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Tank Vapor Chemicals of Potential Concern, Existing Direct Reading Instrumentation and Personal Protective Equipment Considerations

NK Butler

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Richland, WA 99352
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Abstract:

This document evaluates the chemicals of potential concern (COPC) identified in RPP-22491, Rev 0 for selected implementation actions regarding industrial hygiene instrumentation and PPE.

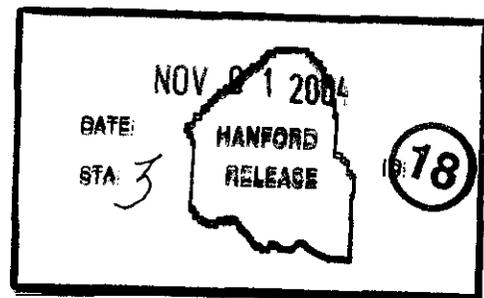
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Tank Vapor Chemicals of Potential Concern

Existing Direct Reading Instrumentation and Personal Protective Equipment Considerations

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
Office of River Protection under Contract DE-AC27-99RL14047

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Executive Summary.....	6
1.0 Background.....	7
2.0 Purpose	8
3.0 Scope	9
4.0 Approach	11
4.1 Instruments	11
4.2 Minimum Respiratory Protection	11
4.3 Chemical Protective Gloves and Suits.....	12
5.0 Summary.....	13
5.1 Instruments	13
5.1.1 Instrument Recommendations.....	13
5.2 Minimum Respiratory Protection	14
5.2.1 Action Limits, Occupational Exposure Limits and Other Protective Limits	14
5.2.2 OEL Recommendations	15
5.2.3 Respiratory Protection Selection Guidance	15
5.2.4 Respiratory Protection Recommendations	15
5.3 Chemical Protective Clothing.....	15
5.3.1 Chemical Protective Glove Selection	16
5.3.2 Chemical Protective Suit Materials.....	16
5.4 Chemical Protective Clothing Recommendations.....	16
6.0 References	17
 <u>Attachments</u>	
A. North Safety Products, September 9, 2004, subject “Dimethyl Mercury”.....	18
B. Instrumentation, Occupational Exposure Limits, Respirators and Chemical Protective Clothing Details	25

LIST OF TABLES

<u>Table</u>	<u>Page</u>
5-1 Instrument Summary for Chemicals of Potential Concern.....	13
5-2 Summary of Detection by Photoionization Detector, Flame Ionization Detector, Infrared Spectrometer, and Gold Film Mercury Analyzer	13
5-3 Summary of OELs (TLV and PELs) and Other Protective Limits for COPC	14
5-4 Summary of Respirator Selection for COPC Exposures at Action Levels.....	15
5-5 Summary of Chemical Protective Glove Selection for COPC with Dermal Absorption Hazard.....	16
5-6 Summary of Chemical Protective Suit Material for COPC with Dermal Absorption Hazard.....	Error! Bookmark not defined.
B-1 Instrumentation, Occupational Exposure Limits, Respirators and Chemical Protective Clothing	27

EXECUTIVE SUMMARY

This document takes the newly released Industrial Hygiene Chemical Vapor Technical Basis (RPP-22491) and evaluates the chemicals of potential concern (COPC) identified for selected implementation actions by the industrial hygiene organization. This document is not intended as a hazard analysis with recommended controls for all tank farm activities. Not all of the chemicals listed are present in all tanks; therefore, hazard analyses can and should be tailored as appropriate.

Detection of each chemical by current industrial hygiene non-specific instrumentation in use at the tank farms is evaluated. Information gaps are identified and recommendations are made to resolve these needs. Of the 52 COPC, 34 can be detected with existing instrumentation. Three additional chemicals could be detected with a photoionization detector (PID) equipped with a different lamp. Discussion with specific instrument manufacturers is warranted. Consideration should be given to having the SapphIRe XL customized for tank farm applications. Other instruments, sampling or modeling techniques should be evaluated to estimate concentrations of chemicals not detected by direct reading instruments. In addition, relative instrument response needs to be factored in to action levels used for direct reading instruments. These action levels should be correlated to exposures to the COPC and corresponding occupational exposure limits (OELs).

The minimum respiratory protection for each of the COPC is evaluated against current options. Recommendations are made for respiratory protection based on each chemical. Until exposures are sufficiently quantified and analyzed, the current use of supplied air respiratory protection is appropriate and protective for the COPC. Use of supplied air respiratory protection should be evaluated once a detailed exposure assessment for the COPC is completed. The established tank farm OELs should be documented in the TFC-PLN-34. For chemicals without an established tank farm OEL, consideration should be given to adopting protective limits from NIOSH, AIHA, or developing OELs.

Protective gloves and suits are evaluated for each chemical for which information is available. Information gaps are identified for some of the compounds and materials. Recommendations are made for resolving these needs. Based on available information, Silver Shield® gloves are promising for tank farm applications. However, permeation testing documentation is needed for the COPC and mixtures for Silver Shield® gloves to evaluate their protectiveness. North Safety Products is expected to provide the requested documentation. Multiple Tychem® products are available. There is overlap between chemicals and effective materials. Further hazard evaluation to determine actual hazards and permeation testing documentation is required to assess the efficacy of a single Tychem® product for tank farm applications.

All of this chemical specific data is combined into a spreadsheet that will assist the industrial hygienist in the selection of monitoring instruments, respiratory protection selection and protective clothing for performing work at a specific tank(s).

1.0 BACKGROUND

Based on a toxicology evaluation of chemicals of potential concern, a list of chemicals has been designated as high priority for exposure assessment and control (RPP-22491, Rev. 0). The high priority chemicals include 1) known and probable carcinogens detected in the waste or headspace of the waste tanks, 2) chemicals with detected headspace concentrations greater than 10% of the lowest occupational exposure guideline (e.g., ACGIH TLVs, OSHA PELs, NIOSH RELs, and AIHA WEELs).

The tank farm action level for airborne exposure is 50% of the tank farm Occupational Exposure Limit (OEL). The tank farm OEL is the more conservative of the Occupational Safety and Health Administration Permissible Exposure Limits (PELs), Short Term Exposure Limits (STELs), or Ceiling Limits (C) or the American Conference of Governmental Industrial Hygienists Threshold Limit Values (TLVs), STELs, or Ceiling Limits. When exposures are measured or anticipated to exceed the action level, exposures will be controlled through engineering controls, administrative controls and/or personal protective equipment (PPE). For airborne exposure, engineering controls include ventilation and reduction of emission points. Administrative controls include posting signs and barriers warning of potentially hazardous airborne chemical emissions and identifying entry controls and requirements as directed in TFC-ESHQ-S_IH-D-35. PPE includes the use of respiratory protection when there is an identified risk that exposure could exceed the tank farm action level.

The tank farm controls for potential direct contact with liquid or solid hazardous waste chemicals are identified during a job hazard analysis. Engineering controls include remote handling equipment and rinsing of waste from tank equipment during removal. Administrative controls include work planning that limits the number of workers in the area with the potential for direct contact. PPE includes chemical protective clothing when there is an identified risk the chemical could contact skin.

2.0 PURPOSE

The three purposes of this document regarding the list of chemicals of potential concern are to:

1. Identify whether the current selected non-specific direct reading instruments are capable of detecting the chemicals of interest within relevant concentration ranges,
2. Identify the recommended minimum respiratory protection if airborne concentrations exceed a given concentration (typically the tank farm action limit), and
3. Identify the recommended chemical protective clothing if direct skin contact with liquid or solid chemical cannot be prevented through other controls.

This document is organized with first a description of the approach used to fulfill the purpose. This is followed by a summary for instrumentation, respiratory protection and chemical protective clothing. Attachment A provides specific permeation testing results for dimethyl mercury. Attachment B provides detailed information for the COPC.

This document is intended as a guide for tank farm industrial hygienists performing hazard analysis for specific tasks, activities, and operations at specific locations within the tank farms. Not all of the chemicals listed are present in all tanks; therefore, hazard analyses can and should be tailored as appropriate. Not all monitoring equipment and protective equipment have adequate test information available for the COPC. Additionally, new technologies, equipment that has not been considered (e.g., equipment not yet commercially available or equipment with limited utility), or new testing may result in recommendations different from those listed in this document. Therefore, manufacturers should be consulted for the most appropriate choice before final selection is made.

3.0 SCOPE

The scope of this document is described in terms of chemicals of potential concern, existing tank farm direct reading instrumentation, existing tank farm respiratory protection devices for tank vapors, and common chemical protective clothing and gloves. The COPC as described in RPP-22491, Rev. 0, are listed in the Table B-1. The instruments considered include the non-specific direct reading instruments listed below. The list of instruments excludes colorimetric indicators, electrochemical ammonia and carbon monoxide sensors in four-gas meters, and combustible gas meters. Respirators considered are those allowed for prescribed protection from tank vapor exposure by the TFC *Respiratory Protection Program*, TFC-ESHQ-S_IH-C-05, Rev. C-5. The maximum use concentrations (MUC) are based on assigned protection factors as listed in the TFC *Respiratory Protection Program* (ANSI Z88.2). There are no specific limitations on chemical protective clothing to consider. However, upon review, Silver Shield® gloves and Tychem® coveralls have reasonable break through times for most chemicals. As this review evolved, tank farm management requested a more focused review of Silver Shield® because the glove is already in use. Other protective barriers are listed in the spreadsheet if Silver Shield® or Tychem® are not the most conservative recommendation.

The instruments considered are the:

- ppbRAE photoionization detector (PID) with a 10.6 eV lamp
- TVA 1000B PID 10.6 eV lamp and flame ionization detector
- Miran SaphIRe XL infrared spectrophotometer

The respiratory protection devices considered are the:

- Scott Supplied air/self-contained breathing apparatus full face piece pressure demand
- Scott full face air purifying respirators with 624-MPC-P100 cartridges
- MSA full face air purifying respirators with GME-P100 cartridges
- 3M Breathe Easy PAPR hoods with FR-57 cartridges

The chemical protective barrier materials for gloves considered are:

- Silver Shield®
- Nitrile
- Viton®
- Butyl
- Chemsoft®
- Natural Rubber
- Neoprene
- Latex

The protective barrier materials for chemical protective suits considered are:

- Tychem® QC, SL, 7500, BR, LV, and TK
- Saranex

The protective limits considered are time-weighted averages, short term exposure limits, and ceiling limits from:

- American Conference of Governmental Industrial Hygienists Threshold Limit Values 2004
- Occupational Safety and Health Administration Permissible Exposure Limits, 29 CFR 1910.1000
- NIOSH RELs and other OELs identified in *Industrial Hygiene Chemical Vapor Technical Basis*, RPP-22491, Draft
- American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Levels (WEELs)

4.0 APPROACH

The approach is a literature review of standard industrial hygiene references and manufacturers' documents. Several references are used to compile the information for each chemical in a spreadsheet. Any differences in information between references are noted in the spreadsheet. For this document, testing or experiments are not performed to fill gaps in the available documentation.

4.1 INSTRUMENTS

Each instrument manufacturer's published documents (e.g., technical notes) are reviewed to determine its detection capabilities. If the chemical could be detected, an X is placed in the spreadsheet in Table B-1.

For the ppbRAE PID, if the chemical would be detected with a lamp other than the 10.6 eV lamp, it is noted in the spreadsheet. If the PID manufacturer's information did not specifically address the chemical, then other references are reviewed to determine if the ionization potential is less than 10.6 eV, indicating the chemical would likely be detected. This is noted in the Table B-1 and footnotes. Relative response to the chemical is not considered in this review.

For the TVA1000B, Table B-1 is marked with an X only if the chemical is listed in the manufacturer's technical notes with a response factor for the FID. There are flammable chemicals on COPC that have not been tested by the manufacturer for FID response. This information is not noted. The TVA100B PID information is listed similarly as stated for the ppbRAE with a 10.6 eV lamp.

For the SapphIRe XL, if the chemical is not found in the manufacturer's published chemical library, then it is so noted in the spreadsheet. However, the SapphIRe XL can be customized for some chemicals that are not in its library. Consultation with manufacturer's technical representatives is recommended for custom options to optimize the SapphIRe XL for tank farm applications.

4.2 MINIMUM RESPIRATORY PROTECTION

NIOSH recommendations for minimum respiratory protection are used based on the selection of respirators currently available at the TFC. Maximum Use Concentrations (MUCs) are added as applicable. Conditions requiring respiratory protection are anticipated personal exposure concentrations exceeding the TFC OEL. If there is no TFC OEL, then the NIOSH Recommended Exposure Level (REL), STEL or C is referenced. For one chemical, the AIHA WEEL is referenced where no other U.S. consensus standard is available. For three chemicals, an independent toxicology panel (ITP) has estimated OELs. This ITP is commissioned by CH2M HILL to participate in development of RPP-22491. These estimated OELs are not available as of the date of this document issue. If there are no OELs available to reference, the default airborne concentration is stated as any detectable concentration in a full shift sample collected and analyzed using NIOSH or OSHA approved methods. For chemicals that didn't have a NIOSH recommendation, full face supplied air/SCBA is the default minimum respiratory protection recommended. Results of this review are noted in Table B-1.

4.3 CHEMICAL PROTECTIVE GLOVES AND SUITS

Chemical protective clothing providing resistance to permeation, penetration and degradation is recommended if the liquid or solid chemical has a potential to contact unprotected skin during the course of performing a task. The American Society for Testing and Materials (ASTM) has devised a standard test method for permeation resistance. This test determines the breakthrough time and steady state permeation rate of chemicals through a sample of the protective barrier at room temperature. All chemicals will eventually permeate protective clothing. In general, higher than normal temperatures will result in a shorter time to breakthrough. Increasing mil thickness of protective materials will increase time to breakthrough for the chemical.

The ACGIH, TLVs and BEIs booklet (2004) is used to identify COPC with "skin" notations. A "skin" notation is considered by ACGIH when, repeated dermal application studies have shown significant absorption or systemic effects following exposure. The notation also alerts the IH that overexposure may occur following dermal contact, even when airborne exposures are at or below the OEL. In Table B-1, an "A" is placed in the Skin column referring to the potential significant contribution to the overall exposure by the cutaneous route, including mucous membranes and the eyes, either by contact with vapors or, of probable greater significance, by direct skin contact with the substance. An "NF" in the Skin column in Table B-1 indicates information on the cutaneous route is not found in the reference. For these substances, chemical protective clothing is reviewed and added to the proceeding columns. A dash in the Skin column indicates cutaneous route is not noted as a significant contributor to overall exposure. If information on chemical protective clothing is available, it is placed in the proceeding columns. If testing information is not available for a chemical, then testing for chemicals from the same subclass is noted. This is not a predictor of permeation resistance. However, permeation testing information on related chemicals in the same subclass may at least rank alternative chemical protective materials as to their probable chemical resistance.

For the purposes of this document, recommendations assume contact with the chemical. Estimated break through time is based on permeation testing for the material totally immersed in the chemical at room temperature. The recommendations are intended only as a guide. The suitability of each product must be determined by an industrial hygienist performing a hazard analysis based on knowledge of the chemical source term and task for the particular waste tank at the TFC.

The Oklahoma State University (OSU) Chemical Guide is used as an initial reference to determine if there are one or two protective materials commonly recommended for the COPC. This guide considers four types of gloves and two chemical suits. The guide states permeation times that are the lowest (most conservative) of the resources consulted.

After initial review of the OSU Chemical Guide is completed, manufacturers' specific guides are reviewed for updated information on breakthrough times. These included the Dupont, Permeation Guide for Dupont™ Tychem® Protective Fabrics (January 2003), and the North Safety Products EZGuide®, version 2.2. The emphasis of this focused review is to find the protective barriers that afford the best protection for the greatest number of COPC. With the exception of dimethyl mercury, actual permeation test results are not reviewed. The results of this focused manufacturers' guide review are noted in the Table B-1.

5.0 SUMMARY

A separate summary is provided for instruments, minimum respiratory protection requirements, chemical protective gloves and chemical protective suits.

5.1 INSTRUMENTS

Most of the COPC can be detected with at least one or more of the four direct reading instruments evaluated. Of the 52 COPC, 34 can be detected by at least one instrument and 3 more could be detected with a PID equipped with an 11.7 eV lamp. There are 15 chemicals of potential concern that are considered not detectable in the referenced manufacturers' documents for the instruments. The results of the review for the COPC list are summarized in Table 5-1.

Table 5-1. Instrument Summary for Chemicals of Potential Concern.

Instrument detection summary	Carcinogens (24)	Non-carcinogens (28)	Total COPC (52)
Detectable by at least one evaluated instrument (PID with 10.6 eV lamp, FID, IR, Jerome® mercury analyzer)	17	17	34
Detectable by PID with 11.7 eV lamp	2	1	3
Not detectable with any evaluated instrument or PID with 11.7 eV lamp	5	10	15

Of the 52 COPC, 23 can be detected by the ppbRAE PID with a 10.6 eV lamp. The SapphIRe XL infrared spectrometer can detect 20 and the TVA1000B FID can detect 12. The Jerome™ Mercury Analyzer can detect mercury and dimethyl mercury (as mercury). The results are summarized in Table 5-2.

Table 5-2. Summary of Detection by Photoionization Detector, Flame Ionization Detector, Infrared Spectrometer, and Gold Film Mercury Analyzer.

Instrument	Carcinogens	Non-carcinogens	Total
PID with 10.6 eV lamp	13	10	23
FID	8	4	12
IR	12	8	20
Gold Film Mercury Analyzer	0	2	2

Note: Some chemicals can be detected by multiple instruments.

5.1.1 Instrument Recommendations

The current use of PIDs with 10.6 eV lamps provides an effective method to screen for a majority of the COPC. Changing several PIDs to 11.7 eV for monitoring at tanks that contain one of the three COPC that can only be detected by a PID with an 11.7 eV lamp should be considered. Changing all PIDs to the 11.7 eV lamp is not recommended due to the shorter operational life for these lamps. Further discussion regarding detection of specific chemicals with instrument manufacturers is warranted. The SapphIRe XL library can be customized to detect more chemicals than those in the standard library. In addition, other instruments,

sampling or modeling techniques should be evaluated to aid in assessing work area conditions and effectiveness of controls when real time detection is not possible. Relative instrument response for the COPC should be evaluated and factored in to instrument specific action levels used for screening for the COPC. Implementation of the new tank farm procedure *Evaluation and Procurement of Industrial Hygiene Monitoring Instruments* (October 2004) should provide a consistent approach for instrument selection.

5.2 MINIMUM RESPIRATORY PROTECTION

If engineering and administrative controls cannot adequately control airborne chemical exposures below the tank farm action levels or during the period of testing engineering controls for effectiveness, respiratory protection is required.

5.2.1 Action Limits, Occupational Exposure Limits and Other Protective Limits

The tank farm action levels are 50% of the tank farm OEL, which is the more conservative between PELs or TLVs. If there isn't a PEL or TLV, the National Institute of Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs) or the American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Levels (WEELs) are provided to give an indication of protective exposure concentrations. If there are no protective limits available in these references, the default airborne concentration is stated as any detectable concentration in a full shift sample collected and analyzed using NIOSH or OSHA approved methods. The number of each chemical type and corresponding protective limit is provided in Table 5-3. For this summary, the protective limit is only counted once and in the following order: OSHA/ACGIH, NIOSH, and AIHA. The tank farm contractor is required to comply with DOE O 440.1A, including compliance with OSHA and ACGIH protective limits. In RPP-22941, more conservative protective limits are considered for establishment of the non-carcinogen COPC. In RPP-2294, protective limits are not considered for establishment of the carcinogen COPC. In general, if a carcinogen is detected or expected at any concentration in the headspace of any tank, it is added to the list of COPC.

Table 5-3. Summary of Protective Limits for COPC.

Type of Protective Limit	Carcinogens (24)	Non-carcinogens (28)	Total (52)
OSHA/ACGIH	20	21	41
NIOSH	0	2	2
AIHA	0	1	1
Default to any detectable	4	4	8

5.2.2 OEL Recommendations

The list of COPC and associated tank farm OELs, including those for carcinogens, should be placed in TFC-PLN-34 and updated periodically as OELs change. Consideration should be given to adopting protective limits from NIOSH and AIHA for the three chemicals that are lacking an OSHA or AIHA protective limit. There are three OELs that have been estimated by the Independent Toxicology Panel (ITP) that are not available at the date of this document issue. These OELs and the rationale for estimation are expected to be provided by the ITP. The ITP estimated OELs should be considered for adoption as tank farm OELs. The TFC-PLN-34 and this document should be updated accordingly.

5.2.3 Respiratory Protection Selection Guidance

At tank farms, respiratory protection is required for measured or anticipated exposures above the tank farm action level of 50% of an OEL. For the list of 24 carcinogens, all but one chemical requires full face, self-contained breathing apparatus or supplied air with positive pressure demand (FF/SCBA/SA) if exposures are measured or anticipated to exceed the action level as described in section 5.2.1. Of the 28 non-carcinogens, 21 require FF/SCBA/SA if exposures are measured or anticipated to exceed the action level. Tables 5-4 summarizes the respirator selection based on NIOSH guidance. If NIOSH guidance is not available for a particular chemical, the default is FF/SCBA/SA. Maximum use concentrations (MUC) are based on assigned protection factors found in TFC-ESHQ-S_IH-C-05, Rev. C-5

Table 5-4. Summary of Respirator Selection for COPC Exposures at Action Levels.

Type of Respirator	Carcinogens (24)	Non-carcinogens (28)	Total (52)
FF/SCBA/SA	23	21	44
FF/APR/OV/NH3	1	7	8

5.2.4 Respiratory Protection Recommendations

Required use of respiratory protection is based on qualitative estimated exposure assessment and/or quantitative exposure assessment with a level of certainty that will be protective of the workforce. The reliability of qualitative and quantitative exposure assessment is critical. Procedures providing guidance on job hazard analysis and employee job task analysis should be enhanced by development and implementation of procedures on performing baseline hazard assessments and qualitative exposure assessment. Implementation of TFC-PLN-34 should result in a reliable quantitative exposure assessment. TFC-PLN-34 could be enhanced by development and implementation of a procedure on performing statistical analysis. In the absence of reliable exposure assessments, the use of supplied air respiratory protection is appropriate and protective.

5.3 CHEMICAL PROTECTIVE CLOTHING

If engineering and administrative controls cannot adequately control direct contact with chemicals, then chemical protective clothing (CPC) must be selected. The selection of CPC that predominately protects for most of the COPC is Silver Shield® for gloves and some form of

Tychem™ material for suits. The information presented in this document is intended as a guide. Actual work conditions should be evaluated by a competent industrial hygienist to determine the whether protective clothing should be used and what type of protective clothing is needed.

5.3.1 Chemical Protective Glove Selection

Upon review, Silver Shield® protects at some level for contact exposure to the majority of 17 COPC with dermal absorption hazards. In some cases, there are multiple glove types that offer protection. In cases of multiple gloves offering protection, Silver Shield® has the greatest break through time in most cases. While in cases where Silver Shield® did not have the greatest break through time, it has a break through time of at least four hours. To summarize the selection of chemical protective gloves, only one glove type is counted per chemical and in the following order: Silver Shield® followed by other glove types. It should be noted that the reference for dimethyl mercury break through times is the testing documents provided by North Safety Products in Attachment A. Table 5-5 summarizes chemical protective glove selection.

Table 5-5. Summary of Chemical Protective Glove Selection for COPC with Dermal Absorption Hazard.

Type of Glove	Carcinogens with Dermal Absorption Hazard (7)	Non-carcinogens with Dermal Absorption Hazard (10)	Total (17)
Silver Shield®	7	5	12
Other	0	2	2
Further Testing of Silver Shield® Needed*	0	3	3

*Chemicals that have not been permeation tested by Silver Shield, but chemicals in the same subclass of chemicals that have been tested. This is not a predictor of permeation resistance for the untested chemical.

5.3.2 Chemical Protective Suit Materials

Multiple Tychem® materials, commonly known as tyvek®, protect at some level for contact exposure to over half of the COPC. Of the 17 COPC that are noted with dermal absorption hazards, 14 COPC have permeation testing indicating at least one Tychem® material offering protection. Three other COPCs have permeation testing of a chemical in the same chemical subclass. This is not a predictor of permeation resistance for the untested chemical.

5.4 CHEMICAL PROTECTIVE CLOTHING RECOMMENDATIONS

When planning work that includes risk of direct chemical waste contact, specific glove and suit products should be researched and identified that will protect against the wastes in the specific tank. It is important to consider clothing construction and material thickness and have direct communication with technical support from the glove and clothing manufacturers prior to procurement and use of a product. Review of actual permeation testing records is recommended as differences have been noted between actual testing documentation and information published in barrier material guides for dimethyl mercury. Specific material permeation testing for COPC that have not been previously tested and for the mixture of tank waste materials is recommended.

6.0 REFERENCES

- CH2M HILL Hanford Group, Respiratory Protection Program, TFC-ESHQ-S_IH-C-05, Rev. C-5
- CH2M HILL Hanford Group, Evaluation and Procurement of Industrial Hygiene Monitoring Instruments, TFC-ESHQ-S_IH-CD-38, Rev. B
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- NIOSH. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 97-140. Washington, D.C. U.S. Government Printing Office
- North Safety Products EZGuide®, version 2.2
- Oklahoma State University Chemical Guide, <http://www.pp.okstate.edu/ehs/hazmat/gloves.htm>
- RAE Technical Note 106 *Correction Factors, Ionization Energies, and Calibration Characteristics.*
- Thermo Environmental, Inc, *TVA 1000 Toxic Vapor Analyzer Response Factors* at http://www.thermo.com/eThermo/CMA/PDFs/Various/156File_13448.pdf
- Thermo Environmental, Inc, *Chemical Compound Library for Thermo Environmental, Inc Miran SapphIRe XL* at http://www.thermo.com/eThermo/CMA/PDFs/Various/156File_17623.pdf

**ATTACHMENT A. NORTH SAFETY PRODUCTS, SEPTEMBER 9, 2004,
SUBJECT "DIMETHYL MERCURY."**



Safety Products

DATE: September 9, 2004
TO: Eldon Burkett
FAX: (509) 373-6208
PAGES: 6 (Including this page)
RE: Dimethyl Mercury

Dear Eldon:

Enclosed are test reports on various North gloves against Dimethyl Mercury. As I told you over the phone, there is some contradicting data on Dimethyl Mercury versus the Silver Shield and Silver Shield Lite gloves. The specification for the Silver Shield gloves that were tested was 4 mils, although the specimens tested ran thicker at 5 mils. The Silver Shield Lite gloves were 3 mils. The Silver Shield gloves that we manufacture now are 2.7 mils. Because of the deviation between the two tests, we recommend that customers perform their own testing to determine compatibility.

We currently manufacture gloves, sleeves, booties, aprons and coat aprons with Silver Shield material. We also have the capability to manufacture bags out of the material, provided that the customer purchase the required dies. We do not manufacture any suits with the Silver Shield material.

If you have any questions, or need additional information, please feel free to contact me either by phone at (843) 308-7935 or e-mail at lisa.rizzo@northsafety.com.

Sincerely,

A handwritten signature in cursive script that reads "Lisa Rizzo".

Lisa Rizzo
Product Manager, Hand Protection

NOV 17 2004

SEP 9 2004 3:56PM



REPORT
INTERTEK TESTING SERVICES

RECEIVED SEP 22 1997

INDUSTRIAL PARK CORTLAND, NEW YORK 13045

ORDER NO.: J97017248

REPORT NO J9717246-002

DATE: September 17, 1997

RENDERED TO:
DARTMOUTH COLLEGE
6216 CLEMENT WEST
HANOVER, NH 03755

COPY

ASTM F739-96 PERMEATION TEST

MATERIAL NAME: North Silver Shield Glove
PRIOR CONDITIONING: None
CHALLENGE CHEMICAL: Dimethyl Mercury
CHEMICAL SOURCE: Alfa Aesar
TEST DATE: 08/28/97

LEVEL
5

TEST TEMP.: 22°C
TEST DURATION: 4 Hours
CONCENTRATION: 100%
CAS NO.: 593-74-8
SAMPLE REC'D: 09/06/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	>240	>240	>240	>240	0.0
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 ug/cm ² /min)	>240	>240	>240	>240	0.0
PERMEATION RATE: ug/cm ² ·min □ Steady state rate ✓ Maximum rate	<0.1	<0.1	<0.1	<0.1	0.0
UNIT AREA WEIGHT (g/m ²)	104	81	83	89	13
SAMPLE THICKNESS (mils)	5	5	5	5	0.0

MODIFICATIONS OF METHOD	1" Cells; Intermittent Splash Collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC	COLLECTION MEDIUM	Ethyl Ether
SAMPLING FREQUENCY	15 Minutes	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.1 ug/cm ² /min

Test Performed by:

[Signature]
Alan Brown
Engineer/Chemist
Performance Group

Report Approved by:

[Signature]
Catherine Dodgen
Senior Project Engineer
Performance Group

An independent organization testing for safety, performance, and certification.

All services are provided subject to the following general policy: Reports are furnished for customer use of the services to whom they are addressed. This organization is not liable for the accuracy and completeness of the data, and to the completeness of the tests, examinations or surveys made. No guarantee from reports or use of ITS name is permitted except as expressly authorized by ITS in writing.

NO. 0072627 P. 01

ALBERTA HEALTH SERVICES

SEP 19 2004 3:57PM



**REPORT
INTERTEK TESTING SERVICES**

INDUSTRIAL PARK

CORTLAND, NEW YORK 13045

ORDER NO.: J97028977

REPORT NO. J9728977-001

DATE: December 23, 1997

RENDERED TO:
NORTH SAFETY PRODUCTS
4090 AZALEA DRIVE
CHARLESTON, SC 29415

ASTM F739-96 PERMEATION TEST

MATERIAL NAME: Silver Shield LITE/ Model #0120CE
PRIOR CONDITIONING: None
CHALLENGE CHEMICAL: Dimethyl Mercury
CHEMICAL SOURCE: Aldrich
TEST DATE: 12/17/97

TEST TEMP.: 22°C
TEST DURATION: 8 Hours
CONCENTRATION: 95%
CAS NO.: 593-74-8
SAMPLE REC'D: 12/01/97

LEVEL
↓

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	30	<15	<15	30	7
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 ug/cm ² -min)	45	<15	<15	25	14
PERMEATION RATE: ug/cm ² -min □ Steady state rate ✓ Maximum rate	0.22	0.86	2.36	1.16	0.9
UNIT AREA WEIGHT (g/m ²)	68.7	64.7	70.2	67.9	2.3
SAMPLE THICKNESS (mils)	3	3	3	3	0.0

MODIFICATIONS OF METHOD	1" Cells; Intermittent Splash Collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC	COLLECTION MEDIUM	Ethyl Ether
SAMPLING FREQUENCY	30 Minutes	MIN. DETECTION LIMIT	1.0 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.1 ug/cm ² -min

Test Performed by:

Brian Brown
Brian Brown
Engineer/Chemist
Performance Group

Report Approved by:

Catherine R. Dodgen
Catherine Dodgen
Senior Project Engineer
Performance Group

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REPORT INTERTEK TESTING SERVICES

3933 US ROUTE 11

CORTLAND, NEW YORK 13045

ORDER NO.: J97028977

REPORT NO. J9728977-002

DATE: December 23, 1997

RENDERED TO:
NORTH SAFETY PRODUCTS
4090 AZALEA DRIVE
CHARLESTON, SC 29415

ASTM F739-96 PERMEATION TEST

MATERIAL NAME: North Viton Model #F-101
PRIOR CONDITIONING: None
CHALLENGE CHEMICAL: Dimethyl Mercury
CHEMICAL SOURCE: Aldrich
TEST DATE: 12/17/97

TEST TEMP.: 22°C
TEST DURATION: 8 Hours
CONCENTRATION: 95%
CAS NO.: 593-74-8
SAMPLE REC'D: 12/02/97

LEVEL
1

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	<15	<15	<15	<15	0.0
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 ug/cm ² *min)	<15	<15	<15	<15	0.0
PERMEATION RATE: ug/cm ² *min □ Steady state rate ✓ Maximum rate	6.06	33.2	16.7	18.6	13.7
UNIT AREA WEIGHT (g/m ²)	530	572	529	544	25
SAMPLE THICKNESS (mils)	11	12	11	11	1

MODIFICATIONS OF METHOD	1" Cells: Intermittent Splash Collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC	COLLECTION MEDIUM	Ethyl Ether
SAMPLING FREQUENCY	30 Minutes	MIN. DETECTION LIMIT	1.0 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.1 ug/cm ² *min

Test Performed by:

[Signature]
Brenda Brown
Engineer/Chemist
Performance Group

Report Approved by:

[Signature]
Catherine R. Dodgen
Senior Project Engineer
Performance Group

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NO. 9912

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TRI / Environmental, Inc.
 9063 Bee Caves Road
 Austin, TX 78733
 Phone : (512) 263-2101



North Safety Products
 4090 Azalea Dr.
 Charleston, SC 29415

Filename : J105T01
 Method Standard : ASTM F739-86
 Material Log No. : 97105-163-01
 Test Date : 9/9/97
 Analyst : [Signature] Q/C Date : 10/1/97

PERMEATION TEST REPORT

Material Name : North Butyl B131/9 Glove Test Temperature : 27 deg. C
 Conditioning : None Test Duration : 8 Hours
 Chemical : Dimethyl Mercury Concentration : 99 %
 Source : Aldrich CAS No. : 593-74-8

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	<15	<15	<15	< 15	0
Normalized Breakthrough : (time in minutes)	<15	<15	<15	< 15	0
Maximum Detectable Rate : (ug/cm ² *min)	369	342	130	280	107
Unit Area Weight (g/cm ²)	0.0401	0.0411	0.0418	0.0408	0.0006
Sample thickness (0.017)	13	14	13	13	0.47

LEVEL
1

Modifications of Method : 1" Cells
 Analytical Technique : Gas Chromatography/Mass Spectrometer, Purge and Trap
 Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration of the test
 Chemical physical state : Liquid
 Type of chemical contact : Continuous
 Collection medium : 2mL Methanol
 Minimum detection limit : 0.40 ppm
 Minimum detectable rate : 0.003 ug/cm²*min

This data was derived from testing performed in accordance with ASTM Standard F739-86. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warrants nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposures.

NOV 00 12 2:00 PM

SEP 9 2004 3:57 PM

TRI / Environmental, Inc.
 9063 Bee Caves Road
 Austin, TX 78733
 Phone: (512) 263-2101



North Safety Products
 4090 Azalea Dr.
 Charleston, SC 29415

Filename : J105T01

Method Standard : ASTM F739-96

Material Log No. : 97105-163-01

Test Date : 9/8/97

Analyst : [Signature]
 D/C Date : 10/19/97

PERMEATION TEST REPORT

Material Name : North Buyl B131/9 Glove
 Conditioning : None
 Chemical : Dimethyl Mercury
 Source : Aldrich

Test Temperature : 27 deg. C
 Test Duration : 8 Hours
 Concentration : 99 %
 CAS No. : 593-74-8

TEST RESULTS	CELL 1	CELL 2	CELL 3	Average	Std. Dev.
Actual Breakthrough : (time in minutes)	<15	<15	<15	< 15	0
Normalized Breakthrough : (time in minutes)	<15	<15	<15	< 15	0
Maximum Detectable Rate : (ug/cm ² *min)	368	342	130	280	107
Unit Area Weight (g/cm ²)	0.0401	0.0411	0.0415	0.0409	0.0006
Sample thickness (.001")	13	14	13	13	0.47

LEVEE
1

Modifications of Method : 1" Cells
 Analytical Technique : Gas Chromatography/Mass Spectrometer, Purge and Trap
 Sampling Frequency : Every 15 minutes for the first hour of the test; every 30 minutes thereafter for the duration of the test
 Chemical physical state : Liquid
 Type of chemical contact : Continuous
 Collection medium : 2mL Methanol
 Minimum detection limit : 0.40 ppm
 Minimum detectable rate : 0.003 ug/cm²*min

This data was derived from testing performed in accordance with ASTM Standard F739-96. These tests were performed under laboratory conditions. TRI / Environmental, Inc. neither warrants nor guarantees protection provided by the use of this material against the tested chemical. The user should determine the applicability of test conditions when assessing the suitability of material for actual anticipated exposure.

NO. 062 2.000N

SEP 9 2004 3:58PM

**ATTACHMENT B. INSTRUMENTATION, OCCUPATIONAL EXPOSURE LIMITS,
RESPIRATORS AND CHEMICAL PROTECTIVE CLOTHING DETAILS**

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TABLE B-1. INSTRUMENTATION, OCCUPATIONAL EXPOSURE LIMITS, RESPIRATORS AND CHEMICAL PROTECTIVE CLOTHING

CAS	Chemical Name	ppbRAE PID 10.6 eV lamp ^a	TVA1000B FID only ^b	Sapphire XL ^c	Respiratory Protection ^d	PELs or TLVs ^e	RELs or WEELs ^f	Skin ^g	Gloves ^h	Suits ^a
Known Carcinogens										
134-32-7	alpha-Naphthylamine	X ⁱ	Not listed	Not in library	FF/SCBA/SA	OSHA 1910.1004 No PEL, default to any detectable concentration	No REL listed.	NF	Silver Shield [®] >240	Tychem [®] BR, LV, TK ^j (Amines, aromatic primary)
71-43-2	Benzene	X	X	X	FF/SCBA/SA	ACGIH TLV 0.5 ppm, STEL 2.5 ppm	0.1 ppm 10-hr. TWA; ST 1 ppm (15 min. TWA)	A	Silver Shield [®] >1440	Tychem [®] 7500, F, BR, LV, TK >480
75-21-8	Ethylene oxide	X	X	X	FF/SCBA/SA	OSHA PEL 1 ppm & STEL 5 ppm; ACGIH TLV 1 ppm.	<0.1 ppm 10 hr -TWA; C 5 ppm (10 min/day)	-	Silver Shield [®] >480	Tychem [®] BR, LV, TK >480
50-00-0	Formaldehyde	yes, with 11.7 eV lamp	X	X	FF/SCBA/SA	ACGIH C 0.3 ppm	0.016 ppm 10-hr. TWA; C 0.1 ppm (15 min)	-	Silver Shield [®] >240	Tychem [®] BR, LV, TK >480
62-75-9	N-Nitrosodimethylamine	X ⁱ	Not listed	Not in library	FF/SCBA/SA	ACGIH TLV As low as possible.	Any detectable concentration	A	Silver Shield [®] (N,N-Diethyl-nitrosamine)	Tychem [®] F >480
75-01-4	Vinyl chloride (chloroethene)	X	X	X	FF/SCBA/SA	OSHA/ ACGIH PEL/TLV 1 ppm;	Any detectable concentration	-	Silver Shield [®] >480	Tychem [®] QC, SL, 7500, F, BR, LV, TK >480
Probable Carcinogens										
75-07-0	Acetaldehyde	X	Not listed	X	FF/SCBA/SA	ACGIH C 25 ppm	Any detectable concentration	-	Silver Shield [®] >480	Tychem [®] BR, LV, TK >480
53469-21-9	Aroclor-1242	IP not known ^k	Not listed	Not in library	FF/SCBA/SA	ACGIH TLV 1 mg/m3	0.001 mg/m3 TWA	A	Silver Shield [®] (Aroclor-1254)	Tychem [®] SL ^j (Aroclor-1254)
11097-69-1	Aroclor-1254	IP not known ^k	Not listed	Not in library	FF/SCBA/SA	ACGIH TLV 0.5 mg/m3	0.001 mg/m3 TWA	A	Silver Shield [®] >480	Tychem [®] SL >480

CAS	Chemical Name	ppbRAE PID 10.6 eV lamp ^a	TVA 1000B FID only ^b	SapphIRE XL ^c	Respiratory Protection ^d	PELs or TLVs ^e	RELs or WEELs ^f	Skin ^g	Gloves ^h	Suits ^h
117-81-7	bis (2-ethylhexyl)phthalate (DEHP, DOP, Dioctylphthalate)	IP not known ^k	Not listed	Not in library	FF/SCBA/SA	ACGIH/OSHA TLV/PEL 5 mg/m ³	5 mg/m ³ 10- hr. TWA; ST 10 mg/m ³ (15 min TWA)	-	Silver Shield [®] >240 Viton >480 Butyl >480	Tychem [®] 7500, Fm, BR, LV, TK >480
106-99-0	Butadiene, 1,3-	X	X	X	FF/SCBA/SA	OSHA PEL 1 ppm & STEL 5 ppm	Any detectable concentration	-	Silver Shield [®] >480 Viton >480 Butyl >480 Chemsoft [®] >480	Tychem [®] SL, 7500, F, BR, LV, TK >180
56-23-5	Carbon Tetrachloride	yes, with 11.7 eV lamp	Not listed. Not flammable	X	FF/SCBA/SA	ACGIH TLV 5 ppm, STEL 10 ppm; OSHA C 200 ppm (for 5 min. in any 3 hour period.	ST 2 (60 min)	A	Silver Shield [®] >480 Viton >780	Tychem [®] BR, LV, TK >480
67-66-3	Chloroform	yes, with 11.7 eV lamp	Not listed. Not flammable	X	FF/SCBA/SA	ACGIH TLV 10 ppm	ST 2, (60 min)	-	Silver Shield [®] >1440 Viton 570	Tychem [®] BR, LV, TK >480
72-55-9	Dichlorodiphenyldichloroethylene (DDE)	Not listed ^k	Not listed	Not in library	Default ⁱ to FF/SCBA/SA	No OSHA PEL or ACGIH TLV. Default to any detectable concentration.	No REL listed.	-	-	-
107-06-2	Dichloroethane, 1,2-	yes, with 11.7 eV lamp	Not listed	Not in library	FF/SCBA/SA	ACGIH TLV 10 ppm; OSHA STEL 100 ppm & C.200 ppm (5 min over 3 hours)	1 ppm 10-hr TWA; ST 2 ppm (15 min TWA)	-	Silver Shield [®] >480 Viton >480	Tychem [®] BR, LV, TK >480
123-91-1	Dioxane, 1,4-	X	Not listed	X	FF/SCBA/SA	ACGIH TLV 20 ppm	C 1 ppm (30 min)	A	Silver Shield [®] >480 Butyl >1200	Tychem [®] 7500, F, BR, LV, TK >480
100-40-3	Ethylcyclohexene, 4- (4-Vinyl cyclohexene)	X	Not listed	Not in library	Default ⁱ to FF/SCBA/SA	ACGIH TLV 0.1 ppm	No REL listed.	-	Viton >480	Tychem [®] SL, BR, LV, TK ^j (Aromatic Polynuclear, aliphatic and alicyclic, unsaturated)

CAS	Chemical Name	ppbRAE PID 10.6 eV lamp ^a	TVA1000B FID only ^b	Sapphire XL ^c	Respiratory Protection ^d	PELs or TLVs ^e	RELs or WEELs ^f	Skin ^g	Gloves ^h	Suits ^h
106-93-4	Ethylene dibromide (1,2-Dibromoethane)	X	Not listed. Not flammable.	Not in library	FF/SCBA/SA	OSHA PEL 20 ppm & STEL 30 ppm & C 50 (5 min.)	0.045 ppm 10-hr. TWA; C 0.13 ppm (15 min.)	A	Silver Shield [®] >480	Tychem [®] BR, LV, TK >480
75-02-5	Fluoroethene (Vinyl Fluoride)	X ⁱ	Not listed	Not in library	a. FF/APR/OV MUC 1-100 ppm b. FF/SCBA/SA MUC >100 ppm	ACGIH TLV 1 ppm	1 ppm 10-hr TWA; C 5 ppm	-	Silver Shield [®] (Halogen compounds, vinyllic)	Tychem [®] BR, LV, TK (Halogen compounds, vinyllic)
75-09-2	Methylene chloride (Dichloromethane)	yes, with 11.7 eV lamp	X	X	FF/SCBA/SA	OSHA PEL 25 ppm & STEL 125 ppm.	Any detectable concentration	-	Silver Shield [®] 648	Tychem [®] TK >480
79-46-9	Nitropropane, 2-	yes, with 11.7 eV lamp	Not listed	Not in library	FF/SCBA/SA	ACGIH TLV 10 ppm	Any detectable concentration	-	Silver Shield [®] >240 Butyl >480	Tychem [®] BR, LV, TK >480
10595-95-6	N-Nitrosomethylethylamine	Not listed. IP not known ^k	Not listed	Not in library	Default to FF/SCBA/SA	No OSHA PEL or ACGIH TLV. Default to any detectable concentration.	No REL listed.	NF	Silver Shield [®] (N,N-Diethyl-nitrosoamine)	Tychem [®] F ^j (Nitrosamines)
127-18-4	Tetrachloroethylene	X	X	X	FF/SCBA/SA	ACGIH TLV 25 ppm, STEL 100 ppm; OSHA C 300 ppm (for 5 min. in any 3 hour period.	Any detectable concentration	-	Silver Shield [®] >480 Viton 1020	Tychem [®] 7500, F, BR, LV, TK >480
79-01-6	Trichloroethylene	X	X	X	FF/SCBA/SA	ACGIH TLV 50 ppm, STEL 100 ppm; OSHA C 300 ppm (for 5 min. in any 2 hour period.	Any detectable concentration	-	Silver Shield [®] >1440 Viton 444	Tychem [®] BR, LV, TK >480
Non-Carcinogens										
75-05-8	Acetonitrile	Not detected	X	X	FF/APR/OV MUC <500	ACGIH TLV 20 ppm	REL TWA 20 ppm	A	Silver Shield [®] >1440 Butyl >480	Tychem [®] BR, LV, TK >480

CAS	Chemical Name	ppbRAE PID 10.6 eV lamp ^a	TVA1000B FID only ^b	Sapphire XL ^c	Respiratory Protection ^d	PELs or TLVs ^e	RELs or WEELS ^f	Skin ^g	Gloves ^h	Suits ⁱ
79-10-7	Acrylic acid	X	X	Not in Library	Default ^l to FF/SCBA/SA.	ACGIH TLV 2 ppm	REL TWA 2 ppm	A	Silver Shield [®] >240 Butyl >480	Tychem [®] SL, F, TK >480
7664-41-7	Ammonia	X	Not listed	X	a. FF/APR/OV with NH3 cartridge MUC 300 ppm	ACGIH TLV 25 ppm, STEL 35 ppm	REL TWA 25 ppm	-	Silver Shield [®] 108	Tychem [®] TK >480
92-52-4	Biphenyl, 1,1'-	X ¹	Not listed	Not in Library	FF/APR/OV and P100 MUC <20 ppm	ACGIH TLV 0.2 ppm/PEL 0.2 ppm	REL TWA 0.2 ppm	-	-	-
84-66-2	Benzenedicarboxylic acid, diethyl ester, 1,2- (Diethyl phthalate)	Not detected (IP not known) ^k	Not listed	Not in Library	Default ^l to FF/SCBA/SA.	ACGIH TLV 5 mg/m3	REL TWA 5 mg/m3	-	Silver Shield [®] >240	Tychem [®] 7500, F, BR, LV, TK ¹ (Benzoates and Phthalates)
123-72-8	Butanal (butyraldehyde)	Not detected	Not listed	Not in Library	Default ^l to FF/SCBA/SA.	No OSHA PEL or ACGIH TLV	No REL. AIHA WEEL 25 ppm	NF	Silver Shield [®] >480 Butyl >900	Tychem [®] BR, LV, TK >480
109-74-0	Butanenitrile	Not detected	Not listed	Not in Library	FF/APR/OV MUC <800	NO OSHA PEL or ACGIH TLV	REL TWA 8 ppm	NF	Silver Shield [®] ¹ (acrylonitrile, acetonitrile)	Tychem [®] BR, LV, TK ¹ (Nitriles, aliphatic and alicyclic)
71-36-3	Butanol, 1-	X	X	X	FF/APR/OV MUC <1400 (IDLH)	ACGIH TLV 20 ppm	C 50 ppm	-	Silver Shield [®] >480	Tychem [®] SL, BR, LV, TK >480
124-38-9	Carbon dioxide	Not detected	Not listed	X	FF/SCBA/SA	OSHA PEL 5000 ppm	REL TWA 5,000 ppm, C 30,000 ppm	-	-	-
75-15-0	Carbon disulfide	X	Not listed	X	FF/APR/OV MUC <100	ACGIH TLV 10 ppm/ OSHA C 30 ppm & 100 ppm (30 minute max peak)	REL TWA 1 ppm	A	Silver Shield [®] >1440 Viton >480	Tychem [®] 7500, F, BR, LV, TK >480
630-08-0	Carbon monoxide ^m	Not detected	Not listed	X	FF/SCBA/SA	ACGIH TLV 25 ppm	REL TWA 35 ppm./C 200 ppm	-	-	-
57-14-7	Dimethylhydrazine, 1,1-	X	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV 0.01 ppm.	REL C 0.06 ppm	A	Silver Shield [®] ¹ (Hydrazines)	Tychem [®] BR, LV, TK >480

CAS	Chemical Name	ppbRAE PID 10.6 eV lamp ^a	TVA 1000B FID only ^b	Saphire XL ^c	Respiratory Protection ^d	PELs or TLV ^e	RELs or WEELs ^f	Skin ^g	Gloves ^h	Suits ^h
593-74-8	Dimethyl mercury ⁿ	Not detected (IP not known)	Not detected	Not in Library	FF/SCBA/SA MUC < 2 mg/m3 (IDLH)	ACGIH/OSHA TLV/PEL 0.01 mg/m3 (as Hg), ACGIH STEL 0.03 mg/m3, OSHA C 0.04 mg/m3	REL 0.01 mg/m3 (as Hg), STEL 0.03 mg/m3	A	Silver Shield [®] <15°	Tychem [®] BR, LV, TK, SL ⁱ (Mercury, organo-metallic compounds)
104-76-7	Ethyl-1-hexanol, 2-	Not detected (IP not known) ^k	Not listed	Not in Library	Default to FF/SCBA/SA.	No OSHA PEL or ACGIH TLV. Default to any detectable concentration.	IIP Estimated OEL	NF	Viton > 480 Silver Shield [®] (n-butanol, methanol, methyl cellosolve)	Tychem [®] BR, LV, TK ⁱ (Hydroxylic, aliphatic and alicyclic, primary)
628-73-9	Hexanenitrile	Not detected (IP not known)	Not listed	Not in Library	Default to FF/SCBA/SA.	No OSHA PEL or ACGIH TLV. Default to any detectable concentration.	IIP Estimated OEL	NF	Silver Shield [®] (acrylonitrile, acetonitrile)	Tychem [®] BR, LV, TK ⁱ (Nitriles, aliphatic and alicyclic)
591-78-6	Hexanone, 2- (Methyl butyl ketone)	X	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV 5 ppm & STEL 10 ppm	REL TWA 1 ppm	A	Silver Shield [®] (Methyl ethyl ketone, Methyl isobutyl ketone, acetone)	Tychem [®] BR, LV, TK ⁱ (Ketones, aliphatic and alicyclic)
589-38-8	Hexanone, 3-	Not detected (IP not known)	Not listed	Not in Library	Default to FF/SCBA/SA.	No OSHA PEL or ACGIH TLV. Default to any detectable concentration.	IIP Estimated OEL	NF	Silver Shield [®] (Methyl ethyl ketone, Methyl isobutyl ketone, acetone)	Tychem [®] BR, LV, TK ⁱ (Ketones, aliphatic and alicyclic)
7439-97-6	Mercury ⁿ	Not detected (IP not known)	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV 0.025 mg/m3	REL TWA 0.05 mg/m3 / C 0.1 mg/m3	A	Silver Shield [®] >480	Tychem [®] BR, LV, TK, SL >480
75-50-3	Methanamine, N,N-dimethyl-	X ⁱ	Not listed	Not in Library	Default to FF/SCBA/SA.	ACGIH TLV 5 ppm & STEL 15 ppm	REL TWA 10 ppm	-	Viton [®] (Triethylamine)	Tychem [®] TK >480
67-56-1	Methanol	Not detected	X	X	FF/SCBA/SA	OSHA/ACGIH PEL/TLV 200 ppm; ACGIH STEL 250 ppm	REL TWA 200ppm	A	Butyl >360	Tychem [®] SL, TK >480

CAS	Chemical Name	ppbRAE PID 10.6 eV lamp ^a	TVA 1000B FID only ^b	Sapphire XL ^c	Respiratory Protection ^d	PELs or TLVs ^e	RELs or WEELS ^f	Skin ^g	Gloves ^h	Suits ^h
60-34-4	Methyl hydrazine	X ⁱ	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV 0.01 ppm, OSHA C 0.2ppm.	REL C 0.04 ppm	A	Silver Shield® ^j (Hydrazines)	Tychem® BR, LV, TK >480
624-83-9	Methyl isocyanate	Yes, with 11.7 eV lamp	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV/ OSHA PEL TWA 0.02 ppm	REL TWA 0.02 ppm	A	Butyl 66	Tychem® BR, LV, TK >480
10102-44-0	Nitrogen Dioxide (NO ₂)	X	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV 3 ppm & STEL 5; OSHA C 5 ppm	REL STEL 1 ppm	-	-	-
10024-97-2	Nitrous Oxide (N ₂ O)	Not detected	Not listed	X	Default ⁱ to FF/SCBA/SA. No Recommendation listed in NIOSH Pocket guide	ACGIH TLV 50 ppm	REL TWA 25 ppm	-	Not listed	Tychem® BR, LV, TK >480
110-59-8	Pentanitrile	Not detected (IP not known)	Not listed	Not in Library	Default ⁱ to FF/SCBA/SA.	No OSHA PEL or ACGIH TLV. Default to any detectable concentration.	IIP Estimated OEL	NF	Butyl >480	Tychem® BR, LV, TK ⁱ (Nitriles, aliphatic and alicyclic)
128-37-0	Phenol, 2,6-bis(1,1-dimethyl-4-methyl- [BHT]	Not detected (IP not known)	Not listed	Not in Library	Default ⁱ to FF/SCBA/SA.	ACGIH TLV 2 mg/m3	REL TWA 10 mg/m3	-	-	-
107-12-0	Propanenitrile	Not detected	Not listed	Not in Library	FF/APR/OV MUC <600	No OSHA PEL or ACGIH TLV	REL TWA 6 ppm	NF	Butyl 24	Tychem® BR, LV, TK ⁱ (Nitriles, aliphatic and alicyclic)
126-73-8	Tributyl Phosphate (TBP)	Not detected (IP not known)	Not listed	Not in Library	FF/SCBA/SA	ACGIH TLV 0.2 ppm	REL TWA 0.2 ppm	-	Silver Shield® >240	-

a. Reference RAE Technical Note 106, *Correction Factors, Ionization Energies, and Calibration Characteristics*. "Not listed" indicates the response factor is not listed in this reference.

b. Reference Thermo Environmental, Inc TVA 1000 Toxic Vapor Analyzer Response Factors at http://www.thermo.com/eThermo/CMA/PDFs/Various/156File_13448.pdf. "Not listed" indicates the response factor is not listed in this reference. However, some chemicals "not listed" are flammable and are likely to be detected by FID.

- c. Reference Chemical Compound Library for Thermo Environmental, Inc Miran SaphIRe XL at http://www.thermo.com/eThermo/CMA/PDFs/Various/156File_17623.pdf. This instrument has customization capability, if a chemical is not listed in the library.
- d. NIOSH recommendations for minimum respiratory protection with selection from respirators currently available for use for tank vapors at TFC.
- e. Lowest of OSHA or ACGIH - (PEL or TLV 8-hr TWA, STEL, C)
- f. NIOSH - (REL 10-hr. TWA, ST, C) or AIHA WEEL - (8-hr. TWA)
- g. An A in the Skin column refers to the potential significant contribution to the overall exposure by the cutaneous route, including mucous membranes and the eyes, either by contact with vapors or, of probable greater significance, by direct skin contact with the substance. An NF in the Skin column indicates information on the cutaneous route is not found in the reference. For these substances, chemical protective clothing is reviewed and added to the preceding columns. A dash in the Skin column indicates cutaneous route is not noted as a significant contributor to overall exposure. If information on chemical protective clothing is available, it is placed in the preceding columns. Reference ACGIH, TLVs and BEIs, 2004.
- h. Estimated break through time in minutes totally immersed at room temperature.
- i. Chemical is not listed in RAE TN 106. However, the ionization potential listed in the NIOSH Pocket Guide is less than 10.6 eV. It is assumed to be detectable by the ppbRac with a 10.6 eV lamp.
- j. Permeation testing has not been performed for this specific chemical. However, permeation testing information on related chemicals in the same subclass may at least rank alternative chemical protective materials as to their probable chemical resistance.
- k. Not listed in Lide, D.R., Handbook of Chemistry and Physics, 77th edition, CRC Press 1996-1997.
- l. No NIOSH respiratory protection recommendation.
- m. Carbon monoxide can be detected by most four-gas monitors available at the tank farms if equipped with a carbon monoxide sensor.
- n. The Jerome™ Mercury Analyzer will detect as mercury.
- o. Reference correspondence from Lisa Rizzo, North Safety Products, September 9, 2004, subject "Dimethyl Mercury." This correspondence provides laboratory testing of Silver Shield gloves of varying thicknesses and dimethyl mercury contact. Results indicate a break through time of <15 minutes for 3 mil gloves. Tank farm has procured Silver Shield gloves 2.7 mil thickness.

