	17.8	27.8	40.1	54.6	71.3	90.2	111	160
20	-	-	0.328	0.737	1.31	2.95	5.24	11.8	21.0	32.8	47.2	64.2	83.9	106	131	189
25	0.0942	0.212	0.377	0.848	1.51	3.39	6.03	13.6	24.1	37.7	54.2	73.8	96.4	122	151	217
30	0.106	0.240	0.426	0.958	1.70	3.83	6.81	15.3	27.2	42.6	61.3	83.5	109	138	170	245
40	0.131	0.295	0.524	1.18	2.40	4.72	8.38	18.9	33.5	52.4	75.4	103	134	170	210	302
50	0.156	0.350	0.622	1.40	2.49	5.60	9.95	22.4	39.8	62.2	89.6	122	159	202	249	358
75	0.217	0.488	0.868	1.95	3.47	7.81	13.9	31.2	55.5	86.8	125	170	222	281	347	500
100	0.278	0.626	1.11	2.50	4.45	10.0	17.8	40.1	71.2	111	160	218	285	361	445	641
125	0.340	0.764	1.36	3.06	5.43	12.2	21.7	48.9	86.9	136	196	266	348	440	543	783
150	0.410	0.902	1.60	3.61	6.42	14.4	25.7	57.7	103	160	231	314	411	520	642	924
175	0.462	1.04	1.85	4.16	7.40	16.6	29.6	66.6	118	-	-	-	-	-	-	-
200	0.524	1.18	2.09	4.71	8.38	18.9	33.5	75.4	134	-	-	-	-	-	-	-
225	0.585	1.32	2.34	5.27	9.36	21.1	37.4	84.3	150	-	-	-	-	-	-	-
250	0.647	1.45	2.59	5.82	10.3	23.3	41.4	93.1	165	-	-	-	-	-	-	-
275	0.708	1.59	2.83	6.37	11.3	25.5	45.3	102	181	-	-	-	-	-	-	-
300	0.769	1.73	3.08	6.92	12.3	27.7	49.2	111	197	-	-	-	-	-	-	-
350	0.892	2.01	3.57	8.03	14.3	32.1	57.1	128	228	-	-	-	-	-	-	-
400	1.01	2.28	4.06	9.13	16.2	36.5	64.9	146	260	-	-	-	-	-	-	-
450	1.14	2.56	4.55	10.2	18.2	40.9	72.8	164	291	-	-	-	-	-	-	-
500	1.26	2.84	5.04	11.3	20.2	45.4	80.6	-	-	-	-	-	-	-	-	-
1000	2.49	5.60	9.95	22.4	-	-	-	-	-	-	-	-	-	-	-	-

Vacuum Support Factors

Dial Type: to 9 psig (0.62 bar) Bar Type: 10psig (0.69 bar) - 22psig (1.52bar)

SIZE	1/2	3/4	1	1 1/2	2	3	4	6	8	10	12	14	16	18	20	24
Dial Type	-	-	-	.56	.57	.60	.62	.58	.60	.60	.60	.60	.60	.60	.60	.60
Bar Type	-	-	.70	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80	.80

To be used for direct discharge to the atmosphere, disk installation eight diameters from vessel nozzle entry, length of discharge pipe 5 pipe diameters, nominal diameter of inlet and discharge piping the NPS designation of the device.

Ordering Specifications

Disk Types

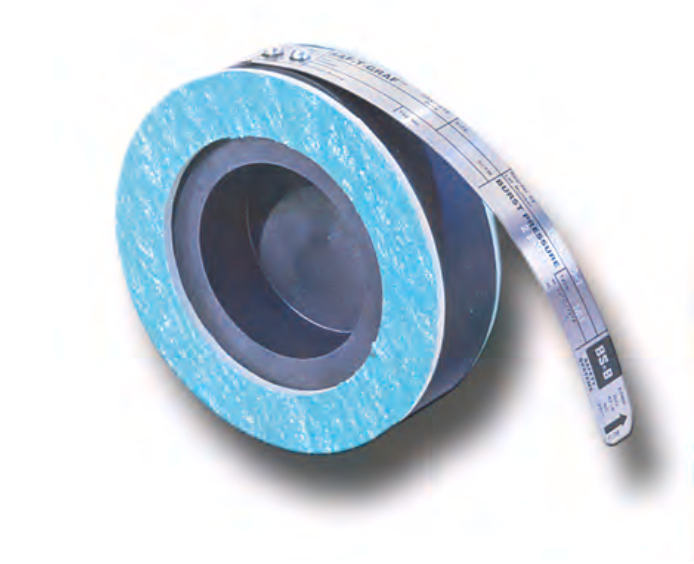
	Model
Monobloc	MB™
Monobloc with vacuum support	MBV™
Armored Monobloc	AMB™
Armored Monobloc with vacuum support	AMBV™
Inverted Monobloc	IMB™
Armored Inverted Monobloc	AIMB™
Inverted Monobloc with liner	IMBL™
Armored Inverted Monobloc with liner	AIMBL™
Armored Monobloc with High Temperature Assembly	AMB-HTA™
Armored Inverted Monobloc with High Temperature Assembly	AIMB-HTA™

1/2 to 24 inches, (15mm to 600) larger sizes available upon request.

Burst Pressures

- 0.017 bar (0.25 psig) to 69 bar (1000 psig)
- Burst pressures vary depending on disk style and size. Please consult MB, IMB, and IMBL specification charts.

For burst pressures outside the standard range consult BS&B Safety Systems, L.L.C. or BS&B Safety Systems LTD.



Vacuum Support

Vacuum support is required on pressures less than 1.52 bar (22 psig) and where a vacuum condition exists, available on Model MBV or AMBV. Vacuum supports are not required on 15mm and 20mm (0.5" and .75") monobloc disks.

Corrosion Resistance

The Saf-T-Graf® line offers excellent corrosion resistance (except free fluorine). The IMBL has a PTFE liner fitted to the process side of the disk for extra protection against corrosion and prevention of product build-up.

Gaskets

- Rupture disks are supplied with gaskets, in materials, Klinger®-Sil (standard), Garlock®, GRAFOIL®.
- Optional materials include: PTFE, Neoprene.

Flange Rating

Graphite monobloc disks are available to fit all standard international flanges ANSI, DIN, BS, AFNOR, JIS etc.

Armor

- Carbon steel or 304/316 Stainless Steel (option)
- Armor is recommended for added safety, easier installation and elimination of breakage during installation. Armor reduces the possibility of a premature burst due to uneven or excessive torqueing of the flange studs.
- Armor is highly recommended in sizes and with burst pressures in excess of the following:

SIZE	BURST PRESSURE	
0.5" (15mm) -3" (80mm)	10.341 barg	150 psig
4" (100mm)	6.894 barg	100 psig
6" (150mm) - 10" (250mm)	5.17 barg	75 psig
12" (300mm) - 24" (600mm)	3.447 barg	50 psig

- Armoring minimizes the possiblity of lateral bursts inherent in standard monobloc graphite disks.

Temperature

- -100°F (-73°C) to 400°F (205°C). Higher temperatures to 800°F (427°C) are accommodated using a High Temperature Assembly used with armored disks (The High Temperature Assemblies are not to be used with model AMBV disk (disks with vacuum support).

Consult BS&B Safety Systems, L.L.C. or BS&B Safety Systems LTD.

- If a disk is ordered with a burst temperature within 40°F (4.5°C) to 100°F (38°C), it will be burst tested and rated at 72° F (22°C).
- If the requested burst temperature is outside of 40°F (4.5°C) to 100°F (38°C) burst tests will be carried out at the actual burst temperature (at no additional charge) and not estimated using a correction coefficient.

(ASME or other international standards certification at additional cost).

Burst Tolerance

The burst tolerance is the maximum variation from the marked burst pressure.

MARKED BURST PRESSURE	TOLERANCE
*less than 0.07 bar (1 psig)	-0/+0.052 bar (0.75 psig)
0.07 bar (1 psig) - 1.03 bar (15 psig)	+/-0.052 bar (0.75 psig)
above 1.03 bar (15 psig)	+/-5%

Example, if a Saf-T-Graf MB type disk is ordered with a 2 bar (29 psig) burst pressure, it will burst between 1.9 bar (27.5 psig) and 2.1 bar (30.5 psig).

** For reduced tolerances contact BS&B Safety Systems, L.L.C. or BS&B Safety Systems LTD.*

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E-mail: sales@bsb-systems.co.uk

Appendix D

Carbon Effluent Analytical Laboratory Test Results

EnSol, Inc.

1550 Balmer Road
Model City, NY 14107
716-286-1550 Phone
716-286-0326 Fax

19 March 2013

Mark Zappy
Aqueous Treatment
1550 Balmer Road
Model City, NY 14107

RE: X00481
Work Order(s): 1302092
Work Order(s): 1303001
Work Order(s): 1303020

CERTIFICATES

NYSDOH LAB ID No.: 11383
U.S. EPA LAB CODE: NY01252

CWM Chemical Services, LLC. **Reported:** **03/19/13 07:08**

Client: Aqueous Treatment

Work Order(s): 1302092

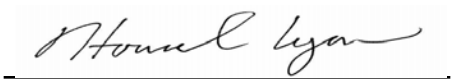
ANALYTICAL REPORT FOR SAMPLES

LabSample ID	Client Sample ID	Matrix	Date Sampled	Date Received
1302092-01	TK 58 QUALIFIER	Aqueous	02/21/13 05:00	02/21/13 09:00
1302092-02	TK 58 QUALIFIER, GRAB	Aqueous	02/21/13 09:00	02/21/13 09:00
1303001-01	TK 125 QUALIFIER	Aqueous	02/28/13 15:00	03/01/13 06:30
1303001-02	TK 125 QUALIFIER, GRAB	Aqueous	02/28/13 18:00	03/01/13 06:30
1303020-01	TK 58 MONTHLY QUALIFIER	Aqueous	03/05/13 07:00	03/05/13 09:00
1303020-02	TK 58 MONTHLY QUALIFIER, GRAE	Aqueous	03/05/13 09:00	03/05/13 09:00

All Quality Control associated with these samples met EPA or laboratory specifications unless noted.

The enclosed analytical results are representative of the sample as received by the laboratory. CWM Chemical Services Laboratory makes no representations or certifications as to the methods of sample collection, sample identification, or transportation handling procedures used prior to our receipt of samples. This report is intended for the sole use and benefit of Waste Management and it's companies. No representation concerning significance of the reported data is made to any person or entity. To the best of my knowledge, the information contained in this report is accurate and complete. All pages of this report are integral parts of the analytical data. Therefore, this report should be reproduced only in its entirety.

According to Sample Collection Requirements for Non-Potable Water located in the ELAP Certification Manual, pH analysis is required within 15 minutes of sample collection. Analysis is generally not completed within 15 minutes, but as soon as possible after laboratory receipt.

Approved By: 

Title: QA/QC Coordinator

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/21/13 05:00
Work Order:	1302092	Project #:	CWM	Received:	02/21/13 09:00
Lab Sample ID:	1302092-01	Client Sample ID:	TK 58 QUALIFIER		Aqueous

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
COD Screen							
Chemical Oxygen Demand	**430**		100	mg/L	03/05/13	CJN	SM 5220D
Cyanide, Total							
Cyanide (Total)	**0.0902**		0.0125	mg/L	03/04/13	LD	EPA 9014
pH by 4500-H B							
pH	**7.97**			pH Units	02/21/13	CJN	SM 4500 H+B
Volatiles - Aqueous							
Chloromethane	ND		10.0	ug/L	02/21/13	LD	EPA 8260C
Vinyl chloride	ND		10.0	"	"	LD	"
Bromomethane	ND		10.0	"	"	LD	"
Chloroethane	ND		10.0	"	"	LD	"
Trichlorofluoromethane	ND		10.0	"	"	LD	"
Diethyl ether	ND		10.0	"	"	LD	"
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		10.0	"	"	LD	"
Acetone	ND		10.0	"	"	LD	"
1,1-Dichloroethene	ND		10.0	"	"	LD	"
Methylene chloride	ND		10.0	"	"	LD	"
Carbon disulfide	ND		10.0	"	"	LD	"
trans-1,2-Dichloroethene	ND		10.0	"	"	LD	"
1,1-Dichloroethane	ND		10.0	"	"	LD	"
Vinyl acetate	ND		10.0	"	"	LD	"
2-Butanone	ND		10.0	"	"	LD	"
Ethyl acetate	ND		10.0	"	"	LD	"
Chloroform	ND		10.0	"	"	LD	"
1,1,1-Trichloroethane	ND		10.0	"	"	LD	"
Carbon tetrachloride	ND		10.0	"	"	LD	"
1,2-Dichloroethane	ND		10.0	"	"	LD	"
Benzene	ND		10.0	"	"	LD	"
Trichloroethene	ND		10.0	"	"	LD	"
1,2-Dichloropropane	ND		10.0	"	"	LD	"
Bromodichloromethane	ND		10.0	"	"	LD	"
2-Chloroethylvinyl ether	ND		10.0	"	"	LD	"
4-Methyl-2-pentanone	ND		10.0	"	"	LD	"
cis-1,3-Dichloropropene	ND		10.0	"	"	LD	"
Toluene	ND		10.0	"	"	LD	"
trans-1,3-Dichloropropene	ND		10.0	"	"	LD	"
1,1,2-Trichloroethane	ND		10.0	"	"	LD	"
2-Hexanone	ND		10.0	"	"	LD	"
Tetrachloroethene	ND		10.0	"	"	LD	"
Dibromochloromethane	ND		10.0	"	"	LD	"
Chlorobenzene	ND		10.0	"	"	LD	"
Ethylbenzene	ND		10.0	"	"	LD	"
Xylenes, total	ND		30.0	"	"	LD	"
Styrene	ND		10.0	"	"	LD	"
Bromoform	ND		10.0	"	"	LD	"
1,1,2,2-Tetrachloroethane	ND		10.0	"	"	LD	"
1,3-Dichlorobenzene	ND		10.0	"	"	LD	"

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/21/13 05:00
Work Order:	1302092	Project #:	CWM	Received:	02/21/13 09:00
Lab Sample ID:	1302092-01	Client Sample ID:	TK 58 QUALIFIER		Aqueous

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
1,4-Dichlorobenzene	ND		10.0	ug/L	02/21/13	LD	EPA 8260C
1,2-Dichlorobenzene	ND		10.0	"	"	LD	"
Surrogate: 1,2-Dichloroethane-d4	*114 %*		*85-118*		"	LD	"
Surrogate: Toluene-d8	*105 %*		*85-115*		"	LD	"
Surrogate: 4-Bromofluorobenzene	*96.5 %*		*85-115*		"	LD	"
Metals Total 200.7							
Silver	ND		0.0100	ug/mL	02/21/13	AAC	EPA 200.7 Rev 4.4
Arsenic	**0.0852**		0.0500	"	"	AAC	"
Barium	**0.179**		0.0500	"	"	AAC	"
Beryllium	ND		0.0200	"	"	AAC	"
Cadmium	ND		0.0100	"	"	AAC	"
Cobalt	**0.00615**	J	0.0500	"	"	AAC	"
Chromium	**0.0121**	J	0.0500	"	"	AAC	"
Copper	ND		0.0500	"	"	AAC	"
Iron	**0.477**		0.0500	"	"	AAC	"
Manganese	**0.246**		0.0500	"	"	AAC	"
Molybdenum	**0.168**		0.0500	"	"	AAC	"
Nickel	**0.0893**		0.0500	"	"	AAC	"
Lead	ND		0.0500	"	"	AAC	"
Antimony	ND		0.0500	"	"	AAC	"
Selenium	**0.0114**	J	0.0500	"	"	AAC	"
Tin	ND		0.0200	"	"	AAC	"
Titanium	ND		0.0200	"	"	AAC	"
Thallium	ND		0.0500	"	"	AAC	"
Vanadium	**0.00723**	J	0.0500	"	"	AAC	"
Zinc	**0.0201**	J	0.0500	"	"	AAC	"

CWM Chemical Services, LLC. **Reported: 03/19/13 07:08**

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/21/13 05:00
Work Order:	1302092	Project #:	CWM	Received:	02/21/13 09:00
Lab Sample ID:	1302092-01	Client Sample ID:	TK 58 QUALIFIER	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Mercury - Total 245.1							
Mercury	ND	REC	0.300	ug/L	03/18/13	AJL	245.1 Rev. 3.0

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/21/13 09:00
Work Order:	1302092	Project #:	CWM	Received:	02/21/13 09:00
Lab Sample ID:	1302092-02	Client Sample ID:	TK 58 QUALIFIER, GRAB	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Cyanide, Total							
Cyanide (Total)	**0.122**		0.0125	mg/L	03/04/13	LD	EPA 9014
Volatiles - Aqueous							
Chloromethane	ND		10.0	ug/L	02/21/13	LD	EPA 8260C
Vinyl chloride	ND		10.0	"	"	LD	"
Bromomethane	ND		10.0	"	"	LD	"
Chloroethane	ND		10.0	"	"	LD	"
Trichlorofluoromethane	ND		10.0	"	"	LD	"
Diethyl ether	ND		10.0	"	"	LD	"
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		10.0	"	"	LD	"
Acetone	ND		10.0	"	"	LD	"
1,1-Dichloroethene	ND		10.0	"	"	LD	"
Methylene chloride	ND		10.0	"	"	LD	"
Carbon disulfide	ND		10.0	"	"	LD	"
trans-1,2-Dichloroethene	ND		10.0	"	"	LD	"
1,1-Dichloroethane	ND		10.0	"	"	LD	"
Vinyl acetate	ND		10.0	"	"	LD	"
2-Butanone	ND		10.0	"	"	LD	"
Ethyl acetate	ND		10.0	"	"	LD	"
Chloroform	ND		10.0	"	"	LD	"
1,1,1-Trichloroethane	ND		10.0	"	"	LD	"
Carbon tetrachloride	ND		10.0	"	"	LD	"
1,2-Dichloroethane	ND		10.0	"	"	LD	"
Benzene	ND		10.0	"	"	LD	"
Trichloroethene	ND		10.0	"	"	LD	"
1,2-Dichloropropane	ND		10.0	"	"	LD	"
Bromodichloromethane	ND		10.0	"	"	LD	"
2-Chloroethylvinyl ether	ND		10.0	"	"	LD	"
4-Methyl-2-pentanone	ND		10.0	"	"	LD	"
cis-1,3-Dichloropropene	ND		10.0	"	"	LD	"
Toluene	ND		10.0	"	"	LD	"
trans-1,3-Dichloropropene	ND		10.0	"	"	LD	"
1,1,2-Trichloroethane	ND		10.0	"	"	LD	"
2-Hexanone	ND		10.0	"	"	LD	"
Tetrachloroethene	ND		10.0	"	"	LD	"
Dibromochloromethane	ND		10.0	"	"	LD	"
Chlorobenzene	ND		10.0	"	"	LD	"
Ethylbenzene	ND		10.0	"	"	LD	"
Xylenes, total	ND		30.0	"	"	LD	"
Styrene	ND		10.0	"	"	LD	"
Bromoform	ND		10.0	"	"	LD	"
1,1,2,2-Tetrachloroethane	ND		10.0	"	"	LD	"
1,3-Dichlorobenzene	ND		10.0	"	"	LD	"
1,4-Dichlorobenzene	ND		10.0	"	"	LD	"
1,2-Dichlorobenzene	ND		10.0	"	"	LD	"
Surrogate: 1,2-Dichloroethane-d4	*112 %*		*85-118*		*"*	LD	*"*
Surrogate: Toluene-d8	*103 %*		*85-115*		*"*	LD	*"*
Surrogate: 4-Bromofluorobenzene	*94.7 %*		*85-115*		*"*	LD	*"*

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/28/13 15:00
Work Order:	1303001	Project #:	CWM	Received:	03/01/13 06:30
Lab Sample ID:	1303001-01	Client Sample ID:	TK 125 QUALIFIER		Aqueous

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
COD Screen							
Chemical Oxygen Demand	**337**		100	mg/L	03/13/13	CJN	SM 5220D
Cyanide, Total							
Cyanide (Total)	**0.0767**		0.0125	mg/L	03/04/13	LD	EPA 9014
pH by 4500-H B							
pH	**8.66**			pH Units	03/01/13	CJN	SM 4500 H+B
Volatiles - Aqueous							
Chloromethane	ND		10.0	ug/L	03/04/13	LD	EPA 8260C
Vinyl chloride	ND		10.0	"	"	LD	"
Bromomethane	ND		10.0	"	"	LD	"
Chloroethane	ND		10.0	"	"	LD	"
Trichlorofluoromethane	ND		10.0	"	"	LD	"
Diethyl ether	ND		10.0	"	"	LD	"
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		10.0	"	"	LD	"
Acetone	ND		10.0	"	"	LD	"
1,1-Dichloroethene	ND		10.0	"	"	LD	"
Methylene chloride	ND		10.0	"	"	LD	"
Carbon disulfide	ND		10.0	"	"	LD	"
trans-1,2-Dichloroethene	ND		10.0	"	"	LD	"
1,1-Dichloroethane	ND		10.0	"	"	LD	"
Vinyl acetate	ND		10.0	"	"	LD	"
2-Butanone	ND		10.0	"	"	LD	"
Ethyl acetate	ND		10.0	"	"	LD	"
Chloroform	ND		10.0	"	"	LD	"
1,1,1-Trichloroethane	ND		10.0	"	"	LD	"
Carbon tetrachloride	ND		10.0	"	"	LD	"
1,2-Dichloroethane	ND		10.0	"	"	LD	"
Benzene	ND		10.0	"	"	LD	"
Trichloroethene	ND		10.0	"	"	LD	"
1,2-Dichloropropane	ND		10.0	"	"	LD	"
Bromodichloromethane	ND		10.0	"	"	LD	"
2-Chloroethylvinyl ether	ND		10.0	"	"	LD	"
4-Methyl-2-pentanone	ND		10.0	"	"	LD	"
cis-1,3-Dichloropropene	ND		10.0	"	"	LD	"
Toluene	ND		10.0	"	"	LD	"
trans-1,3-Dichloropropene	ND		10.0	"	"	LD	"
1,1,2-Trichloroethane	ND		10.0	"	"	LD	"
2-Hexanone	ND		10.0	"	"	LD	"
Tetrachloroethene	ND		10.0	"	"	LD	"
Dibromochloromethane	ND		10.0	"	"	LD	"
Chlorobenzene	ND		10.0	"	"	LD	"
Ethylbenzene	ND		10.0	"	"	LD	"
Xylenes, total	ND		30.0	"	"	LD	"
Styrene	ND		10.0	"	"	LD	"
Bromoform	ND		10.0	"	"	LD	"
1,1,2,2-Tetrachloroethane	ND		10.0	"	"	LD	"
1,3-Dichlorobenzene	ND		10.0	"	"	LD	"

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/28/13 15:00
Work Order:	1303001	Project #:	CWM	Received:	03/01/13 06:30
Lab Sample ID:	1303001-01	Client Sample ID:	TK 125 QUALIFIER		Aqueous

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
1,4-Dichlorobenzene	ND		10.0	ug/L	03/04/13	LD	EPA 8260C
1,2-Dichlorobenzene	ND		10.0	"	"	LD	"
Surrogate: 1,2-Dichloroethane-d4	*108 %*		*85-120*		"	LD	"
Surrogate: Toluene-d8	*105 %*		*85-115*		"	LD	"
Surrogate: 4-Bromofluorobenzene	*99.9 %*		*85-115*		"	LD	"
Metals Total 200.7							
Silver	ND		0.0100	ug/mL	03/01/13	AAC	EPA 200.7 Rev 4.4
Arsenic	**0.111**		0.0500	"	"	AAC	"
Barium	**0.236**		0.0500	"	"	AAC	"
Beryllium	ND		0.0200	"	"	AAC	"
Cadmium	ND		0.0100	"	"	AAC	"
Cobalt	**0.00537**	J	0.0500	"	"	AAC	"
Chromium	**0.00768**	J	0.0500	"	"	AAC	"
Copper	ND		0.0500	"	"	AAC	"
Iron	**0.121**		0.0500	"	"	AAC	"
Manganese	**0.218**		0.0500	"	"	AAC	"
Molybdenum	**0.225**		0.0500	"	"	AAC	"
Nickel	**0.0625**		0.0500	"	"	AAC	"
Lead	ND		0.0500	"	"	AAC	"
Antimony	**0.0117**	J	0.0500	"	"	AAC	"
Selenium	**0.0237**	J	0.0500	"	"	AAC	"
Tin	ND		0.0200	"	"	AAC	"
Titanium	ND		0.0200	"	"	AAC	"
Thallium	ND		0.0500	"	"	AAC	"
Vanadium	**0.0324**	J	0.0500	"	"	AAC	"
Zinc	**0.0178**	J	0.0500	"	"	AAC	"

CWM Chemical Services, LLC. **Reported: 03/19/13 07:08**

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/28/13 15:00
Work Order:	1303001	Project #:	CWM	Received:	03/01/13 06:30
Lab Sample ID:	1303001-01	Client Sample ID:	TK 125 QUALIFIER		Aqueous

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Mercury - Total 245.1							
Mercury	ND		0.300	ug/L	03/18/13	AJL	245.1 Rev. 3.0

Client:	Aqueous Treatment	Project:	X00481	Sampled:	02/28/13 18:00
Work Order:	1303001	Project #:	CWM	Received:	03/01/13 06:30
Lab Sample ID:	1303001-02	Client Sample ID:	TK 125 QUALIFIER, GRAB	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Cyanide, Total							
Cyanide (Total)	**0.0988**		0.0125	mg/L	03/04/13	LD	EPA 9014
Volatiles - Aqueous							
Chloromethane	ND		10.0	ug/L	03/04/13	LD	EPA 8260C
Vinyl chloride	ND		10.0	"	"	LD	"
Bromomethane	ND		10.0	"	"	LD	"
Chloroethane	ND		10.0	"	"	LD	"
Trichlorofluoromethane	ND		10.0	"	"	LD	"
Diethyl ether	ND		10.0	"	"	LD	"
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		10.0	"	"	LD	"
Acetone	ND		10.0	"	"	LD	"
1,1-Dichloroethene	ND		10.0	"	"	LD	"
Methylene chloride	ND		10.0	"	"	LD	"
Carbon disulfide	ND		10.0	"	"	LD	"
trans-1,2-Dichloroethene	ND		10.0	"	"	LD	"
1,1-Dichloroethane	ND		10.0	"	"	LD	"
Vinyl acetate	ND		10.0	"	"	LD	"
2-Butanone	ND		10.0	"	"	LD	"
Ethyl acetate	ND		10.0	"	"	LD	"
Chloroform	ND		10.0	"	"	LD	"
1,1,1-Trichloroethane	ND		10.0	"	"	LD	"
Carbon tetrachloride	ND		10.0	"	"	LD	"
1,2-Dichloroethane	ND		10.0	"	"	LD	"
Benzene	ND		10.0	"	"	LD	"
Trichloroethene	ND		10.0	"	"	LD	"
1,2-Dichloropropane	ND		10.0	"	"	LD	"
Bromodichloromethane	ND		10.0	"	"	LD	"
2-Chloroethylvinyl ether	ND		10.0	"	"	LD	"
4-Methyl-2-pentanone	ND		10.0	"	"	LD	"
cis-1,3-Dichloropropene	ND		10.0	"	"	LD	"
Toluene	ND		10.0	"	"	LD	"
trans-1,3-Dichloropropene	ND		10.0	"	"	LD	"
1,1,2-Trichloroethane	ND		10.0	"	"	LD	"
2-Hexanone	ND		10.0	"	"	LD	"
Tetrachloroethene	ND		10.0	"	"	LD	"
Dibromochloromethane	ND		10.0	"	"	LD	"
Chlorobenzene	ND		10.0	"	"	LD	"
Ethylbenzene	ND		10.0	"	"	LD	"
Xylenes, total	ND		30.0	"	"	LD	"
Styrene	ND		10.0	"	"	LD	"
Bromoform	ND		10.0	"	"	LD	"
1,1,2,2-Tetrachloroethane	ND		10.0	"	"	LD	"
1,3-Dichlorobenzene	ND		10.0	"	"	LD	"
1,4-Dichlorobenzene	ND		10.0	"	"	LD	"
1,2-Dichlorobenzene	ND		10.0	"	"	LD	"
Surrogate: 1,2-Dichloroethane-d4	*109 %*		*85-120*		*"*	LD	*"*
Surrogate: Toluene-d8	*106 %*		*85-115*		*"*	LD	*"*
Surrogate: 4-Bromofluorobenzene	*99.1 %*		*85-115*		*"*	LD	*"*

Client:	Aqueous Treatment	Project:	X00481	Sampled:	03/05/13 07:00
Work Order:	1303020	Project #:	CWM	Received:	03/05/13 09:00
Lab Sample ID:	1303020-01	Client Sample ID:	TK 58 MONTHLY QUALIFIER	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
COD Screen							
Chemical Oxygen Demand	**383**		100	mg/L	03/13/13	CJN	SM 5220D
Cyanide, Total							
Cyanide (Total)	**0.0728**		0.0125	mg/L	03/12/13	LD	EPA 9014
pH by 4500-H B							
pH	**8.01**			pH Units	03/05/13	CJN	SM 4500 H+B
Sulfide by Test Kit							
Sulfide	ND		0.100	mg/L	03/05/13	CJN	MC-229
Volatiles - Aqueous							
Chloromethane	ND		10.0	ug/L	03/05/13	LD	EPA 8260C
Vinyl chloride	ND		10.0	"	"	LD	"
Bromomethane	ND		10.0	"	"	LD	"
Chloroethane	ND		10.0	"	"	LD	"
Trichlorofluoromethane	ND		10.0	"	"	LD	"
Diethyl ether	ND		10.0	"	"	LD	"
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		10.0	"	"	LD	"
Acetone	ND		10.0	"	"	LD	"
1,1-Dichloroethene	ND		10.0	"	"	LD	"
Methylene chloride	ND		10.0	"	"	LD	"
Carbon disulfide	ND		10.0	"	"	LD	"
trans-1,2-Dichloroethene	ND		10.0	"	"	LD	"
1,1-Dichloroethane	ND		10.0	"	"	LD	"
Vinyl acetate	ND		10.0	"	"	LD	"
2-Butanone	ND		10.0	"	"	LD	"
Ethyl acetate	ND		10.0	"	"	LD	"
Chloroform	ND		10.0	"	"	LD	"
1,1,1-Trichloroethane	ND		10.0	"	"	LD	"
Carbon tetrachloride	ND		10.0	"	"	LD	"
1,2-Dichloroethane	ND		10.0	"	"	LD	"
Benzene	ND		10.0	"	"	LD	"
Trichloroethene	ND		10.0	"	"	LD	"
1,2-Dichloropropane	ND		10.0	"	"	LD	"
Bromodichloromethane	ND		10.0	"	"	LD	"
2-Chloroethylvinyl ether	ND		10.0	"	"	LD	"
4-Methyl-2-pentanone	ND		10.0	"	"	LD	"
cis-1,3-Dichloropropene	ND		10.0	"	"	LD	"
Toluene	ND		10.0	"	"	LD	"
trans-1,3-Dichloropropene	ND		10.0	"	"	LD	"
1,1,2-Trichloroethane	ND		10.0	"	"	LD	"
2-Hexanone	ND		10.0	"	"	LD	"
Tetrachloroethene	ND		10.0	"	"	LD	"
Dibromochloromethane	ND		10.0	"	"	LD	"
Chlorobenzene	ND		10.0	"	"	LD	"
Ethylbenzene	ND		10.0	"	"	LD	"
Xylenes, total	ND		30.0	"	"	LD	"
Styrene	ND		10.0	"	"	LD	"
Bromoform	ND		10.0	"	"	LD	"

Client:	Aqueous Treatment	Project:	X00481	Sampled:	03/05/13 07:00
Work Order:	1303020	Project #:	CWM	Received:	03/05/13 09:00
Lab Sample ID:	1303020-01	Client Sample ID:	TK 58 MONTHLY QUALIFIER	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
1,1,2,2-Tetrachloroethane	ND		10.0	ug/L	03/05/13	LD	EPA 8260C
1,3-Dichlorobenzene	ND		10.0	"	"	LD	"
1,4-Dichlorobenzene	ND		10.0	"	"	LD	"
1,2-Dichlorobenzene	ND		10.0	"	"	LD	"
Surrogate: 1,2-Dichloroethane-d4	*106 %*		*85-120*		*"*	LD	*"*
Surrogate: Toluene-d8	*102 %*		*85-115*		*"*	LD	*"*
Surrogate: 4-Bromofluorobenzene	*101 %*		*85-115*		*"*	LD	*"*
Metals Total 200.7							
Silver	ND		0.0100	ug/mL	03/05/13	AAC	EPA 200.7 Rev 4.4
Arsenic	**0.175**		0.0500	"	"	AAC	"
Barium	**0.111**		0.0500	"	"	AAC	"
Beryllium	ND		0.0200	"	"	AAC	"
Cadmium	ND		0.0100	"	"	AAC	"
Cobalt	**0.00913**	J	0.0500	"	"	AAC	"
Chromium	**0.00639**	J	0.0500	"	"	AAC	"
Copper	ND		0.0500	"	"	AAC	"
Iron	**0.255**		0.0500	"	"	AAC	"
Manganese	**0.205**		0.0500	"	"	AAC	"
Molybdenum	**0.0798**		0.0500	"	"	AAC	"
Nickel	**0.0774**		0.0500	"	"	AAC	"
Lead	ND		0.0500	"	"	AAC	"
Antimony	ND		0.0500	"	"	AAC	"
Selenium	ND		0.0500	"	"	AAC	"
Tin	ND		0.0200	"	"	AAC	"
Titanium	ND		0.0200	"	"	AAC	"
Thallium	ND		0.0500	"	"	AAC	"
Vanadium	**0.00932**	J	0.0500	"	"	AAC	"
Zinc	**0.102**		0.0500	"	"	AAC	"

CWM Chemical Services, LLC. **Reported: 03/19/13 07:08**

Client:	Aqueous Treatment	Project:	X00481	Sampled:	03/05/13 07:00
Work Order:	1303020	Project #:	CWM	Received:	03/05/13 09:00
Lab Sample ID:	1303020-01	Client Sample ID:	TK 58 MONTHLY QUALIFIER	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Mercury - Total 245.1							
Mercury	ND		0.300	ug/L	03/18/13	AJL	245.1 Rev. 3.0

Client:	Aqueous Treatment	Project:	X00481	Sampled:	03/05/13 09:00
Work Order:	1303020	Project #:	CWM	Received:	03/05/13 09:00
Lab Sample ID:	1303020-02	Client Sample ID:	TK 58 MONTHLY QUALIFIER, GRAB	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Cyanide, Total							
Cyanide (Total)	**0.0814**		0.0125	mg/L	03/12/13	LD	EPA 9014
Sulfide by Test Kit							
Sulfide	ND		0.100	mg/L	03/05/13	CJN	MC-229
Volatiles - Aqueous							
Chloromethane	ND		10.0	ug/L	03/05/13	LD	EPA 8260C
Vinyl chloride	ND		10.0	"	"	LD	"
Bromomethane	ND		10.0	"	"	LD	"
Chloroethane	ND		10.0	"	"	LD	"
Trichlorofluoromethane	ND		10.0	"	"	LD	"
Diethyl ether	ND		10.0	"	"	LD	"
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		10.0	"	"	LD	"
Acetone	ND		10.0	"	"	LD	"
1,1-Dichloroethene	ND		10.0	"	"	LD	"
Methylene chloride	ND		10.0	"	"	LD	"
Carbon disulfide	ND		10.0	"	"	LD	"
trans-1,2-Dichloroethene	ND		10.0	"	"	LD	"
1,1-Dichloroethane	ND		10.0	"	"	LD	"
Vinyl acetate	ND		10.0	"	"	LD	"
2-Butanone	ND		10.0	"	"	LD	"
Ethyl acetate	ND		10.0	"	"	LD	"
Chloroform	ND		10.0	"	"	LD	"
1,1,1-Trichloroethane	ND		10.0	"	"	LD	"
Carbon tetrachloride	ND		10.0	"	"	LD	"
1,2-Dichloroethane	ND		10.0	"	"	LD	"
Benzene	ND		10.0	"	"	LD	"
Trichloroethene	ND		10.0	"	"	LD	"
1,2-Dichloropropane	ND		10.0	"	"	LD	"
Bromodichloromethane	ND		10.0	"	"	LD	"
2-Chloroethylvinyl ether	ND		10.0	"	"	LD	"
4-Methyl-2-pentanone	ND		10.0	"	"	LD	"
cis-1,3-Dichloropropene	ND		10.0	"	"	LD	"
Toluene	ND		10.0	"	"	LD	"
trans-1,3-Dichloropropene	ND		10.0	"	"	LD	"
1,1,2-Trichloroethane	ND		10.0	"	"	LD	"
2-Hexanone	ND		10.0	"	"	LD	"
Tetrachloroethene	ND		10.0	"	"	LD	"
Dibromochloromethane	ND		10.0	"	"	LD	"
Chlorobenzene	ND		10.0	"	"	LD	"
Ethylbenzene	ND		10.0	"	"	LD	"
Xylenes, total	ND		30.0	"	"	LD	"
Styrene	ND		10.0	"	"	LD	"
Bromoform	ND		10.0	"	"	LD	"
1,1,2,2-Tetrachloroethane	ND		10.0	"	"	LD	"
1,3-Dichlorobenzene	ND		10.0	"	"	LD	"
1,4-Dichlorobenzene	ND		10.0	"	"	LD	"
1,2-Dichlorobenzene	ND		10.0	"	"	LD	"
Surrogate: 1,2-Dichloroethane-d4	*110 %*		*85-120*		*"*	LD	*"*

CWM Chemical Services, LLC. **Reported: 03/19/13 07:08**

Client:	Aqueous Treatment	Project:	X00481	Sampled:	03/05/13 09:00
Work Order:	1303020	Project #:	CWM	Received:	03/05/13 09:00
Lab Sample ID:	1303020-02	Client Sample ID:	TK 58 MONTHLY QUALIFIER, GRAB	Aqueous	

Analyte	Result	Notes	Reporting Limit	Units	Analyzed	Analyst	Method
Surrogate: Toluene-d8	*105 %*		*85-115*		*03/05/13*	LD	*EPA 8260C*
Surrogate: 4-Bromofluorobenzene	*97.6 %*		*85-115*		*"*	LD	*"*

Notes and Definitions

REC	Recovery of MS/MSD was outside quality control limits. Matrix interference is suspected.
J	Indicates an estimated value. The data indicates the presence of an analyte above the MDL but below the reporting limit.
ND	Analyte NOT DETECTED at or above the reporting limit
dry	Sample results reported on a dry weight basis

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(800) 848-4983 ♦ (518) 434-4546 ♦ Fax (518) 434-0891

March 19, 2013

Jonathan Rizzo
CWM Chemical Services, Inc.
1550 Balmer Road
Model City, NY 14107

TEL: (716) 754-0233
FAX: (716) 286-0337

Work Order No: 130306017
PO#: L957-2045-329

RE: Tank Effluent
Monthly Tank Qualifier

Dear Jonathan Rizzo:

Adirondack Environmental Services, Inc received 1 sample on 3/6/2013 for the analyses presented in the following report.

Please see case narrative for specifics on analysis.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

ELAP#: 10709

Christopher Hess
QA Manager

Adirondack Environmental Services, Inc — CASE NARRATIVE

CLIENT:	CWM Chemical Services, Inc.	**Date:**	*19-Mar-13*
Project:	Tank Effluent		
Lab Order:	130306017		

Sample containers were supplied by Adirondack Environmental Services.

Qualifiers:

- ND - Not Detected at reporting limit
- J - Analyte detected below quantitation limit
- B - Analyte detected in Blank
- X - Exceeds maximum contamination limit
- H - Hold time exceeded
- S - LCS Spike recovery outside acceptable limits
- R - Duplication outside acceptable limits
- T - Tentatively Identified Compound-Estimated
- E -Above quantitation range-Estimated
- M - Matrix Spike outside acceptable limits
- C - Details are above in Case Narrative

Note : All Results are reported as wet weight unless noted

Adirondack Environmental Services, Inc

Date: *19-Mar-13*

CLIENT: CWM Chemical Services, Inc.
Work Order: 130306017
Reference: Tank Effluent / Monthly Tank Qualifier
PO#: L957-2045-329

Client Sample ID: 130302001 Tk 58 Monthly Qual
Collection Date: 3/5/2013
Lab Sample ID: 130306017-001
Matrix: WASTEWATER

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
POLYCHLORINATED BIPHENYLS E608 (**Prep: SW3535 - 3/6/2013**)						Analyst: **KF**
Aroclor 1016	< 0.065	0.065		µg/L	1	3/6/2013 4:54:12 PM
Aroclor 1221	< 0.065	0.065		µg/L	1	3/6/2013 4:54:12 PM
Aroclor 1232	< 0.065	0.065		µg/L	1	3/6/2013 4:54:12 PM
Aroclor 1242	0.052	0.065	J	µg/L	1	3/6/2013 4:54:12 PM
Aroclor 1248	< 0.065	0.065		µg/L	1	3/6/2013 4:54:12 PM
Aroclor 1254	0.221	0.065		µg/L	1	3/6/2013 4:54:12 PM
Aroclor 1260	0.070	0.065		µg/L	1	3/6/2013 4:54:12 PM
Surr: Decachlorobiphenyl	51.0	48.1-152		%REC	1	3/6/2013 4:54:12 PM
SEMI-VOLATILE ORGANICS E625 (**Prep: SW3510/E625 - 3/8/2013**)						Analyst: **MT**
Azobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Benzothiazole	< 10	10		µg/L	1	3/13/2013 5:40:00 PM
Hexamethylbenzene	< 10	10		µg/L	1	3/13/2013 5:40:00 PM
n-decane	< 10	10		µg/L	1	3/13/2013 5:40:00 PM
n-Octadecane	< 10	10		µg/L	1	3/13/2013 5:40:00 PM
Phenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Bis(2-chloroethyl)ether	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2-Chlorophenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
1,3-Dichlorobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
1,4-Dichlorobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
1,2-Dichlorobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2-Methylphenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Bis(2-chloroisopropyl)ether	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
4-Methylphenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
N-Nitrosodi-n-propylamine	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Hexachloroethane	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Nitrobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Isophorone	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2-Nitrophenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2,4-Dimethylphenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Bis(2-chloroethoxy)methane	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2,4-Dichlorophenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
1,2,4-Trichlorobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Naphthalene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Hexachlorobutadiene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
4-Chloro-3-methylphenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2-Methylnaphthalene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Hexachlorocyclopentadiene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2,4,6-Trichlorophenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM

Adirondack Environmental Services, Inc

Date: *19-Mar-13*

CLIENT: CWM Chemical Services, Inc.
Work Order: 130306017
Reference: Tank Effluent / Monthly Tank Qualifier
PO#: L957-2045-329

Client Sample ID: 130302001 Tk 58 Monthly Qual
Collection Date: 3/5/2013
Lab Sample ID: 130306017-001
Matrix: WASTEWATER

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
SEMI-VOLATILE ORGANICS E625						Analyst: **MT**
(Prep: SW3510/E625 - 3/8/2013)						
2,4,5-Trichlorophenol	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2-Chloronaphthalene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Dimethyl phthalate	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Acenaphthylene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2,6-Dinitrotoluene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Acenaphthene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2,4-Dinitrophenol	< 25	25		µg/L	1	3/13/2013 5:40:00 PM
4-Nitrophenol	< 25	25		µg/L	1	3/13/2013 5:40:00 PM
Dibenzofuran	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
2,4-Dinitrotoluene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Diethyl phthalate	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
4-Chlorophenyl phenyl ether	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Fluorene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
4,6-Dinitro-2-methylphenol	< 25	25		µg/L	1	3/13/2013 5:40:00 PM
N-Nitrosodiphenylamine	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
4-Bromophenyl phenyl ether	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Hexachlorobenzene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Pentachlorophenol	< 20	20		µg/L	1	3/13/2013 5:40:00 PM
Phenanthrene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Anthracene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Carbazole	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Di-n-butyl phthalate	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Fluoranthene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Pyrene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Butyl benzyl phthalate	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
3,3'-Dichlorobenzidine	< 10	10		µg/L	1	3/13/2013 5:40:00 PM
Benzidine	< 25	25		µg/L	1	3/13/2013 5:40:00 PM
Benz(a)anthracene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Chrysene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Bis(2-ethylhexyl)phthalate	110	10		µg/L	2	3/14/2013 12:26:00 PM
Di-n-octyl phthalate	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Benzo(b)fluoranthene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Benzo(k)fluoranthene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Benzo(a)pyrene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Indeno(1,2,3-cd)pyrene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Dibenz(a,h)anthracene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Benzo(g,h,i)perylene	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
N-Nitrosodimethylamine	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Pyridine	< 5.0	5.0		µg/L	1	3/13/2013 5:40:00 PM
Surr: 2,4,6-Tribromophenol	40.5	17-120		%REC	2	3/14/2013 12:26:00 PM

Adirondack Environmental Services, Inc

Date: *19-Mar-13*

CLIENT: CWM Chemical Services, Inc.
Work Order: 130306017
Reference: Tank Effluent / Monthly Tank Qualifier
PO#: L957-2045-329

Client Sample ID: 130302001 Tk 58 Monthly Qual
Collection Date: 3/5/2013
Lab Sample ID: 130306017-001
Matrix: WASTEWATER

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed
SEMI-VOLATILE ORGANICS E625						Analyst: **MT**
(Prep: SW3510/E625 - 3/8/2013)						
Surr: 2,4,6-Tribromophenol	**48.2**	17-120		%REC	1	3/13/2013 5:40:00 PM
Surr: 2-Fluorobiphenyl	**53.2**	34.9-134		%REC	2	3/14/2013 12:26:00 PM
Surr: 2-Fluorobiphenyl	**58.5**	34.9-134		%REC	1	3/13/2013 5:40:00 PM
Surr: 2-Fluorophenol	**18.6**	13.5-105	J	%REC	2	3/14/2013 12:26:00 PM
Surr: 2-Fluorophenol	**19.8**	13.5-105		%REC	1	3/13/2013 5:40:00 PM
Surr: 4-Terphenyl-d14	**60.8**	41-132		%REC	2	3/14/2013 12:26:00 PM
Surr: 4-Terphenyl-d14	**71.9**	41-132		%REC	1	3/13/2013 5:40:00 PM
Surr: Nitrobenzene-d5	**50.1**	36.9-116		%REC	2	3/14/2013 12:26:00 PM
Surr: Nitrobenzene-d5	**52.4**	36.9-116		%REC	1	3/13/2013 5:40:00 PM
Surr: Phenol-d5	**22.6**	5.2-93		%REC	1	3/13/2013 5:40:00 PM
Surr: Phenol-d5	**19.6**	5.2-93	J	%REC	2	3/14/2013 12:26:00 PM

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CHAIN OF CUSTODY RECORD

AES Work Order # 1303060017

A full service analytical research laboratory offering solutions to environmental concerns

Client Name: Waste Management	Address: 1550 Balmer Road, Model City, NY 14107	
Send Report To: Jonathan Bass	Project Name (Location) ~~Area~~ Monthly Tank Quality	Samplers: (Names) Chris Nisco ST 10
Client Phone No:	Client Email:	PO Number:

Samplers: (Signature)

AES Sample Number	Client Sample Identification & Location	Date Sampled	Time A=a.m. P=p.m.	Sample Type: Matrix	Comp	Grab	Number of Cont's	Analysis Required
001	1303020 01, JC58 Monthly Qual	3-5-13	700 (A) P	WW	X		1	E625
~~002~~	1	1	700 (A) P	WW	X		1	E608
3/6/13			A P					
			A P					
			A P					
			A P					
			A P					
			A P					
			A P					
			A P					
			A P					
			A P					
			A P					
			A P					

Shipment Arrived Via:
FedEx (UPS) Client AES Other:_____

CC Report To / Special Instructions/Remarks:

Turnaround Time Request:
☐ 1 Day ☐ 3 Day ☐ Normal
☐ 2 Day ☐ 5 Day

Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received by: (Signature)	Date/Time
Relinquished by: (Signature)	Received for Laboratory by: Amanda L. Mottucci	Date/Time 3-6-13 10:41am

Temperature	AES Bottles	Properly Preserved	Received Within Holding Times
Ambient or (Chilled) 1.0°	Y ☑ N ☐	(Y) N	(Y) N
Notes:		Notes:	Notes:

WHITE - Lab Copy YELLOW - Sampler Copy PINK - Generator Copy

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TERMS, CONDITIONS & LIMITATIONS

All service rendered by the **Adirondack Environmental Services, Inc.** are undertaken and all rates are based upon the following terms:

(a) Neither **Adirondack Environmental Services, Inc.,** nor any of its employees, agents or sub-contractors shall be liable for any loss or damage arising out of **Adirondack Environmental Services, Inc.'s** performance or nonperformance, whether by way of negligence or breach of contract, or otherwise, in any amount greater than twice the amount billed to the customer for the work leading to the claim of the customer. Said remedy shall be the sole and exclusive remedy against **Adirondack Environmental Services, Inc.** arising out of its work.

(b) All claims made must be in writing within forty-five (45) days after delivery of the **Adirondack Environmental Services, Inc.** report regarding said work or such claim shall be deemed or irrevocably waived.

(c) **Adirondack Environmental Services, Inc.** reports are submitted in writing and are for our customers only. Our customers are considered to be only those entities being billed for our services. Acquisition of an **Adirondack Environmental Services, Inc.** report by other than our customer does not constitute a representation of **Adirondack Environmental Services, Inc.** as to the accuracy of the contents thereof.

(d) In no event shall **Adirondack Environmental Services, Inc.,** its employees, agents or sub-contractors be responsible for consequential or special damages of any kind or in any amount.

(e) No deviation from the terms set forth herein shall bind **Adirondack Environmental Services, Inc.** unless in writing and signed by a Director of **Adirondack Environmental Services, Inc.**

(f) Results pertain only to items analyzed. Information supplied by client is assumed to be correct. This information may be used on reports and in calculations and **Adirondack Environmental Services, Inc.** is not responsible for the accuracy of this information.

(g) Payments by Credit Card/Purchase Cards are subject to a 3% additional charge.