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Dinitrogen Tetroxide Tank Cleaning Work Plan

Former Vicksburg Chemical Company
Vicksburg, Mississippi

13 January 2009

ARCADIS

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Former Vicksburg Chemical Company
Vicksburg, Mississippi

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1. Introduction and Work Plan Rationale

1.1 Objectives/Rationale

This Work Plan presents a scope of work for performing tank cleaning activities at the former Vicksburg Chemical Company (Vicksburg Chemical) site in Vicksburg, Mississippi (Figure 1). The site was formerly a pesticide and herbicide manufacturing facility divided into two areas called the North Plant and South Plant. The primary objective of the activities proposed in this document is to present a procedure for the treatment of dinitrogen tetroxide (N_2O_4) presently stored in on-site tanks (N_2O_4 may also be present in piping, pumps, filter housing, valves, etc. affiliated with these tanks) in the North Plant (Figure 2).

1.2 Background

1.2.1 Property Location

Vicksburg Chemical was formerly owned by Cedar Chemical Corporation. The facility is located south of Interstate 20 on Rifle Range Road and within the southwest section of the city of Vicksburg, Warren County, Mississippi. The site is comprised of approximately 535 acres located in Sections 4, 5, 8, 9, and 10, township 15 north, range 3 east (Latitude: North 32° 18' 01", Longitude: West 90° 53' 57"). The site location is shown on Figure 1.

1.2.2 Dinitrogen Tetroxide Site History

The North Plant began operation in 1961 and produced potassium nitrate, liquid chlorine, and liquid N_2O_4. The N_2O_4 was sold to the federal government as an oxidizer for rocket fuels. Just prior to Vicksburg Chemical declaring bankruptcy, operations were shut down. Various chemicals, including N_2O_4, were left in their storage tanks in anticipation of restarting operations at the facility. Once the bankruptcy became final, the chemicals in the storage tanks remained.

U.S. Environmental Protection Agency (USEPA) Region 4 Pollution Reports document N_2O_4 removal activities conducted at the site (Appendix A). Disposal of the N_2O_4 was conducted by DuPont and BOC Gases via Mississippi Chemical Company. This report indicates that the USEPA completed removal activities at the site on February 16, 2003.

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There are presently 11 tanks on site that were previously used in the production and storage of N_2O_4 at the site. These tanks are designated V-131 through V-138, V-152, V-154, and V-162. The USEPA compiled a list of the remaining tank contents. A portion of this list with pertinent information on the N_2O_4 tanks is included in Appendix B. Based on a mass balance calculation conducted by the Mississippi Department of Environmental Quality (MDEQ) after the USEPA removal events, approximately 250 gallons of N_2O_4 remain in the tanks. N_2O_4 may also be present in piping, pumps, filter housing, valves, etc. affiliated with these tanks.

1.3 Work Plan Approach

The general Work Plan strategy was developed to first and foremost maintain worker and community safety. In October 1995, an accident involving improper handling and transfer of N_2O_4 from a rail car occurred in Bogalusa, Louisiana. As reported by the National Transportation Safety Board (NTSB), this accident resulted in 4,710 people seeking medical treatment at area hospitals resulting in 81 hospitalizations (Appendix C). A review of the NTSB report revealed some situations to avoid that were applied in the development of this Work Plan.

In addition to worker safety and environmental protection, this Work Plan was developed considering the compliance requirements to clean these tanks. It is ARCADIS' understanding that the material in the tanks is not a waste. However, if it is determined by MDEQ, or other regulatory agencies, that this material is a waste, the tanks would be considered "Resource Conservation and Recovery Act (RCRA) empty" as defined in 40 Code of Federal Regulations (CFR) 261.7.

During the USEPA removal events, the tanks were pumped until the pump broke suction. This indicates that the tanks were drained to the fullest extent possible. Material left in the tanks considered "RCRA empty" are not considered hazardous waste. However, the disposal of remaining N_2O_4 by the methods outlined in this Work Plan will help to mitigate the risks associated with this product.

2. Properties of Dinitrogen Tetroxide

The information presented in this section is a compilation of data obtained from published material safety data sheets, the National Institute for Occupational Safety and Health (NIOSH) Pocket Guide (September 2005), the Center for Disease Control's International Chemical Safety Card, and the U.S. Department of Health & Human Services – Agency for Toxic Substances and Disease Registry. Copies of pertinent data obtained from these sources are included in Appendix D.

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2.1 Physical Properties

N_2O_4 is colorless. Nitrogen dioxide (NO_2) has a reddish-brown color. The presence of the reddish-brown color will indicate a release. Under pressure, these two compounds exist in an equilibrium mixture. N_2O_4 is the dimer of NO_2, which means that it is formed from the weak union of two NO_2 molecules. The degree to which this substance is N_2O_4 or NO_2 is temperature dependent. NO_2 has a boiling point of 70 degrees Fahrenheit (°F) (21.2 degrees Celsius [°C]). Its freezing point is 15°F (-11.2°C). The specific gravity of liquid N_2O_4 is 1.44 to 1.45 at 20°C, which means that it is heavier than water. Its vapor density of 1.58 indicates that it is heavier than air. Therefore, NO_2 in liquid and/or gas states will tend to sink to the bottom of its container, or to ground level.

2.2 Chemical Properties

N_2O_4 is a strong oxidizer with an irritating, pungent odor. While not flammable, it is hypergolic. Therefore, N_2O_4 may cause a fire to occur when it contacts flammable or combustible materials. It is not soluble in water because it will decompose and form nitric acid (HNO_3) and nitric oxide (NO). The production of HNO_3 is believed to be one of the drivers for the tank failure incident described in the NTSB brief in Appendix C.

2.3 Toxicity Characteristics

Inhalation of NO_2 may be fatal. If inhalation does not result in death, it may cause lung edema (fluid buildup in the lungs). NO_2 is corrosive to the eyes, skin, mucous membranes, and respiratory tract. Some of the effects of NO_2 exposure may be delayed by 48 to 72 hours. In the event of exposure, medical observation is indicated.

NO_2 is listed in 29 CFR 1910.1000 and, therefore, is regulated under the Occupational Safety and Health Administration (OSHA). The OSHA Permissible Exposure Limit for NO_2 is 5 parts per million (ppm), or 9 milligrams per cubic meter. The NIOSH Immediately Dangerous to Life and Health concentration is 20 ppm (Appendix D).

2.4 Regulatory Considerations

NO_2 is a listed waste (Waste Code P078) in 40 CFR 268. It is subject to land disposal restrictions. As such, it has specific treatment requirements. In the “Treatment Standards for Hazardous Wastes” table in 40 CFR 268.40, the only allowable treatment method is “ADGAS”. ADGAS as defined in 40 CFR 268.42 Table 1, Technology Codes and Description of Technology-Based Standards, consists of

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"Venting of compressed gases into an absorbing or reacting media (i.e., solid or liquid)...".

Because NO_2 is a listed waste, only permitted Treatment, Storage, and Disposal Facilities can legally treat this waste. NO_2 is one of the permitted wastes that Waste Management in Emelle, Alabama, can treat. Their preferred treatment process for this waste is solidification. The final disposal of the solidified material will be in their on-site landfill.

3. Health and Safety Precautions

Exclusion zone, decontamination zone, and support zone boundaries will be developed prior to conducting site operations. Anyone working in the exclusion zone shall be in Level A personal protective equipment (PPE). Level A PPE offers the highest respiratory protection (supplied air) and dermal protection (fully encapsulating suit). The fully encapsulating suits will be made of a material resistant to degradation by N_2O_4 and NO_2.

Prior to implementing transfer operations as described in Section 4, the local fire department's hazardous materials unit will be notified of the planned activities. In addition, the local hospital's emergency room will be notified of the planned activities.

A water curtain will be installed in proximity to the tank connections. The water curtain will be used to spray water onto a plume in the event of an uncontrolled release of NO_2. The purpose of contacting the NO_2 with water is to create HNO_3 that will fall to the ground surface, instead of dispersing to the atmosphere. The HNO_3 will be containerized and neutralized.

4. Treatment Process

The activities described herein will be conducted with prior approval from MDEQ. A conceptualized treatment schematic is included as Figure 3. MDEQ has oversight on all aspects of remediation activities conducted at this site.

4.1 N_2O_4 and NO_2 Treatment

The activities contained in this section will be conducted if MDEQ allows ARCADIS to handle the material in the N_2O_4 tanks and considers it legal for ARCADIS and its subcontractors to conduct these operations on MDEQ's behalf.

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The operations described below will ideally proceed when the ambient temperature is less than 70°F. All transfer lines, tanks, treatment equipment, etc. that may be in contact with N_2O_4 will be property cleaned prior to connecting to the treatment process. This will maximize the liquid N_2O_4 content in the storage tanks, thereby making transfer and treatment operations easier.

The N_2O_4 liquid in the tank will be treated before the NO_2 vapors. Each tank will be connected to the treatment system and pressure tested prior to beginning treatment. To move the N_2O_4 liquid into the treatment system, an air compressor connected to the tank vent will be coupled to the tank. Air will be added to the tank vent until the pressure in the tank is 10 pounds per square inch above the initial tank pressure. The introduction of air will be maintained until the nitrogen oxide (NOx) level in the inlet stream to the scrubber drops off significantly. After this period, the tank will be allowed to depressurize through the treatment system. Steam will then be introduced for a period of not less than 30 minutes to force vapors to the treatment system.

The N_2O_4 liquid will be transferred to the first stage of the treatment process, an agitated liquid reaction vessel containing sodium hydroxide (NaOH). The pH of the reaction vessel will be monitored. NaOH will be added as needed to maintain the strength of the solution. Treated liquid will be transferred to a frac tank for testing. The vapors from the liquid reaction vessel will be exhausted to two wet scrubbers connected in series. A throttle valve will be installed to control the feed rate to the scrubber, so that no visible cloud exits the scrubbers to the atmosphere. The scrubbers will use an NaOH solution to treat NO_2 vapors that escape the liquid reaction vessel. Each scrubber will have pH controllers to maintain the strength of the NaOH solution. In addition, tubing will extend into the scrubber to allow monitoring of the scrubber's inlet and exhaust NOx concentrations with a portable meter. The treated vapors will be exhausted to the atmosphere after migration through the second scrubber.

A windsock will be installed prior to beginning treatment activities. Fence line monitoring for NO_2 will be conducted at the nearest property line downwind of the scrubber exhaust. In the event that the wind is not blowing during treatment, the fence line monitoring will be conducted at the property boundary nearest to the scrubber exhaust. Treatment operations will be halted if the fence line monitor detects an NO_2 concentration of 0.053 ppm or greater. This concentration is the USEPA National Ambient Air Quality Standard (NAAQS). After testing indicates that the NO_2 concentration is below the NAAQS for a period of 30 minutes, the flow through the treatment unit will be adjusted to increase the treatment of NO_2. The unit will be restarted and ambient air monitoring will continue.

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4.2 Tank Cleaning

Once the material in each tank has been treated, the tanks will be entered, if necessary, by trained personnel certified for confined space entry. The interior of the tank will be treated with a mild caustic solution. This solution will be allowed to react with any residue left on the interior walls of the tank for 30 minutes. The pH of the reacting solution will be measured by taking wipe samples from the top and bottom of the interior of the tank. The tank walls will be retreated with a mild caustic solution if the pH of the wipe samples is below 6.0 standard units (s.u.), or with water if the pH is above 9.0 s.u. All solution in the tank will then be transferred to the frac tank. The final pH, date, and time will be painted on the tank after cleaning has been completed.

5. Tank Cleaning Derived Wastes

Waste materials generated during these tank cleaning activities will consist of treated water, remaining caustic solution, decontamination water, and used PPE. Liquid and solid waste will be segregated to facilitate final disposal. Final disposal of liquids may include a combination of transferring the treated water to the City of Vicksburg Publicly Owned Treatment Works or to a permitted solid waste facility. Solid materials will be containerized in waste compatible bulk containers or 55-gallon drums. All containers will be labeled with the contents and date of generation of the waste material. The containers will be staged in a secure location and will be disposed of off site. A determination of the final treatment and disposal option(s) for the liquid and solid wastes will be made based on guidance from MDEQ. All final disposal manifests will be provided to MDEQ.

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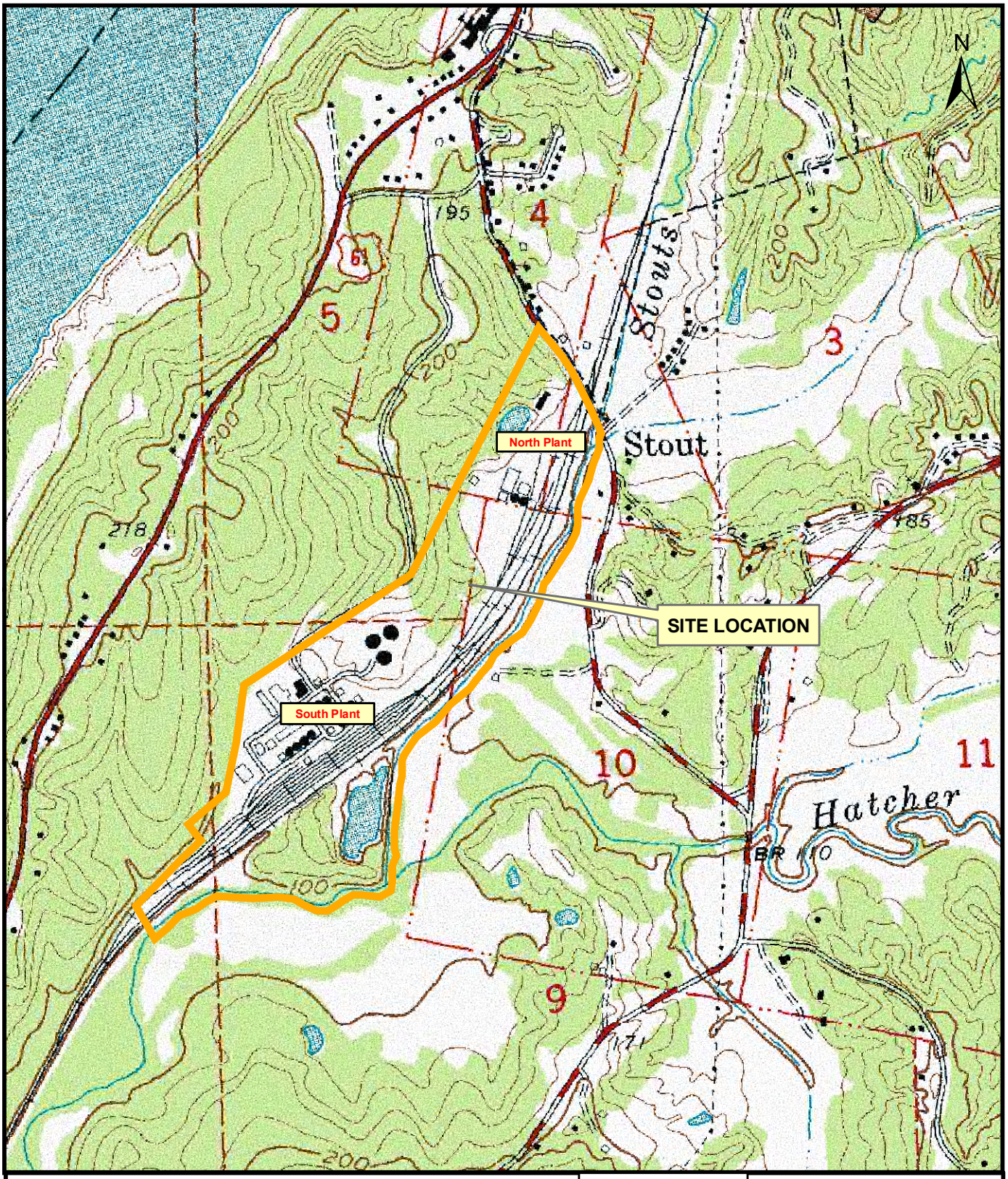


Former Plant Site

Note: Approximate Property Boundary

ARCADIS
10352 Plaza Americana Drive
Baton Rouge, Louisiana 70816
Tel: 225.292.1004 Fax: 225.218.9677

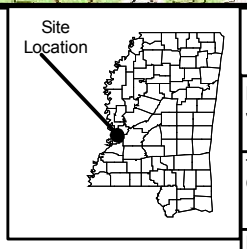
REFERENCE:

USGS, Vicksburg West Quadrangle, Mississippi
7.5 Minute Series (Topographic)

SITE LOCATION MAP

FORMER VICKSBURG
CHEMICAL COMPANY

VICKSBURG, MISSISSIPPI



500 0 500 1,000 Feet

Project Manager: JE	Completed By: JC
Task Manager: CD	Date: 07/09/2007
Project No.: LA002656.0001	Figure No.: 1

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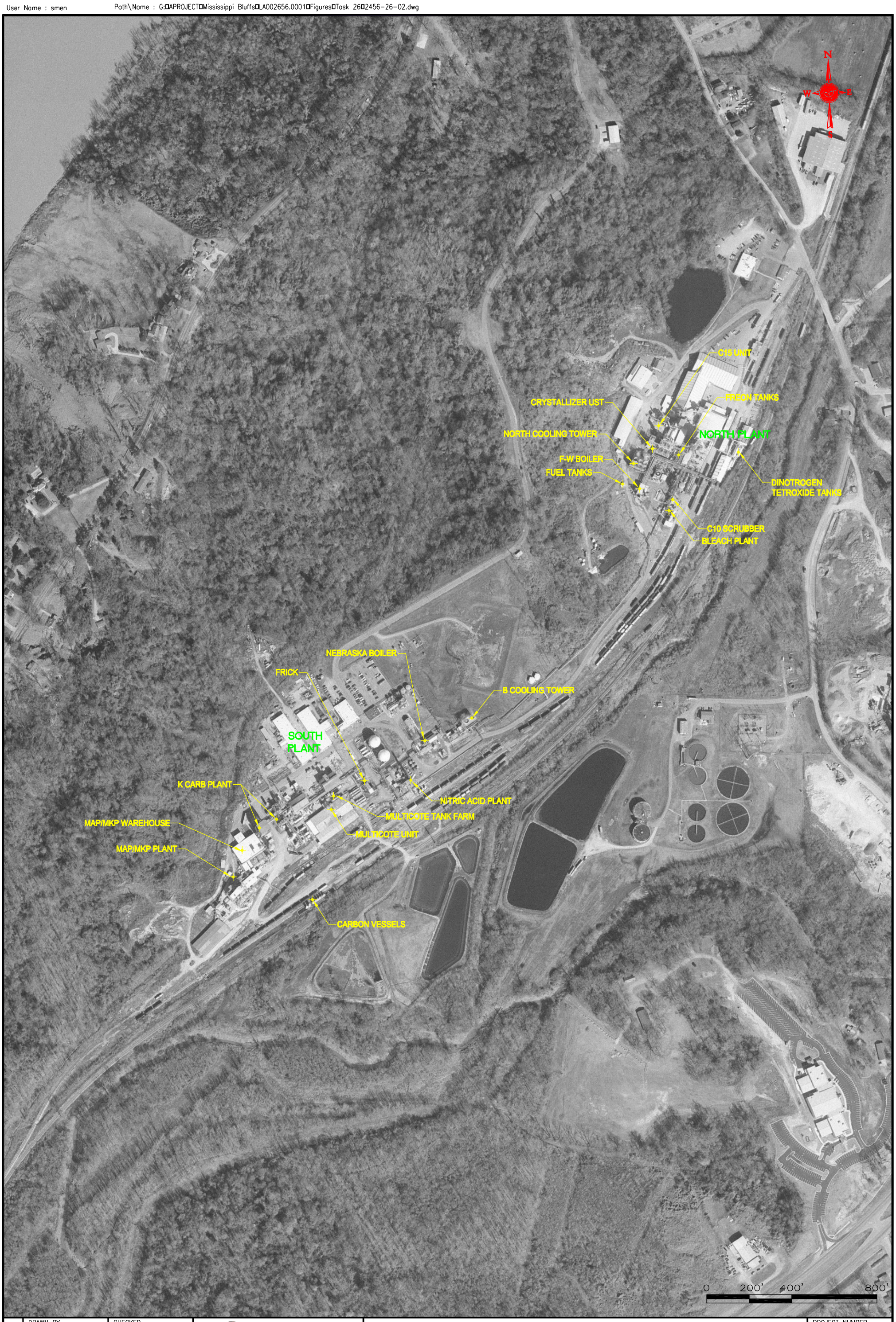

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FORMER PLANT PROCESS AREAS

FORMER VICKSBURG CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

PROJECT NUMBER
LA002656.0001

DRAWING NUMBER
2

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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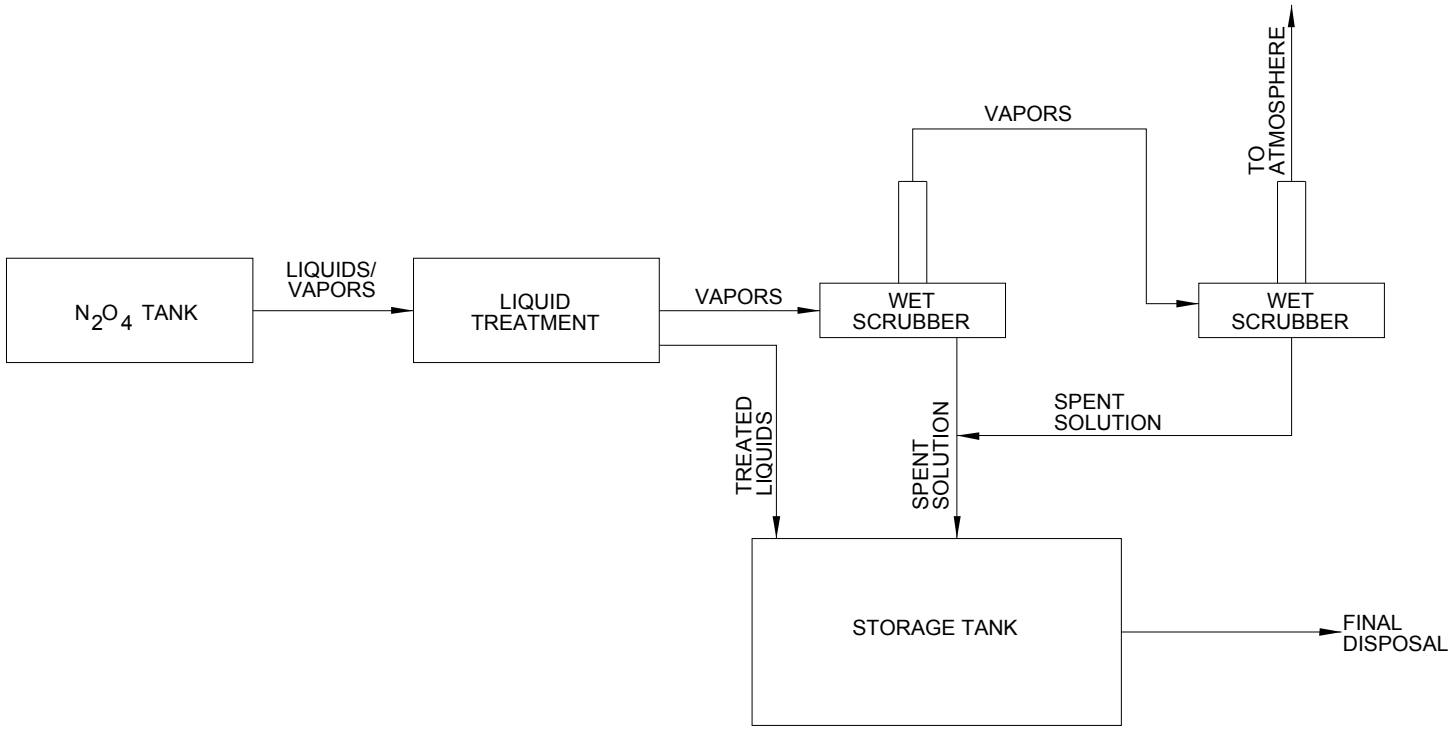

FORMER VICKSBURG CHEMICAL COMPANY
VICKSBURG, MISSISSIPPI

CONCEPTUALIZED TREATMENT SCHEMATIC
N_2O_4 TANK CLEANING

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FIGURE
3

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Appendix A

USEPA Pollution Reports

Vicksburg Chemical Fire

POLREP #8, 12/06/02-12/13/02
Situation
The USCG GST demobilized personnel from the site on December 19, 2002. ERRS demobilized personnel and equipment from the site on December 20, 2002 for the Christmas and New Year's holiday break. From December 21, 2002 to January 5, 2003, a small ERRS crew remained at the site to perform the following operations:

• Monitor the facility and provide security to control access to the site.

• Apply water to the cooling tower structure in the north plant. This is done to prevent ignition of the structure which has been impregnated with nitrates.

• Operate and maintain the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

• Winterize the north and south plant vessels and piping to prevent releases of hazardous substances into the environment.

• Inventory and document tanks and vessels including the contents and quantity of materials being stored in each.

ERRS mobilized additional personnel and equipment back to the Vicksburg Chemical Site from the holiday break on January 6, 2003. USCG GST mobilized to the site on January 7, 2003. ERRS continued the operations listed above and the following additional activities were performed:

• ERRS completed the inventory of all known tanks and vessels located on the Vicksburg Chemical Site. The dimensions of each tank were recorded along with the current status of any contents within each tank.

• ERRS / USCG began to plan and set up for sulfuric acid and di-nitrogen tetroxide (N2O4) transfer operations. This involved a review of the hazards associated with these chemicals, inspection and repair of valves and pumping systems and testing of the scrubber system which will be used during transfer operations for the N2O4.

Planned Removal Activities
See Polrep 1 for an outline of the scope of the Emergency Removal Action.

>Next Steps
• ERRS will continue to monitor the site and provide security.

• ERRS will continue operation of the effluent control system.

• ERRS will continue to apply water to the north cooling tower to prevent ignition.

• ERRS / USCG will continue to inspect and monitor tanks, vessels and other process equipment on site. Any release or threats of release will be mitigated.

• ERRS will begin transfer operations to remove sulfuric acid and N2O4 from the site. These materials will be transferred to Mississippi Chemical Company.

• ERRS will prepare to transport, dispose or treat additional chemicals from the site including sodium hydroxide, potassium hydroxide, bleach and MDI.

• USCG will continue health and safety monitoring, contractor oversight, documentation of site activities and provide additional support to the OSC.

• OSC Misenheimer / Adams will continue coordination of all site activities and maintain communications with MDEQ.

POLREP #8, 12/06/02-12/13/02
Situation
• ERRS crews continued to monitor the facility and provide security to control access to the site.

• ERRS continued to apply water to the cooling tower structure in the north plant. This is being done to prevent ignition of the structure which has been impregnated with nitrates.

• ERRS continued to operate the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

• ERRS continued to transfer nitric acid from the north plant to the south plant. Tank T-1 was emptied to prepare for the dilution of the 85% concentration nitric acid located in the north plant.

• ERRS added de-mineralized water to tank T-1 followed by an addition of the 85% nitric acid. The resulting dilution was approximately 60% nitric acid. Once the dilution operations were completed, the nitric acid was pumped to the south plant to be loaded into trucks.

• ERRS completed the transfer of approximately 77,400 gallons of nitric acid into 18 trucks. The nitric acid was taken to Mississippi Chemical Company, Yazoo City, MS. This material will be used by Mississippi Chemical in their process operations.

• USCG GST provided on site oversight of health and safety during all transfer operations. This included air monitoring for nitric acid and nitrogen dioxide.

Planned Removal Activities
See Polrep 1 for an outline of the scope of the Emergency Removal Action.

Next Steps
• ERRS will continue to monitor the site and provide security.

• ERRS will continue operation of the effluent control system.

• ERRS will continue to apply water to the north cooling tower to prevent ignition.

• ERRS / USCG will continue to inspect and monitor tanks, vessels and other process equipment on site. Any release or threats of release will be mitigated.
• ERRS will complete all transfer operations involving nitric acid. Once all nitric acid transfer operations have been completed, EPA/ERRS will evaluate the remaining on site product and waste material to determine what additional actions are required.

• ERRS will continue to winterize the north and south plant vessels and piping to prevent releases of hazardous substances into the environment. Piping and process lines are being drained and purged with compressed air.

• USCG will continue health and safety monitoring, contractor oversight, documentation of site activities and provide additional support to the OSC.

• OSC Misenheimer / Adams will continue coordination of all site activities and maintain communications with MDEQ.

POLREP #7, 11/23/02-12/05/02
Situation
ERRS continued transfer operations in the south plant. Approximately 79,200 gallons of nitric acid was loaded into 18 trucks and shipped to Mississippi Chemical Company, Yazoo City, MS. This material will be used by Mississippi Chemical in their process operations. ERRS crews continued transfer operations at the site until November 27, 2002. ERRS demobilized personnel and equipment for the Thanksgiving holiday. A skeleton crew remained at the site during the break to perform the following operations:

• Monitor the facility and provide security to control access to the site.

• Apply water to the cooling tower structure in the north plant. This is done to prevent ignition of the structure which has been impregnated with nitrates.

• Operate and maintain the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this

system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

• Winterize the north and south plant vessels and piping to prevent releases of hazardous substances into the environment. Piping and process lines are being drained and purged with compressed air.

ERRS mobilized back to the Vicksburg Chemical Site from the holiday break on December 2, 2002. ERRS continued the operations listed above and resumed transfer operations. The following actions were completed:

• ERRS completed the transfer of nitric acid from the south plant. After evaluating the plant piping configuration, EPA / ERRS / USCG determined that nitric acid from the north plant could be pumped to the south plant storage tanks and transferred using the previously defined load out configuration. ERRS began pumping nitric acid from the north plant to the south plant where it was loaded into trucks. Approximately, 76,377 gallons of nitric acid from the south and north plant was loaded into 18 trucks and shipped to Mississippi Chemical Company, Yazoo, MS. This material will be used by Mississippi Chemical in their process operations.

• USCG GST provided on site oversight of health and safety during all transfer operations. This included air monitoring for nitric acid and nitrogen dioxide. Additionally, USCG and ERRS calibrated and recorded readings from the facility air monitoring devices located in throughout the plant.

Planned Removal Activities
See Polrep 1 for an outline of the scope of the Emergency Removal Action.

Next Steps
• ERRS will continue to monitor the site and provide security.

• ERRS will continue operation of the effluent control system.

• ERRS will continue to apply water to the north cooling tower to prevent ignition.

• ERRS / USCG will continue to inspect and monitor tanks, vessels and other process equipment on site. Any release or threats of release will be mitigated.

• ERRS will continue to pump acid from the north plant to the south plant. This acid will be loaded into trucks from the tanks in the south plant. ERRS will dilute the higher concentration nitric acid (85%) using de-mineralized water. This operation will be completed in the vacated T-1 tank in the north plant. Once the dilution is completed, the nitric acid will be pumped to the south plant and loaded into trucks.

• Once all nitric acid transfer operations have been completed, EPA/ERRS will evaluate the remaining on site product and waste material to determine what additional actions are required.

• USCG will continue health and safety monitoring, contractor oversight, documentation of site activities and provide additional support to the OSC.

• OSC Misenheimer / Adams will continue coordination of all site activities and maintain communications with MDEQ.

POLREP #6, 11/22/02
Situation
• ERRS crews continue to monitor the facility and provide security to control access to the site.

• ERRS continues to apply water to the cooling tower structure in the north plant. This is being done to prevent ignition of the structure which has been impregnated with nitrates.

• ERRS continues to operate the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

• USCG inventoried and marked all tanks and vessels on site. USCG met with former facility personnel to identify the contents and estimated quantities of materials in the vessels.

• ERRS began to winterize the north and south plant vessels and piping to prevent releases of hazardous substances into the environment. Piping and process lines are being drained and purged with compressed air.

• ERRS conducted transfer operations in the south plant. Approximately 48,000 gallons of Nitric acid was loaded into eleven trucks and shipped to Mississippi Chemical Company in Yazoo City, MS. This material will be used by Mississippi Chemical in their process operations.

Planned Removal Activities
See Polrep 1 for an outline of the scope of the Emergency Removal Action.

Next Steps
• ERRS will continue to monitor the site and provide security.

• ERRS will continue operation of the effluent control system.

• ERRS / USCG will continue to inspect and monitor tanks, vessels and other process equipment on site. Any release or threats of release will be mitigated.

• ERRS will continue the load out of nitric acid in the south plant. Once this operation is completed, operations will be moved to address the nitric acid in the north plant.

• USCG will continue health and safety monitoring and provide additional support to the OSC.

• OSC Misenheimer will continue coordination of all site activities.

POLREP #4, 10/31/02
Situation
• ERRS crews continue to monitor the facility and provide 24 hour security to control access to the site.

• ERRS continues to apply water to the cooling tower structure in the north plant. This is being done to prevent ignition of the structure which has been impregnated with nitrates.

• ERRS continues to operate the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

• EPA OSC and MDEQ personnel collected water samples from the Mississippi River discharge pipe. Water samples will be analyzed for known contaminants of concern as well as water quality parameters.

• GST continues to will provide support to the OSC and assist with health and safety monitoring.

Planned Removal Activities
See Polrep 1 for an outline of the scope of the Emergency Removal Action.

Next Steps
• ERRS will continue to monitor the site and provide 24 hour security.

• ERRS will continue operation of the effluent control system.

• ERRS / GST will continue to inspect and monitor tanks, vessels and other process equipment on site. Any release or threats of release will be mitigated.

• MDEQ / ERRS will sample storm water and effluent in the north and south plant. Based on the results of the sampling effort, modifications to the current system will be considered to reduce the manpower and energy demands of the systems.

• OSC Misenheimer will continue coordination of all site activities.

POLREP #3, 10/25/02

Situation

• ERRS crews continue to monitor the facility and provide 24 hour security to control access to the site.

• ERRS has developed a checklist which is followed during routine inspections of the facility. These inspections are aimed to assess the condition of tanks and vessels on site which contain hazardous substances as well as to monitor the storm water and effluent control system. Additionally, ERRS continues to apply water to the cooling tower structure in the north plant. This is being done to prevent ignition of the structure which has been impregnated with nitrates.

• ERRS is currently operating the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

• EPA OSC coordinated with MDEQ personnel to develop a sampling strategy for the storm water collection system. MDEQ will lead the sampling event during the next major rainfall event. Water samples will be analyzed for known contaminants of concern as well as water quality parameters.

• At the request of the EPA OSC, two members from the USCG Gulf Strike Team (GST) mobilized to the site. GST will provide support to the OSC and assist with health and safety monitoring.

Planned Removal Activities

See Polrep 1 for an outline of the scope of the Emergency Removal Action.

Next Steps

• ERRS will continue to monitor the site and provide 24 hour security.

• ERRS will continue operation of the effluent control system.

• ERRS / GST will continue to inspect and monitor tanks, vessels and other process equipment on site. Any release or threats of release will be mitigated.

• MDEQ / ERRS will sample storm water and effluent in the north and south plant. Based on the results of the sampling effort, modifications to the current system will be considered to reduce the manpower and energy demands of the systems.

• OSC Misenheimer will continue coordination of all site activities.

Key Issues

Several potential buyers of the property have requested access to tour the site. Access for these parties will be coordinated with EPA and MDEQ legal staff.

POLREP #2, 10/19/02
SITE INFORMATION
MSDEQ requested EPA lead of an abandoned chemical facility, Vicksburg Chemicals Corporation (VCC). The 650 acre facility is located within the city limits of Vicksburg among industrial and residential properties. Approximately 500,000 gallons of chemicals and wastes remain on site. Several tanks and associated piping are corroded and leaking corrosive substances.

RESPONSE INFORMATION:
A. Actions Taken: OSC Negron directed START to assimilate data regarding identification and hazard characterization of the substances on site. OSC Negron directed Ferguson Harbour Inc. (FHI) to provide site security and mitigate the releases from several nitric acid tanks.

B. Future Actions: FHI will manage storm water runoff that collects in the process areas and maintain fire suppression on the cooling structure impregnated with nitrate.

C. Use of Innovative Technologies: None.

D. Community Involvement: None required to date.

E. Unusual Circumstances: None.

F. Future Considerations: EPA ERRB will evaluate this site for time-critical removal action.

G. Post Removal Site Control: None identified at this time.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

1. HEADING

Date: January 24, 2003

Subject: Vicksburg Chemical Company Site
Vicksburg, Mississippi

From: Kevin S. Misenheimer, OSC
Emergency Response and Removal Branch

To: Jim Kutzman, WMD
Region 4 Response Center
Don Rigger, ERRB
Shane Hitchcock, ERRB
Matthew Taylor, ERRB
Wilda Cobb, ORC
Ken Whitten, MSDEQ
USCG Gulf Strike Team
EPA HQ

POLREP 11

Period of Record: 01/11/03 - 01/24/03

2. BACKGROUND

Site No: A49H
Location: 4280 Rifle Range Road
TO Amount: $ 650,000
Response Authority : CERCLA
NPL Status: non-NPL
Start Date: 10-15-02

EPA ID: MSD990714081
Task Order No: 68-S4-02-07
Contractor: Ferguson Harbour
Incident Category: Removal Action
State Notification: MSDEQ
Completion Date: on-going

3. SITE INFORMATION

See Polrep 1

IV. RESPONSE INFORMATION

A. Situation

- ERRS crews continued to monitor the facility and provide security to control access to the site.

- ERRS continued to apply water to the cooling tower structure in the north plant. This is being done to prevent ignition of the structure which has been impregnated with nitrates.

- ERRS continued to operate the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

- ERRS completed the transfer of approximately 3,787 gallons of sulfuric acid into 2 trucks. The sulfuric acid was taken by Mississippi Chemical Company. This material will be recycled by Mississippi Chemical in their process operations. This concludes the removal of sulfuric acid from storage tanks in the north plant.

- ERRS completed the loading of 14 cylinders with N_2O_4. Each cylinder was filled with 2,000 lbs of N_2O_4 except for the final cylinder which was only half filled. The total loaded was approximately 27,000 lbs. Ten of the cylinders were loaded into trucks for shipment to DuPont, as arranged by the MDEQ. Four of the cylinders remain onsite and will be picked up by BOC. All of the pumpable N_2O_4 has been removed from the N_2O_4 plant.

- USCG GST provided oversight of all site operations including monitoring health and safety during all transfer operations. USCG GST demobilized from the site on January 24, 2003.

B. Planned Removal Activities

See Polrep 1 for an outline of the scope of the Emergency Removal Action.

C. Next Steps

- ERRS will continue to monitor the site, maintain the effluent control system and apply water to the north cooling tower to prevent ignition.

- ERRS will inspect, evaluate and repair fencing surrounding the site.

- ERRS will arrange for the disposal of 7 drums of MDI. ERRS will evaluate disposal options for additional materials onsite including bleach, tall oil, and castor oil.

- OSC Misenheimer / Adams will continue coordination of all site activities and maintain communications with MDEQ.

V. COST INFORMATION (as of 01-15-03)

	Total	Ceiling
ERRS	$ 471,000	$ 650,000
START-2	$ 17,000	$ 25,000
USCG	$ 51,700	$ 85,000
TOTAL	$ 539,700	$ 760,000

The above accounting of expenditures is an estimate based on figures known to the OSC at the time this report was written. The cost accounting provided in this report does not necessarily represent an exact monetary figure which the government may include in any claim for cost recovery.

VI. DISPOSITION OF WASTES

Waste Stream	Medium	Weight	Volume	Containment-Migration Control	Treatment	Disposal
Nitric Acid	Liquid	1615.7 tons	289,309 gal[1]	Transported Off Site	Recycled	Mississippi Chemical Company Yazoo City, MS
Sulfuric Acid	Liquid	29.03 tons	3,787 gal[2]	Transported Off Site	Recycled	Mississippi Chemical Company
Dinitrogen Tetroxide	Liquid	10 tons	N/A	Transported Off Site	Recycled	DuPont via Mississippi Chemical Company
Castor Oil	Liquid	N/A	4 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Amberlite		N/A	25 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Cation resin		N/A	18 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Anion resin		N/A	2 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Silica desicant		N/A	1 drum	Transported Off Site	Recycled	Mississippi Chemical Company

[1] Nitric acid volume based on 11.5 lbs/gallon density.

[2] Sulfuric acid volume based on 15.33 lbs / gallon density.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

1. HEADING

Date: February 6, 2003

Subject: Vicksburg Chemical Company Site
Vicksburg, Mississippi

From: Kevin S. Misenheimer, OSC
Emergency Response and Removal Branch

To: Jim Kutzman, WMD
Region 4 Response Center
Don Rigger, ERRB
Shane Hitchcock, ERRB
Matthew Taylor, ERRB
Wilda Cobb, ORC
Ken Whitten, MSDEQ
EPA HQ

POLREP 12

Period of Record: 01/25/03 - 02/06/03

2. BACKGROUND

Site No: A49H
Location: 4280 Rifle Range Road
TO Amount: $ 650,000
Response Authority : CERCLA
NPL Status: non-NPL
Start Date: 10-15-02

EPA ID: MSD990714081
Task Order No: 68-S4-02-07
Contractor: Ferguson Harbour
Incident Category: Removal Action
State Notification: MSDEQ
Completion Date: on-going

3. SITE INFORMATION

See Polrep 1

IV. RESPONSE INFORMATION

A. Situation

- ERRS crews continued to monitor the facility and provide security to control access to the site.

- ERRS continued to apply water to the cooling tower structure in the north plant. This is being done to prevent ignition of the structure which has been impregnated with nitrates.

- ERRS continued to operate the storm water and effluent control system. This system collects storm water and remaining process water prior to discharge from the site. Within this system are treatment units for pH adjustment, sedimentation and the removal of organic contaminants.

- ERRS / EPA collected five surface water samples from sumps throughout the site for water quality analysis. ERRS collected one surface water sample from the treatment ponds on site.

- ERRS loaded four cylinders of N_2O_4 onto a truck provided by BOC Gases for shipment to the BOC facility in Chattanooga, TN.

- ERRS evaluated the status of fencing surrounding the property and began to repair and replace sections as necessary.

- ERRS modified the effluent control system to reduce electrical demands. This involved the mobilization of fuel driven, mobile pumps which were plumbed into the existing piping at the site.

B. Planned Removal Activities

See Polrep 1 for an outline of the scope of the Emergency Removal Action.

C. Next Steps

- ERRS will arrange for the disposal of 7 drums of MDI.

- ERRS will demobilize personnel and equipment from the site as necessary. EPA will transfer operations and management of the site to MDEQ.

- OSC Misenheimer / Adams will maintain communications with MDEQ.

D. Key Issues

The Mississippi Department of Environmental Quality (MDEQ) will takeover day to day management of the Vicksburg Chemical Company Site. EPA has completed the initial response actions necessary to mitigate the emergency threats to human health and the environment resulting from the abandonment of the facility. Response to any new releases or threats of releases from the site will be managed by MDEQ, unless additional requests are made to EPA for assistance.

V. COST INFORMATION (as of 02-01-03)

	Total	Ceiling
ERRS	$ 485,000	$ 650,000
START-2	$ 17,000	$ 25,000
USCG	$ 57,700	$ 85,000
TOTAL	$ 559,700	$ 760,000

The above accounting of expenditures is an estimate based on figures known to the OSC at the time this report was written. The cost accounting provided in this report does not necessarily represent an exact monetary figure which the government may include in any claim for cost recovery.

VI. DISPOSITION OF WASTES

Waste Stream	Medium	Weight	Volume	Containment-Migration Control	Treatment	Disposal
Nitric Acid	Liquid	1615.7 tons	289,309 gal[1]	Transported Off Site	Recycled	Mississippi Chemical Company Yazoo City, MS
Sulfuric Acid	Liquid	29.03 tons	3,787 gal[2]	Transported Off Site	Recycled	Mississippi Chemical Company
Dinitrogen Tetroxide	Liquid	13 tons	N/A	Transported Off Site	Recycled	DuPont and BOC via Mississippi Chemical Company
Castor Oil	Liquid	N/A	4 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Amberlite		N/A	25 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Cation resin		N/A	18 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Anion resin		N/A	2 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Silica desicant		N/A	1 drum	Transported Off Site	Recycled	Mississippi Chemical Company

[1] Nitric acid volume based on 11.5 lbs/gallon density.

[2] Sulfuric acid volume based on 15.33 lbs / gallon density.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

1. HEADING

Date: February 6, 2004

Subject: Vicksburg Chemical Company Site
Vicksburg, Mississippi

From: Kevin S. Misenheimer, OSC
Emergency Response and Removal Branch

To: Region 4 Response Center
Shane Hitchcock, ERRB
Don Rigger, ERRB
Matthew Taylor, ERRB
Tony Moore, ERRB
Wilda Cobb, ORC
Ken Whitten, MSDEQ
EPA HQ

POLREP 13 and FINAL

2. BACKGROUND

Site No: A49H
Location: 4280 Rifle Range Road
TO Amount: $ 650,000
Response Authority : CERCLA
NPL Status: non-NPL
Start Date: 10-15-02

EPA ID: MSD990714081
Task Order No: 68-S4-02-07
Contractor: Ferguson Harbour
Incident Category: Removal Action
State Notification: MSDEQ
Completion Date: 02-16-03

3. SITE INFORMATION

The Vicksburg Chemical Company is located within the city limits of the City of Vicksburg, Warren County, Mississippi. The Site is comprised of approximately 650 acres divided into two separate and distinct operations known as the North Plant and the South Plant. The North Plant produced potassium nitrate (fertilizer), liquid chlorine and liquid dinitrogen tetraoxide (rocket fuel). The South Plant produced chlorinated pesticides, herbicides and other agricultural products including among others: dinitro butyl phenol, monosodium methane

arsonate, toxaphene, methyl parathion, and atrazine. Currently, VCC as well as its parent company filed a voluntary petition for relief 300.415(b)(2)(i) under Chapter 11 of the Title 11 of the United States Code (Bankruptcy Code) as well as to abandon the Site.

IV. RESPONSE INFORMATION

A. Situation

1. Current Situation

EPA completed the removal action on February 16, 2003. EPA contractors (Ferguson Harbor, Inc.) were demobilized from the site on this date, however, MSDEQ continued using Ferguson Harbor, Inc. to maintain the site after the EPA action was completed. Since that time, MSDEQ has been providing site security as well as maintaining critical systems to manage contaminated storm water runoff. Due to uncertainties related to the future use or sale of the property, EPA has continued to maintain communications with MSDEQ during this period.

2. Removal Activities to Date

During the removal action, EPA maintained the facilities' environmental control systems and also mitigated numerous threats posed by leaking tanks, drums and other bulk storage containers on the Vicksburg Chemical Site. These activities are outlined in the previous Pollution Reports and are also summarized in the attached report entitled Vicksburg Chemical Project, Final Report.

B. Planned Removal Activities

EPA's removal activities as listed in the Action Memorandum were as follows:

1. Conduct personnel and site air monitoring activities and other health and safety actions as may be required;

2. Maintain site security to control access to the site;

3. Maintain and operate existing effluent control system as long as effluent requires treatment;

4. Inspect, evaluate and maintain all bulk storage containers and process equipment to prevent releases of hazardous substances, pollutants or contaminants;

5. Respond to leaks and spills from bulk storage containers and process equipment to mitigate threats to public health and the environment;

6. Modify and/or re-configure effluent control system and site storm water

management system;

7. Characterize, load-out, transport and recycle or dispose of product and waste material stored on site

C. Next Steps

MSDEQ is currently maintaining the Vicksburg Chemical Site. Although no additional EPA removal activity is anticipated at this time, EPA continues to monitor MSDEQ activities at the site.

D. Key Issues

EPA's removal activities have addressed the most time-critical threats posed by the Vicksburg Chemical Company Site. Threats posed by leaking tanks containing nitric acid, sulfuric acid and nitrogen dioxide have been mitigated. Additionally, other bulk storage containers containing hazardous substances have been removed from the site. Access to the site has been restricted by placing and repairing the perimeter fence. This has reduced the threat of exposure to trespassers who might come into contact with contaminated soils which remain on the facility.

V. COST INFORMATION (as of 02-01-04)

	Total	Ceiling
ERRS	$ 548,700	$ 650,000
START-2	$ 17,000	$ 25,000
USCG	$ 62,300	$ 85,000
TOTAL	$ 628,000	$ 760,000

The above accounting of expenditures is an estimate based on figures known to the OSC at the time this report was written. The cost accounting provided in this report does not necessarily represent an exact monetary figure which the government may include in any claim for cost recovery.

VI. DISPOSITION OF WASTES

Waste Stream	Medium	Weight	Volume	Containment-Migration Control	Treatment	Disposal
Nitric Acid	Liquid	1615.7 tons	289,309 gal[1]	Transported Off Site	Recycled	Mississippi Chemical Company Yazoo City, MS
Sulfuric Acid	Liquid	29.03 tons	3,787 gal[2]	Transported Off Site	Recycled	Mississippi Chemical Company
Dinitrogen Tetroxide	Liquid	13 tons	N/A	Transported Off Site	Recycled	DuPont and BOC via Mississippi Chemical Company
Castor Oil	Liquid	N/A	4 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Amberlite		N/A	25 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Cation resin		N/A	18 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Anion resin		N/A	2 drums	Transported Off Site	Recycled	Mississippi Chemical Company
Silica desicant		N/A	1 drum	Transported Off Site	Recycled	Mississippi Chemical Company
MDI			7 drums	Transported Off SIte	Disposed	Perma Fix

[1] Nitric acid volume based on 11.5 lbs/gallon density.

[2] Sulfuric acid volume based on 15.33 lbs / gallon density.

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Appendix B

USEPA Tank List (Partial)

VICKSBURG CHEMICAL SITE
TANK INVENTORY

Area	Old Tank Name/#	New Tank Name/#	Sample ID#	Mat. of Const.	Contents	Total Capacity	Start Level	Diameter in Feet	Circum. In Feet	Height / Length in Feet	Gallons	Tons	Sec. Cont.	Volume Remaining	Disposition	Comments
North Plant																
KNO3 E-side	V-131			C.S.	N2O4	5,500	0 ft.	6'		32'	X		N			Empty & air blown, not gas free
KNO3 E-side	V-132			C.S.	N2O4	6,200	0 ft.	6'		32'	X		N			Empty & air blown, not gas free
C12 Loadout	V-133			C.S.	N2O4	25,000	0-1 ft.	10'		44'	X		N			Not air swept or cleaned
C12 Loadout	V-134			C.S.	N2O4	20,000	0-1 ft.	10'		34'	X		N			Not air swept or cleaned
C-12 Loadout	V-135						Residue	6'		9'						Nitric Oxide Dryer
C-12 Loadout	V-136						Residue	2'		7'						N2O4 - H2O Reaction pot
C-12 Loadout	V-137		24	C.S.	N2O4		30,000#	5'		25'			N	Residue	MS Chem	Loaded out and shipped to Dupont/Dow and to BOC Gases
C12 Loadout	V-138			C.S.	N2O4	15,000	0-1 ft.	8'		42'	X		N			Not air swept or cleaned
C12 Loadout	V-152			C.S.	N2O4	14,579	0-1 ft.	8'		38'	X		N			Not air swept or cleaned
C12 Loadout	V-154						Residue	1'		5'						Heel Filter
C12 Loadout	V-162			S.S.	N2O4	8,129	0-1 ft.	6'		40'	X		N			Not air swept or cleaned

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Appendix C

NTSB Hazardous Materials Accident Brief

National Transportation Safety Board

Washington, D.C. 20594

Hazardous Materials Accident Brief

Accident No.:	DCA-96-MZ-001
Transportation Mode:	Rail
Type of Accident:	Tank car failure and release of poisonous and corrosive vapors
Location:	Gaylord Chemical Corporation, Bogalusa, Louisiana
Date and Time:	October 23, 1995, about 4:45 p.m.
Shipper:	Vicksburg Chemical Company
Tank Car Specification:	DOT 105A500W
Tank Car Manufacturer:	Union Tank Car Company
Injured:	4,710 people were treated at area hospitals, of whom 81 were admitted
Evacuated:	Approximately 3,000 people
Material Released:	Nitrogen tetroxide, a poisonous material (oxidizer)
Type of Failure:	Corrosion

Accident Narrative

At 3:55 p.m. on October 23, 1995, at the Gaylord Chemical Corporation plant in Bogalusa, Louisiana, yellow-brown vapors began leaking from the dome of the DOT class 105A railroad tank car UTLX 82329 that contained a mixture of nitrogen tetroxide, which is a liquefied poisonous gas and oxidizer, and water. The vapors initially formed a plume between 10 and 15 feet in diameter. Plant personnel notified emergency response agencies and used two plant fire hoses to spray water into the plume to suppress the vapors. About 4:30 p.m. Bogalusa fire personnel arrived at the plant and set up fire hoses to help-suppress the vapors.

The head on the B-end of the tank car failed about 4:45 p.m., resulting in one end of the tank car jacket being torn away and thrown about 350 feet. The tank car was then propelled 35 feet down the track and derailed at a track bumping block. A large reddish-brown vapor cloud was released from the tank car. Vapors continued to be released from the opening in the tank car for another 36 hours until the chemical reaction that had occurred within the tank was brought under control through neutralization and dilution.

Some 3,000 people were evacuated from the area as a result of the vapor cloud. Of 4,710 people who were treated at local hospitals, 81 people were admitted.

Events Preceding the Accident

On September 14, 1995, nitrogen tetroxide vapors had leaked at a valve on the tank car while it was at the Gaylord plant. A mechanic sprayed water to suppress the vapors and then directed the water stream onto the valve stem as the tank car was unloaded. When the water

was turned off could not be determined. Another mechanic stated that the water was no longer being applied over the valve on September 22, when employees of the Union Tank Car Company (manufacturer and owner of the tank car) arrived at the plant to replace the valve; they replaced four valves. Postaccident examination of those valves removed from the tank car disclosed that one valve stem had significant wear.

The tank car was moved to the Vicksburg Chemical Company in Vicksburg, Mississippi, on September 26, for another load of nitrogen tetroxide. On October 5, the chemical company recorded that the tare weight of this tank car was 9,500 pounds over the marked weight for the tank car. A Vicksburg employee noticed the new valves on the tank car and assumed that the car had been rebuilt and that the tank car's trucks had been replaced, thus changing the weight. He did not, however, verify these assumptions. The tank car was then filled with approximately 10,000 gallons (110,000 pounds) of nitrogen tetroxide. A quality check had been conducted on the nitrogen tetroxide before it was transferred to the tank car, and it was found to meet the specifications of the Gaylord Chemical Corporation. No quality check was performed on the material after it was loaded into the tank car. The loaded tank car was returned to Gaylord.

On October 12, Gaylord mechanics began transferring nitrogen tetroxide from the tank car to a storage tank. While this transfer was taking place, the material in the storage tank was simultaneously being transferred into the plant. At 9 a.m., the process safety interlocks shut down the chemical reactor. Gaylord's investigation into the cause of the chemical reactor shutdown revealed that the nitrogen tetroxide had been contaminated with water. To prevent corrosion damage from nitric acid, which results when water reacts with nitrogen tetroxide, Gaylord decided to transfer the contaminated material from the tank car and storage tank into stainless steel highway cargo tank trailers. A meter was used to measure the amount of product transferred from the tanks. A pressure gauge with a maximum calibrated pressure of 100 psig was used to monitor the internal pressure of the tank car.

Overnight, between October 12 and 13, the meter indicated that 10,100 gallons of product were transferred from the tank car into two cargo tanks. No other check was made on the tank car or the cargo tanks before the accident to determine how much material had been transferred. When the transfer operation was stopped, a material sample was taken from the transfer system; the sample contained a small amount of green liquid with foam. At 4 a.m. on October 13, Gaylord employees believed the tank car was empty, except for a small amount of residual material that could not be pushed up through one of the eduction pipes, and water was added to the tank car to dilute this residual material. Postaccident weighing of the material loaded into the two cargo tanks revealed that only 491 gallons (6,080 pounds) had been transferred. Postaccident examination of the tank car showed that the carbon steel eduction pipes had corroded and that only a small section of each, near the top of the tank, remained.

No work was performed on the tank car for several days while Gaylord employees were cleaning, testing, and inspecting the plant storage tank. On October 16, Gaylord determined that the vapors coming from the tank car were excessive, indicating that the material in the tank car was not dilute enough to permit discharge of the residual material into the plant sewer system. Plans were made to transfer the residual material into another cargo tank, but these plans were changed when vapors started leaking from the manway of another cargo tank

that had been filled with material from the storage tank. Gaylord determined that several cargo tanks had gaskets and valves that were not appropriate for nitrogen tetroxide and fuming nitric acid and between October 17 and 20 replaced these gaskets and valves.

On October 19, material samples obtained from the tank car and the three cargo tanks were taken to the Vicksburg Chemical Company for chemical analysis. Gaylord employees began the transfer of the material remaining in the tank car on October 20, and by 6 p.m. that day, the meter indicated that 6,700 gallons of material had been transferred from the tank car to a cargo tank. At the conclusion of the transfer, a material sample taken from the transfer system was observed to contain foam and a very small amount of green liquid. Postaccident weighing of the material loaded into this cargo tank revealed that only about 850 gallons (10,520 pounds) of material had been transferred.

Water was added to the tank car using a fire hose to purge and clean it; the addition of water was discontinued when the internal pressure of the tank car rose to between 60 and 65 psig. Gaylord employees vented the vapors from the tank car through the plant scrubber to lower the pressure in the tank car. Later on the evening of October 20, Gaylord employees began emptying the material from the tank car into the plant sewer system; after 2 or 3 minutes, a large vapor cloud was released, and the unloading was stopped. On October 21, a Gaylord employee twice added water to dilute the material in the tank car and vented the vapors through the scrubber. The internal pressure of the tank car increased each time the water was added.

On October 23, the gauge on the tank car indicated that the internal pressure was 18 psig. Plans were made to complete the emptying and the cleaning of the tank car. At 12:54 p.m., Gaylord received the results of the chemical analysis of the material sample obtained from the tank car on October 19. The results indicated that the material was wet nitrogen tetroxide. These results were unexpected because Gaylord believed that on October 13 the nitrogen tetroxide had been unloaded from the tank car and that the residue had been diluted with water. After discussing the apparent discrepancy with the Vicksburg laboratory specialist who had tested the sample, Gaylord personnel decided the sample may not have been representative of the material in the tank car.

Between 1:30 and 1:45 p.m. on October 23, Gaylord employees put more water into the tank car, and the internal pressure rose from 18 to 80 psig in 4 to 5 minutes, at which point the water was turned off. About 2 p.m., the pressure reached 92 psig and then slowly began to decline. The plant scrubber was still being used to vent the vapors from the tank car, and an additional hose was run from one of the tank car valves to a water-filled drum for additional venting. The internal tank car pressure was 55 psig by 2:30 p.m. When Gaylord employees reopened the fire hose, the pressure rose to 100 psig, which is the maximum calibrated pressure on the gauge. The water was turned off, and the vapors were again vented. At 3 p.m., the pressure appeared to be falling, but at 3:30 p.m., it was still above the measurement limit of the gauge and appeared to be rising. At 3:55 p.m., a yellow-brown vapor was observed leaking from the dome of the tank car. The head on the B-end of the tank car failed about 4:45 p.m. releasing a huge reddish-brown vapor cloud.

Postaccident examination of the safety relief mechanism mounted in the dome revealed that it had recently activated. (Activation pressure is about 375 psig.) The examination also revealed an 8-inch-high by 66-inch-wide corroded opening in the B-end head of the tank car near the top. In addition, at least three distinctive horizontal bands of corrosion were found near the top of the interior tank wall; one band was at the same level as the opening in the tank head.

Postaccident Actions

Gaylord Chemical Corporation has discontinued the use of tank cars to transport nitrogen tetroxide and now uses smaller tanks that hold only 3 percent of the volume capacity of the tank car involved in the accident. Cargo purity assurance procedures, including the testing of cargo before and after loading, have been implemented to prevent the transport of contaminated cargo. The plant has additionally installed equipment to warn residents of any accidental release and, in coordination with the city of Bogalusa, has developed emergency procedures and conducted training.

The tank car destroyed in this accident was the last carbon steel tank car in use that had been approved by the US Department of Transportation for transporting nitrogen tetroxide.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the lack of adequate procedures on the part of the Gaylord Chemical Corporation and the Vicksburg Chemical Company to prevent or detect the contamination of nitrogen tetroxide with water, resulting in the formation of an extremely corrosive product and the subsequent failure of the tank car. Contributing to the severity of the accident were the Gaylord Chemical Corporation's inadequate procedures for emergency transfer of contaminated cargo from the tank car.

Recommendations – None

Adopted 1/27/98

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Appendix D

Selected Published Guidance on N_2O_4

International Chemical Safety Cards

NITROGEN DIOXIDE

ICSC: 0930

Nitrogen peroxide
NO_2
Molecular mass: 46.01
(cylinder)

ICSC # 0930
CAS # 10102-44-0
RTECS # QW9800000
UN # 1067
EC # 007-002-00-0
May 09, 2003 Peer reviewed

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible but enhances combustion of other substances.	NO contact with combustibles.	In case of fire in the surroundings: use appropriate extinguishing media.
EXPLOSION			In case of fire: keep cylinder cool by spraying with water.
EXPOSURE		STRICT HYGIENE!	IN ALL CASES CONSULT A DOCTOR!
•INHALATION	Burning sensation. Sore throat. Cough. Dizziness. Headache. Sweating. Laboured breathing. Nausea. Vomiting. Shortness of breath. Weakness. Symptoms may be delayed (see Notes).	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration may be needed. Refer for medical attention.
•SKIN	Redness. Pain. Skin burns.	Protective gloves. Protective clothing.	First rinse with plenty of water, then remove contaminated clothes and rinse again. Refer for medical attention.
•EYES	Redness. Pain. Severe deep burns.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION		Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Ventilation. Do NOT absorb in saw-dust or other combustible absorbents. Remove vapour with fine water spray. Neutralize used water with chalk or soda. Gas-tight chemical protection suit including self-contained breathing apparatus.	Ventilation along the floor.	Note: 5 T+ symbol R: 26-34 S: 1/2-9-26-28-36/37/39-45 UN Hazard Class: 2.3 UN Subsidiary Risks: 5.1 and 8

SEE IMPORTANT INFORMATION ON BACK

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 1994. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

NITROGEN DIOXIDE

ICSC: 0930

I M P O R T A N T D A T A	**PHYSICAL STATE; APPEARANCE:** BROWN GAS BROWN YELLOW LIQUID , WITH PUNGENT ODOUR. **PHYSICAL DANGERS:** The gas is heavier than air. **CHEMICAL DANGERS:** The substance is a strong oxidant and reacts violently with combustible and reducing materials. Reacts with water to produce Attacks many metals in the presence of water. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 3 ppm as TWA 5 ppm as STEL A4 (ACGIH 2003). MAK: 5 ppm 9.5 mg/m³ Peak limitation category: I (DFG 2002). OSHA PEL†: C 5 ppm (9 mg/m^3) NIOSH REL: ST 1 ppm (1.8 mg/m^3) NIOSH IDLH: 20 ppm See: 10102440	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation. **INHALATION RISK:** On loss of containment, a harmful concentration of this gas in the air will be reached very quickly. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance is corrosive to the skin and the respiratory tract. Inhalation of the gas or the vapor may cause lung oedema (see Notes). Exposure far above the OEL may result in death. The effects may be delayed. Medical observation is indicated. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The substance may have effects on the immune system lungs , resulting in decrease in resistance to infection. Animal tests show that this substance possibly causes toxic effects upon human reproduction.
PHYSICAL PROPERTIES	Boiling point: 21.2°C Melting point: -11.2°C Relative density (water = 1): 1.45 (liquid) Solubility in water: reaction	Vapour pressure, kPa at 20°C: 96 Relative vapour density (air = 1): 1.58
ENVIRONMENTAL DATA		

NOTES

The commercial brown liquid under pressure is an equilibrium mixture of nitrogen dioxide and the colourless nitrogen tetroxide. Non irritant concentration may cause lung oedema. The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential. Immediate administration of an appropriate inhalation therapy by a doctor or a person authorized by him/her, should be considered. Rinse contaminated clothes (fire hazard) with plenty of water. Turn leaking cylinder with the leak up to prevent escape of gas in liquid state.

Transport Emergency Card: TEC (R)-20S1067
NFPA Code: H3; F0; R0; OX

ADDITIONAL INFORMATION

(C) IPCS, CEC, 1994

IMPORTANT LEGAL NOTICE: Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

NIOSH Publication No. 2005-149: September 2005

NIOSH Pocket Guide to Chemical Hazards

NPG Home | Introduction | Synonyms & Trade Names | Chemical Names | CAS Numbers | RTECS Numbers | Appendices | Search

Nitrogen dioxide

CAS 10102-44-0

NO_2

RTECS QW9800000

Synonyms & Trade Names
Dinitrogen tetroxide (N_2O_4), Nitrogen peroxide

DOT ID & Guide
1067 124

Exposure Limits
NIOSH REL: ST 1 ppm (1.8 mg/m^3)

OSHA PEL†: C 5 ppm (9 mg/m^3)

IDLH 20 ppm See: 10102440

Conversion 1 ppm = 1.88 mg/m^3

Physical Description
Yellowish-brown liquid or reddish-brown gas (above 70°F) with a pungent, acrid odor. [Note: In solid form (below 15°F) it is found structurally as N_2O_4.]

MW: 46.0	BP: 70°F	FRZ: 15°F	Sol: Reacts
VP: 720 mmHg	IP: 9.75 eV	RGasD: 2.62	Sp.Gr: 1.44 (Liquid at 68°F)
Fl.P: NA	UEL: NA	LEL: NA	

Noncombustible Liquid/Gas, but will accelerate the burning of combustible materials.

Incompatibilities & Reactivities
Combustible material, water, chlorinated hydrocarbons, carbon disulfide, ammonia [Note: Reacts with water to form nitric acid.]

Measurement Methods
NIOSH 6014; OSHA ID182
See: NMAM or OSHA Methods

Personal Protection & Sanitation (See protection)
Skin: Prevent skin contact
Eyes: Prevent eye contact
Wash skin: When contaminated
Remove: When wet or contaminated
Change: No recommendation
Provide: Eyewash, Quick drench

First Aid (See procedures)
Eye: Irrigate immediately
Skin: Water flush immediately
Breathing: Respiratory support
Swallow: Medical attention immediately

Respirator Recommendations NIOSH
Up to 20 ppm:
(APF = 25) Any supplied-air respirator operated in a continuous-flow mode£
(APF = 50) Any self-contained breathing apparatus with a full facepiece
(APF = 50) Any supplied-air respirator with a full facepiece
Emergency or planned entry into unknown concentrations or IDLH conditions:
(APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode
(APF = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus
Escape:
(APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted canister providing protection against the compound of concern¿/Any appropriate escape-type, self-contained breathing apparatus
Important additional information about respirator selection

Exposure Routes inhalation, ingestion, skin and/or eye contact

Symptoms Irritation eyes, nose, throat; cough, mucoid frothy sputum, decreased pulmonary function, chronic bronchitis, dyspnea (breathing difficulty); chest pain; pulmonary edema, cyanosis, tachypnea, tachycardia

Target Organs Eyes, respiratory system, cardiovascular system

See also: INTRODUCTION See ICSC CARD: 0930 See MEDICAL TESTS: 0164

NIOSH Home | NIOSH Search | Site Index | Topic List | Contact Us

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name:	Nitrogen Dioxide	**Trade Name:**	Nitrogen Dioxide
Product Use:	Many.		
Chemical Name:	Nitrogen dioxide	**Synonym:**	Dinitrogen tetroxide, nitrogen tetroxide, NTO, nitrogen peroxide, red oxide of nitrogen
Chemical Formula:	Mixture of NO_2 & N_2O_4 in equlibrium	**Chemical Family:**	Nitrogen oxides
Telephone:	**Emergencies:** * 1-800-363-0042	**Supplier /Manufacture:**	Praxair Canada Inc. 1 City Centre Drive Suite 1200 Mississauga, ON L5B 1M2
		Phone:	905-803-1600
		Fax:	905-803-1682

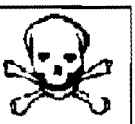
**Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier or Praxair sales representative.*

2. Composition and Information on Ingredients

INGREDIENTS	% (VOL)	CAS NUMBER	LD_{50} (Species & Routes)	LC_{50} (Rat, 4 hrs.)	TLV-TWA (ACGIH)
Nitrogen dioxide (Dinitrogen tetroxide)	100	10102-44-0	Not applicable.	88 ppm	3 ppm

3. Hazards Identification

Emergency Overview



DANGER! **Toxic, oxidizing, corrosive gas and liquid under pressure. May be fatal if inhaled. May cause lung damage. May increase respiration and heart rate. Can cause eye and skin burns. Symptoms may be delayed. Vigorously accelerates combustion. Self-contained breathing apparatus and protective clothing must be worn by rescue workers.**

ROUTES OF EXPOSURE: Inhalation. Swallowing. Skin absorption. Skin contact. Eye contact.

THRESHOLD LIMIT VALUE: TLV-TWA Data from 2004 Guide to Occupational Exposure Values (ACGIH). TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

EFFECTS OF A SINGLE (ACUTE) OVEREXPOSURE:

INHALATION: Overexposure may cause irritation of mucous membranes, sinuses, pharynx, and bronchia, with pain, headache, cyanosis, irregular respiration, choking, dizziness, and possibly pulmonary edema. Often no pulmonary symptoms at time of exposure; may have latency of 5-72 hours. High vapour concentrations may cause pain, choking, bronchoconstriction, reflex slowing of the heart, and possibly asphyxiation. Lack of oxygen can kil. STEL: 5 ppm (ACGIH).

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SKIN CONTACT:	Severe irritant; may cause burns.
SKIN ABSORPTION:	Prolonged or widespread skin contact with the liquid may result in the absorption of harmful amounts of material.
SWALLOWING:	Harmful if swallowed. An unlikely route of exposure. This product is a gas at normal temperature and pressure. May cause burns to mouth, throat and stomach.
EYE CONTACT:	May cause severe conjunctivitis seen as marked redness and swelling of the conjunctiva, and corneal injury with opacification.

EFFECTS OF REPEATED (CHRONIC) OVEREXPOSURE:
Repeated inhalation may result in bronchitis or emphysema. Repeated skin contact may result in cumulative dermatitis.
OTHER EFFECTS OF OVEREXPOSURE:
None known.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE:
Inhalation may aggravate asthma and inflammatory or fibrotic pulmonary disease. Because of its irritating properties, this material may aggravate an existing dermatitis.

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH HAZARD EVALUATION:

Nitrogen dioxide has been shown to cause mutations in bacteria, and to cause mutation, sister-chromatid exchanges, and chromosomal aberrations in mammalian cells.

CARCINOGENICITY:
Not listed as carcinogen by OSHA, NTP or IARC.

4. First Aid Measures

INHALATION:

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately. Keep patient warm.

SKIN CONTACT:

Immediately flush affected areas with water for at least 15 minutes while removing contaminated clothing and shoes. Discard clothing and shoes. Call a physician.

SWALLOWING:

This product is a gas at normal temperature and pressure.

EYE CONTACT:

Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. See a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN:

In case of overexposure, keep patient under medical observation for at least 72 hours to observe for pulmonary edema. Patient may have second acute pulmonary reaction 2-6 weeks after the first one. The hazards of this material are mainly due to its severe irritant and corrosive properties on the skin and mucosal surfaces. There is no specific antidote. Treatment of over-exposure should be directed at the control of symptoms and the clinical condition.

5. Fire Fighting Measures

FLAMMABLE :	No.	**IF YES, UNDER WHAT CONDITIONS?**	Not applicable. Vigorously accelerates combustion.
FLASH POINT (test method)	Not applicable.	**AUTOIGNITION TEMPERATURE**	Not applicable.
FLAMMABLE LIMITS IN AIR, % by volume:	**LOWER:** Not applicable.	**UPPER:**	Not applicable.

EXTINGUISHING MEDIA:

Oxidizing agent. Vigorously accelerates combustion. Use media appropriate for surrounding fire.

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SPECIAL FIRE FIGHTING PROCEDURES:

DANGER! Highly toxic gas. Evacuate all personnel from danger area. Do not approach area without self-contained breathing apparatus and protective clothing. Immediately cool containers with water spray from maximum distance until cool, then move containers away from fire area if without risk. If containers are leaking, reduce vapours with water spray or fog. Shut off leak if without risk while continuing cooling water spray. Remove containers away from fire area of fire if without risk.

UNUSUAL FIRE AND EXPLOSION HAZARD:

Oxidizing agent, may accelerate combustion. Contact with flammable materials may cause fire or explosion. Container may rupture due to heat of fire. Vapours are extremely irritating. Contact may cause burns to skin and eyes. No part of a container should be subjected to a temperature higher than 52 C. See incompatibility in Section X. Most containers are provided with a pressure relief divice designed to vent contents when they are exposed to elevated temperature.

HAZARDOUS COMBUSTION PRODUCTS:

Burning produces highly toxic oxides of nitrogen.

SENSITIVITY TO IMPACT:

Avoid impact against container.

SENSITIVITY TO STATIC DISCHARGE:

Not applicable.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! Corrosive, toxic gas. Use self-contained breathing apparatus and protective clothing where needed. Reduce vapours with fog or fine water spray. Reverse flow into cylinder may cause rupture. Shut off leak if without risk. Ventilate area of leak or move leaking container to well ventilated area. Prevent runoff from contaminating surrounding evironment. Corrosive, toxic vapours may spread from spill. Before entering area, especially confined areas, check atmosphere with appropriate device.

WASTE DISPOSAL METHOD:

Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, provincial, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN STORAGE:

DANGER: Toxic, corrosive, liquefied gas under pressure. May be fatal if inhaled. Do not breathe gas. Do not get liquid or vapours in eyes, or on skin or clothing. Safety showers and eye wash fountains should be immediately available.

PRECAUTIONS TO BE TAKEN IN HANDLING:

Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. For other precautions, see Section 16.

For additional information on stroage and handling, refer to Compressed Gas Association (CGA) pamphlet P-1, *Safe Handling of Compressed Gases in Containers*, available from the CGA. Refer to Section 16 for the address and phone number along with a list of other available publications.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE:

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Toxic, oxidizing, corrosive high-pressure gas. May be fatal if inhaled. Do not breathe gas. Do not get vapour in eyes, on skin, or on clothing. Have safety showers and eyewash fountains immediately available. ***Use piping and equipment adequately designed to withstand pressures to be encountered.*** Use only in a closed system constructed of corrosion-resistant materials. ***May accelerate combustion.*** Keep oil, grease, and combustibles away. ***Store and use with adequate ventilation at all times.*** Close valve after each use; keep closed even when empty. ***Prevent reverse flow.*** Reverse flow into cylinder may cause rupture. Use a check valve or other protective device in any line or piping from the cylinder ***When returning cylinder to supplier,*** be sure valve is closed, then install valve outlet plug tightly. ***Never work on a pressurized system.*** *If there is a leak, close the cylinder valve. Vent the system down in a safe and environmentally sound manner in compliance with all federal, provincial, and local laws; then repair the leak.* ***Never place a compressed gas cylinder where it may become part of an electrical circuit.***

8. Exposure Controls/Personal Protection

VENTILATION/ENGINEERING CONTROLS:

LOCAL EXHAUST:	A corrosion-resistant system is acceptable. See SPECIAL.
MECHANICAL (general):	Inadequate. See SPECIAL.
SPECIAL:	Use only in a closed system. A corrosion-resistant, forced-draft fume hood is preferred.
OTHER:	See SPECIAL.

PERSONAL PROTECTION:

RESPIRATORY PROTECTION:	For concentrations up to 10 times the applicable exposure limit any NIOSH/MSHA approved supplied air respirator is recommended. Up to 50 times the TLV, a NIOSH/MSHA approved respirator with a full-face piece or self-contained breathing apparatus is recommended. For higher concentration us only self-contained breathing apparatus operated in the pressure demand mode
SKIN PROTECTION:	Neoprene gloves.
EYE PROTECTION:	Wear safety glasses when handling cylinders. Select in accordance with the current CSA standard Z94.3, "Industrial Eye and Face Protection", and any provincial regulations, local bylaws or guidelines.
OTHER PROTECTIVE EQUIPMENT:	Metatarsal shoes for cylinder handling. Protective clothing where needed. Cuffless trousers should be worn outside the shoes. Select in accordance with the current CSA standard Z195, "Protective Foot Wear", and any provincial regulations, local bylaws or guidelines.

9. Physical and Chemical Properties

PHYSICAL STATE:	Gas. (Compressed Gas.)	FREEZING POINT:	-11.2°C (11.8°F)	pH:	Not applicable.
BOILING POINT	21.2°C (70.2°F)	VAPOUR PRESSURE	101.3 kPa (@ 20°C)	MOLECULAR WEIGHT:	46.0055 g/mole
SPECIFIC GRAVITY: LIQUID (Water = 1)	1.45 @ 21.1 C	SOLUBILITY IN WATER,	Not available.		
SPECIFIC GRAVITY:	2.62	EVAPORATION RATE	>1 compared to (Butyl Acetate = 1)	COEFFICIENT OF WATER/OIL DISTRIBUTION:	Not applicable.

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VAPOUR (air = 1)	(Butyl Acetate=1):	
VAPOUR DENSITY: 0.00339 g/ml @ 21.1 C	% VOLATILES BY VOLUME: 100% (v/v).	ODOUR THRESHOLD: 5 ppm

APPEARANCE & ODOUR: Reddish-brown Odour: Irritating.

10. Stability and Reactivity

STABILITY:	The product is stable.
CONDITIONS OF CHEMICAL INSTABILITY:	Elevated temperatures (> 160 C).
INCOMPATIBILITY (materials to avoid):	Water, bases, flammable and combustible materials, copper, aluminium. Very corrosive to metals when wet. Explosions may occur on contact with ammonia, boron trichloride, carbon disulfide, cyclohexane, fluorine, formaldehyde, nitrobenzene, toluene, incompletely halogenated, propylene, alcohols and ozone.
HAZARDOUS DECOMPOSITION PRODUCTS:	Above 160 C nitrogen dioxide decomposes to form nitric oxide and oxygen. Reacts with water to form nitric acid and nitric oxide.
HAZARDOUS POLYMERIZATION:	Will not occur.
CONDITIONS OF REACTIVITY:	None.

11. Toxicological Information

See section 3.

12. Ecological Information

No adverse ecological effects expected. This product does not contain any Class I or Class II ozone-depleting chemicals. The components of this mixture are not listed as marine pollutants by TDG Regulations.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

TDG/IMO SHIPPING NAME: Nitrogen dioxide

HAZARD CLASS: CLASS 2.3: Poisonous gas. CLASS 5.1: Oxidizing material.	IDENTIFICATION #: UN1067	PRODUCT RQ: All

SHIPPING LABEL(s): Poison gas, Oxidizing material

PLACARD (when required): Poison gas, Oxidizing material

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SPECIAL SHIPPING INFORMATION:

Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of vehicle can present serious safety hazards.

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, provincial, and local regulations.

WHMIS (Canada)
CLASS A: Compressed gas.
CLASS C: Oxidizing material.
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
CLASS E: Corrosive gas.

International Regulations

EINECS Not available.

DSCL (EEC) R8- Contact with combustible material may cause fire.
R26- Very toxic by inhalation.

International Lists No products were found.

16. Other Information

MIXTURES:

When two or more gases, or liquefied gases are mixed, their hazardous properties may combine to create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an Industrial Hygienist, or other trained person when you make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

HAZARD RATING SYSTEM:

HMIS RATINGS:

HEALTH	3
FLAMMABILITY	0
PHYSICAL HAZARD	0

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED:	CGA-660
PIN-INDEXED YOKE:	Not applicable.
ULTRA-HIGH-INTEGRITY CONNECTION:	Not applicable.

Use the proper CGA connections. **DO NOT USE ADAPTERS.** Additional limited-standard connections may apply. See CGA pamphlets V-1 and V-7 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information about this product can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700, Fax (703) 961-1831, website: www.cganet.com.

AV-1 Safe Handling and Storage of Compressed Gas
P-1 Safe Handling of Compressed Gases in Containers
V-1 Compressed Gas Cylinder Valve Inlet and Outlet Connections
V-7 Standard Method of Determining Cylinder Valve Outlet Connections for Industrial Gas Mixtures
--- Handbook of Compressed Gases, Fourth Edition

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PREPARATION INFORMATION:

DATE: **10/15/2004**
DEPARTMENT: **Safety and Environmental Services**
TELEPHONE: **905-803-1600**

The opinions expressed herein are those of qualified experts within Praxair Canada Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair Canada Inc., it is the user's obligation to determine the conditions of safe use of the product.

Praxair Canada Inc. requests the users of this product to study this Material Data Sheet (MSDS) and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify its employees, agents and contractors of the information on this MSDS and any product hazards and safety nformation, (2) furnish this same information to each of its customers for the product, and (3) request such customers to notify their employees and customers for the product of the same product hazards and safety information.

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PRAXAIR

Praxair Canada Inc.
1 City Centre Drive
Suite 1200
Mississauga, ON L5B 1M2

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Scott Specialty Gases

Material Safety Data Sheets

MSDS No: 10102-44-0
Date: 01/30/2007

SUPPLIER ADDRESS: 6141 Easton Road, Bldg. 1
PO Box 310
Plumsteadville, PA
18949-0310

EMERGENCY PHONE NUMBER: (215) 766-8861

1. CHEMICAL PRODUCT

PRODUCT NAME: NITROGEN DIOXIDE

SYNONYMS: Dinitrogen tetroxide, nitrogen peroxide

2. COMPOSITION, INFORMATION ON INGREDIENTS

				Exposure Limits (PPM)			
Ingredient Name	Formula	CAS #	Concentration	ACGIH TLV	OSHA PEL	MAC	Other STEL
NITROGEN DIOXIDE	NO2	10102-44-0	99+%	3	5(c)	2	5

(c) = ceiling

Note: NE = NONE ESTABLISHED S/A = SIMPLE ASPHYXIANT

3. HAZARD INDENTIFICATION

* * * EMERGENCY OVERVIEW * * *
Poisonous liquid and gas under pressure.
May be fatal if inhaled.
Can cause severe lung damage.
Can cause eye and skin burns.
Symptoms of exposure may be delayed.
Vigorously accelerates combustion.

POTENTIAL HEALTH EFFECTS

ROUTES OF ENTRY: Inhalation, Eye, Skin

ACUTE EFFECTS: Inhalation will cause constriction of the throat and bronchi and edema of the lungs.Arterial dilation, fallen blood pressure, headache, dizziness, and possible formation of methemoglobin, irritation of nose and throat, coughing, burning in throat and chest.Gas may cause irritation to the eye and mucous membrane.Nitrogen dioxide is a corrosive liquid and may severely burn body tissue.Nitrogen dioxide may produce malaise, dysnpea and nausea.

CHRONIC EFFECTS: Nitrogen dioxide at 5-50 ppm can cause a slowly evolving pulmonary edema with respiratory tract irritation, cough, headache, weakness, and corrosion of teeth.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: None known

OTHER EFFECTS OF OVEREXPORSURE: None

CARCINOGENICITY (US ONLY):

NTP - No
IARC MONOGRAPHS - No
OSHA REGULATED - No

4. FIRST AID MEASURES

INHALATION: Give victim 100% oxygen if breathing has not stopped; give 100% oxygen with artificial respiration if breathing has stopped.Do not move victim until permitted to do so by physician.

EYE CONTACT: Immediately flush with copious amounts of water for at least 15 minutes.

SKIN CONTACT: Immediately flush with copious amounts of water for at least 15 minutes while removing contaminated clothing.

INGESTION: None

IN EVENT OF EXPOSURE, CONSULT A PHYSICIAN

NOTE TO PHYSICIAN: Effects may be delayed for 48-72 hours, keep under observation.

5. FIRE FIGHTING MEASURES

FLASH POINT: Nonflammable

AUTOIGNITION TEMPERATURE: N/Ap

FLAMMABLE LIMITS: Nonflammable

LOWER:
UPPER:

EXTINGUISHING MEDIA: Use what is appropriate for surrounding fire.

SPECIAL FIRE FIGHTING INSTRUCTION AND EQUIPMENT: Wear self-contained breathing apparatus and full protective clothing.Keep fire exposed cylinders cool with water spray.Nitrogen dioxide is a strong oxidizing agent which may cause fire on contact with flammables or combustibles.

HAZARDOUS COMBUSTION PRODUCTS: Nitrogen dioxide when heated or reacted with water may release toxic fumes.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Cylinder rupture may occur under fire conditions.Oxidizer that accelerates the combustion of other materials.

6. ACCIDENTAL RELEASE MEASURES

CLEAN UP PROCEDURES: Evacuate and ventilate area.Remove leaking cylinder to exhaust hood or safe outdoor area.Red-brown color will identify large leaks.Cover liquid spills with excess $NaHCO_3$; mix; spray with H_2O atomizer; flush to holding tank for disposal.

SPECIALIZED EQUIPMENT: None

7. HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN IN HANDLING: Use suitable hand truck to move cylinders.Use only in a well-ventilated area.

PRECAUTIONS TO BE TAKEN IN STORAGE: Store in well ventilated areas.Keep valve protection cap on cylinders when not in use.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide adequate general and local exhaust ventilation to maintain concentration below exposure limits.

EYE / FACE PROTECTION: Goggles.

SKIN PROTECTION: Impervious gloves, coveralls, boots, and/or other resistant protective clothing.

RESPIRATORY PROTECTION: Use a self-contained breathing apparatus in case of emergency or non-routine use.

OTHER PROTECTIVE EQUIPMENT: Safety shoes when handling cylinders.

9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Colorless to pale yellow

ODOR: Irritating pungent odor.

PHYSICAL PRESSURE: Liquid

VAPOR PRESSURE: @20 deg C: 720 mm Hg

VAPOR DENSITY (AIR=1): 1.58

BOILING POINT (C): 21

SOLUBILITY IN WATER: Decomposes to form nitric acid and nitric oxide.

SPECIFIC GRAVITY (H_2O=1): @20 deg.C: 1.45

EVAPORATION RATE: N/Ap

ODOR THRESHOLD: 0.058-0.4ppm

10. STABILITY AND REACTIVITY

STABILITY: Stable under normal storage conditions.

CONDITIONS TO AVOID: Avoid contact with incompatible chemicals.

MATERIALS TO AVOID: Reacts with hydrocarbons, organic dust, cyclohexane, fluorine, formaldehyde, alcohol's, nitrobenzene, petroleum, and toluene.Also reacts with incompletely halogenated hydrocarbons.

HAZARDOUS POLYMERIZATION: Will not occur.

HAZARDOUS DECOMPOSITION: When heated to decomposition or reacted with water, may emit toxic fumes.

11. TOXICOLOGICAL INFORMATION

LETHAL CONCENTRATION (LC50): 115 ppm, rat 1 hour.

LETHAL DOSE 50 (LD50): N/Ap

TERATOGENICITY: N/Ap

REPRODUCTIVE EFFECTS: N/Ap

MUTAGENICITY: N/Ap

12. ECOLOGICAL INFORMATION

No adverse ecological effects are expected.

13. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Dispose of non-refillable cylinders in accordance with federal, state and local regulations. Allow gas to vent slowly to atmosphere in an unconfined area or exhaust hood. If the cylinders are the refillable type, return cylinders to supplier with any valve outlet plugs or caps secured and valve protection caps in place.

14. TRANSPORT INFORMATION

CONCENTRATION: 99+%

DOT DESCRIPTION (US ONLY):

PROPER SHIPPING NAME: Dinitrogen tetroxide
HAZARD CLASS: 2.3 (poison), Hazard Zone A
INDENTIFICATION NUMBER: UN1067
REPORTABLE QUANTITIES: 10
LABELING: POISON GAS, OXIDIZER, CORROSIVE

ADR / RID (EU Only): Class 2, 2TOC

SPECIAL PRECAUTIONS: Cylinders should be transported in a secure upright position in a well ventilated truck.

15. REGULATORY INFORMATION

OSHA: Process Safety Management: Material is listed in appendix A of 29 CFR 1910.119 as highly hazardous chemical.

TSCA: Material is listed in TSCA inventory.

SARA: The threshold planning quantity for this material is100 lbs.

EU NUMBER: 233-272-6

NUMBER IN ANNEX 1 OF DIR 67/548: Material is listed in annex 1.

EU CLASSIFICATION: N/Av

R: 26-37

S: 7/9-26-45

16. OTHER INFORMATION

OTHER PRECAUTIONS: Protect containers from physical damage. Do not deface cylinders or labels. Cylinders should be refilled by qualified producers of compressed gas. Shipment of a compressed gas cylinder which has not been filled by the owner or with his written consent is a violation of federal law (49 CFR).

ABBREVIATIONS: N/Ap - Not Applicable N/Av - Not Available SA - Simple Asphyxiant NE - None Established

DISCLAIMER: Information included in this document is given to the best of our knowledge, however, no warranty is made that the information is accurate or complete. We do not accept any responsibility for damages by the use of the document.

Nitrogen Oxides (NO, NO_2, and others)
CAS 10102-43-9; UN 1660 (NO)
CAS 10102-44-0; UN 1067 (NO_2)
UN 1975 (Mixture)

Synonyms for nitric oxide (NO) include mononitrogen monoxide and nitrogen monoxide. Synonyms for nitrogen dioxide (NO_2) include dinitrogen tetroxide, nitrogen peroxide, nitrogen tetroxide, and NTO. Synonyms for mixtures of nitrogen oxides include nitrogen fumes and nitrous fumes.

Persons exposed only to nitrogen oxide gases do not pose substantial secondary contamination risks. Persons whose clothing is contaminated with liquid nitrogen oxides can secondarily contaminate others by direct contact or through off-gassing vapors.

Nitric oxide and nitrogen dioxide are nonflammable liquids or gases; however, they will accelerate the burning of combustible materials. Odor generally provides an adequate warning of acute exposure providing the higher oxides (NO_2, N_2O_4 and N_2O_5) are present. Nitric oxide (NO) is odorless and nitrous oxide (N_2O) has only a very faint odor.

The primary route of exposure to nitrogen oxides is by inhalation, but exposure by any route can cause systemic effects. Nitrogen oxides are irritating to the eyes, skin, mucous membranes, and respiratory tract. On contact with moisture, nitrogen dioxide forms a mixture of nitric and nitrous acids.

Description

Nitrogen oxides represent a mixture of gases designated by the formula NO_x. The mixture includes nitric oxide (NO), nitrogen dioxide (NO_2), nitrogen trioxide (N_2O_3), nitrogen tetroxide (N_2O_4), and nitrogen pentoxide (N_2O_5). The toxicity of nitrous oxide (N_2O) or laughing gas, which is used as an anesthetic, is different from that of the other nitrogen oxides and is not discussed in this protocol.

The most hazardous of the nitrogen oxides are nitric oxide and nitrogen dioxide; the latter exists in equilibrium with its dimer, nitrogen tetroxide. Nitric oxide is a colorless gas at room temperature, very sparingly soluble in water. Nitrogen dioxide is a colorless to brown liquid at room temperature and a reddish-brown gas above 70 °F poorly soluble in water. Nitric oxide is rapidly oxidized in air at high concentrations to form nitrogen dioxide.

Routes of Exposure

Inhalation

Nitrogen oxides (NO_2, N_2O_4, N_2O_3 and N_2O_5) are irritating to the upper respiratory tract and lungs even at low concentrations. Only one or two breaths of a very high concentration can cause severe toxicity. Odor is generally an adequate warning property for acute

exposures. Nitrogen dioxide is heavier than air, such that exposure in poorly ventilated, enclosed, or low-lying areas can result in asphyxiation.

Children exposed to the same levels of nitrogen oxides as adults may receive larger doses because they have greater lung surface area:body weight ratios and increased minute volumes:weight ratios. In addition, they may be exposed to higher levels of nitrogen dioxide than adults in the same location because of their short stature and the higher levels of nitrogen dioxide found nearer to the ground.

Skin/Eye Contact

Exposure to relatively high air concentrations can produce eye irritation and inflammation.

Children are more vulnerable to toxicants affecting the skin because of their relatively larger surface area:body weight ratio.

Ingestion

Both nitrogen dioxide and nitric oxide are gases at room temperature. However, nitrogen dioxide exists as a liquid below 21 °C and, if ingested, will cause gastrointestinal irritation or burns.

Sources/Uses

Nitrogen oxides form naturally during the oxidation of nitrogen-containing compounds such as coal, diesel fuel, and silage. Nitrogen oxides are also formed during arc welding, electroplating, engraving, dynamite blasting, as components of rocket fuel, and nitration reactions such as in the production of nitro-explosives, including gun-cotton, dynamite and TNT. They are produced commercially, usually as the first step in the production of nitric acid, either by the direct oxidation of atmospheric nitrogen in the electric arc (Birkeland-Eyder Process) or by the catalytic oxidation of anhydrous ammonia (Oswald Process). Trace metal impurities most likely cause nitrogen oxides to form in nitric acid and its solutions. Nitrogen oxides are intermediates in the production of lacquers, dyes, and other chemicals and are important components of photo-oxidant smog.

Standards and Guidelines

Nitric Oxide: OSHA PEL (permissible exposure limit) = 25 ppm (averaged over an 8-hour workshift)

NIOSH IDLH (immediately dangerous to life or health) = 100 ppm
Nitrogen Dioxide: OSHA PEL (permissible exposure limit) = 5 ppm (Ceiling)

NIOSH IDLH (immediately dangerous to life or health) = 20 ppm

Physical Properties	Nitric Oxide	Nitrogen Dioxide
Description:	Colorless gas	Yellow-brown liquid or red-brown gas
Warning properties:	Non-irritating, odorless and colorless gas; no adequate warning for acute exposure unless accompanied by NO2 or another higher oxide as is usual.	Irritating, sharp odor at 1–5 ppm; adequate warning for acute exposure; inadequate warning for chronic exposure.
Molecular weight:	30.0 daltons	46.0 daltons
Boiling point (760 mm Hg):	-241 °F (-152 °C)	70 °F (21 °C)
Freezing point:	-263 °F (-164 °C)	12 °F (-11 °C)
Vapor pressure:	>760 mm Hg at 68 °F (20 °C)	720 mm Hg at 68 °F (20 °C)
Gas density:	1.0 (air = 1)	1.5 (air = 1)
Water solubility:	Water soluble	Highly soluble, but reacts with water to form a mixture of nitric and nitrous acids.
Flammability:	Not flammable, but will accelerate burning of combustible materials	Not flammable, but will accelerate burning of combustible materials

Incompatibilities

Nitrogen dioxide and nitric acid react with combustible materials, chlorinated hydrocarbons, carbon disulfide, and ammonia. May react violently with cyclohexane, fluorine, formaldehyde and alcohol, nitrobenzene, petroleum, and toluene.

Health Effects

Most of the higher oxides of nitrogen are eye, skin, and respiratory tract irritants. Nitrogen dioxide is a corrosive substance that forms nitric and nitrous acids upon contact with water; it is more acutely toxic than nitric oxide, except at lethal concentrations when nitric oxide may kill more rapidly.

Nitric oxide is a potent and rapid inducer of methemoglobinemia.

Exposure to nitrogen oxides may result in changes of the pulmonary system including pulmonary edema, pneumonitis, bronchitis, bronchiolitis, emphysema, and possibly methemoglobinemia. Cough, hyperpnea, and dyspnea may be seen after some delay.

- **Damage to, and subsequent scarring of, the bronchioles may result in a life-threatening episode several weeks following exposure involving cough, rapid, shallow breathing, rapid heartbeat, and inadequate oxygenation of the tissues.**
- **Populations that may be particularly sensitive to nitrogen oxides include asthmatics and those with chronic obstructive pulmonary disease or heart disease.**

Acute Exposure

Nitrogen dioxide is thought to damage lungs in three ways: (1) it is converted to nitric and nitrous acids in the distal airways, which directly damages certain structural and functional lung cells; (2) it initiates free radical generation, which results in protein oxidation, lipid peroxidation, and cell membrane damage; and (3) it reduces resistance to infection by altering macrophage and immune function. There may be an immediate response to exposure to nitrogen oxide vapors that may include coughing, fatigue, nausea, choking, headache, abdominal pain, and difficulty breathing. A symptom-free period of 3 to 30 hours may then be followed by the onset of pulmonary edema with anxiety, mental confusion, lethargy, and loss of consciousness. If survived, this episode may be followed by bronchiolitis obliterans (fibrous obstruction of the bronchioles) several weeks later. Any of these phases can be fatal.

Children do not always respond to chemicals in the same way that adults do. Different protocols for managing their care may be needed.

Respiratory

The higher nitrogen oxides are respiratory irritants. The primary site of toxicity is the lower respiratory tract. Low concentrations initially may cause mild shortness of breath and cough; then, after a period of hours to days, victims may suffer bronchospasm and

pulmonary edema. Inhalation of very high concentrations can rapidly cause burns, spasms, swelling of tissues in the throat, upper airway obstruction, and death.

Exposure to certain chemicals can lead to Reactive Airway Dysfunction Syndrome (RADS), a chemically- or irritant-induced type of asthma.

Children may be more vulnerable to corrosive agents than adults because of the relatively smaller diameter of their airways. Children also may be more vulnerable because of relatively increased minute ventilation per kg and failure to evacuate an area promptly when exposed.

Cardiovascular

Absorption of nitrogen oxides can lead to a weak rapid pulse, dilated heart, chest congestion, and circulatory collapse.

Hematologic

High-dose exposure may convert Fe^{+2} in hemoglobin to Fe^{+3}, by virtue of the presence of nitric oxide (NO), causing methemoglobinemia and impaired oxygen transport.

Dermal

Higher nitrogen oxides are skin irritants and corrosives. Skin moisture in contact with liquid nitrogen dioxide or high concentrations of its vapor can result in nitric acid formation, which may lead to second-and third-degree skin burns. Nitric acid may also cause yellowing of the skin and erosion of dental enamel.

Because of their relatively larger surface area:body weight ratio, children are more vulnerable to toxicants affecting the skin.

Ocular

Liquid nitrogen oxides cause severe eye burns after brief contact. High concentrations of the gas cause irritation and, after prolonged exposure, may cause clouding of the eye surface and blindness.

Potential Sequelae

Obstruction of the bronchioles may develop days to weeks after severe exposure. Patients suffer malaise, weakness, fever, chills, progressive shortness of breath, cough, hemorrhage of the lungs or bronchioles, blue or purple coloring of the skin, and respiratory failure. This condition may be confused with the adult respiratory distress syndrome secondary to infectious diseases such as miliary tuberculosis.

Victims of inhalation exposure may suffer reactive airways dysfunction syndrome (RADS) after a single acute, high-dose exposure.

Chronic Exposure

Chronic exposure to nitrogen oxides is associated with increased risk of respiratory infections in children. Permanent restrictive and obstructive lung disease from bronchiolar damage may occur.

Carcinogenicity

Nitrogen oxides have not been classified for carcinogenic effects.

Reproductive and Developmental Effects

Nitric oxide and nitrogen dioxide are not included in *Reproductive and Developmental Toxicants,* a 1991 report published by the U.S. General Accounting Office (GAO) that lists 30 chemicals of concern because of widely acknowledged reproductive and developmental consequences. Methemoglobin inducers are considered harmful to the fetus and nitrogen dioxide has been shown to be fetotoxic in rats and has affected behavior and growth statistics in newborn mice. Nitrogen dioxide also causes DNA damage, mutations, sister chromatid exchanges, and other DNA aberrations.

Special consideration regarding the exposure of pregnant women may be warranted, since nitrogen oxides have been shown to be mutagenic and clastogenic, and fetotoxic in rats; thus, medical counseling is recommended for the acutely exposed pregnant woman.

Prehospital Management

- **Victims exposed only to nitrogen oxide gases do not pose risks of secondary contamination to rescuers. Victims whose clothing or skin is contaminated with liquid nitrogen oxides or nitric acid can secondarily contaminate response personnel by direct contact or through off-gassing vapors.**

  Most of the higher nitrogen oxides are eye, skin, and respiratory tract irritants. Initial respiratory symptoms after exposure to nitrogen oxides may be mild, but progressive inflammation of the lungs may develop several hours to days after exposure. Noncardiogenic pulmonary edema may develop even if initial pulmonary signs were minimal. Exposures may result in methemoglobinemia, depending upon the presence of nitric oxide (NO) in the gas mixture.

  There is no antidote for nitrogen oxides. Primary treatment consists of respiratory and cardiovascular support. Methylene blue may be necessary to treat methemoglobinemia.

Hot Zone

Rescuers should be trained and appropriately attired before entering the Hot Zone. If the proper equipment is not available, or if rescuers have not been trained in its use, assistance should be obtained from a local or regional HAZMAT team or other properly equipped response organization.

Rescuer Protection

Nitrogen oxides are severe respiratory tract irritants.

Respiratory Protection: Positive-pressure, self-contained breathing apparatus (SCBA) is recommended in response situations that involve exposure to potentially unsafe levels of nitrogen oxides.

Skin Protection: Chemical-protective clothing is recommended when repeated or prolonged contact with liquids of nitrogen oxides or with high concentrations of nitrogen oxide vapors is anticipated because skin irritation or burns may occur.

ABC Reminders

Quickly access for a patent airway, ensure adequate respiration and pulse. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible.

Victim Removal

If victims can walk, lead them out of the Hot Zone to the Decontamination Zone. Victims who are unable to walk may be removed on backboards or gurneys; if these are not available, carefully carry or drag victims to safety.

Consider appropriate management of chemically contaminated children, such as measures to reduce separation anxiety if a child is separated from a parent or other adult.

Decontamination Zone

Victims exposed only to nitrogen oxide gases may appear to have no skin or eye irritation. However, they should still be decontaminated as described below as irritation may not become evident until washing commences.

Rescuer Protection

If exposure levels are determined to be safe, decontamination may be conducted by personnel wearing a lower level of protection than that worn in the Hot Zone (described above).

ABC Reminders

Quickly access for a patent airway, ensure adequate respiration and pulse. Stabilize the cervical spine with a collar and a backboard if trauma is suspected. Administer supplemental oxygen as required. Assist ventilation with a bag-valve-mask device if necessary.

Basic Decontamination

Victims who are able may assist with their own decontamination. Remove and double-bag contaminated clothing and personal belongings.

Flush exposed skin and hair with water for 20 minutes. Use caution to avoid hypothermia when decontaminating children or the elderly. Use blankets or warmers when appropriate.

Immediately begin irrigation of exposed or irritated eyes with plain water or saline and continue for at least 20 minutes. Remove contact lenses if easily removable without additional trauma. Continue eye irrigation during other basic care and transport.

If the victim has ingested a solution of nitrogen oxides or nitric acid, **do not induce emesis**. Do not administer activated charcoal. Victims who are conscious and able to swallow should be given 4 to 8 ounces of water or milk.

Consider appropriate management of chemically contaminated children at the exposure site. Also, provide reassurance to the child during decontamination, especially if separation from a parent occurs. If possible, seek assistance from a child separation expert.

Transfer to Support Zone

As soon as decontamination is complete, move the victim to the Support Zone.

Support Zone

Be certain that victims have been decontaminated properly (see *Decontamination Zone* above). Victims who have undergone decontamination pose no serious risks of secondary contamination to rescuers. In such cases, Support Zone personnel require no specialized protective gear.

ABC Reminders

Quickly access for a patent airway. If trauma is suspected, maintain cervical immobilization manually and apply a cervical collar and a backboard when feasible. Ensure adequate respiration and pulse. Administer supplemental oxygen as required and establish intravenous access if necessary. Place on a cardiac monitor.

Additional Decontamination

Continue irrigating exposed skin and eyes, as appropriate.

If the patient has ingested a solution of nitrogen oxides or nitric acid, **do not induce emesis**. Do not administer activated charcoal. Patients who are able to swallow should be given 4 to 8 ounces of water or milk, if not provided previously.

Advanced Treatment

In cases of respiratory compromise secure airway and respiration via endotracheal intubation. If not possible, perform cricothyroidotomy if equipped and trained to do so.

Treat patients who have bronchospasm with aerosolized bronchodilators. The use of bronchial sensitizing agents in situations of multiple chemical exposures may pose additional risks. Consider the health of the myocardium before choosing which type of bronchodilator should be administered. Cardiac sensitizing agents may be appropriate; however, the use of cardiac sensitizing agents after exposure to certain chemicals may pose enhanced risk of cardiac arrhythmias (especially in the elderly).

Consider racemic epinephrine aerosol for children who develop stridor. Dose 0.25–0.75 mL of 2.25% racemic epinephrine solution in 2.5 cc water, repeat every 20 minutes as needed, cautioning for myocardial variability.

Patients who are comatose, hypotensive, or are having seizures or cardiac arrhythmias should be treated according to advanced life support (ALS) protocols.

If evidence of shock or hypotension is observed begin fluid administration. For adults, bolus 1,000 mL/hour intravenous saline or lactated Ringer's solution if blood pressure is under 80 mm Hg; if systolic pressure is over 90 mm Hg, an infusion rate of 150 to 200 mL/hour is sufficient. For children with compromised perfusion

administer a 20 mL/kg bolus of normal saline over 10 to 20 minutes, then infuse at 2 to 3 mL/kg/hour.

Transport to Medical Facility

Only decontaminated patients or patients not requiring decontamination should be transported to a medical facility. "Body bags" are not recommended.

Report to the base station and the receiving medical facility the condition of the patient, treatment given, and estimated time of arrival at the medical facility.

If a solution of nitrogen oxides, which means in effect a mixture of nitric (HNO_3) and nitrous (HNO_2) acids, has been ingested, prepare the ambulance in case the victim vomits toxic material. Have ready several towels and open plastic bags to quickly clean up and isolate vomitus.

Multi-Casualty Triage

Consult with the base station physician or regional poison control center for advice regarding triage of multiple victims. Because delayed respiratory compromise may occur even with minimal initial symptoms, all patients who have histories or evidence of exposure should be transported to a medical facility for evaluation. Because of the danger of acute, though delayed, onset of severe, life-threatening pulmonary edema from 3 to 30 hours after what may appear to have been quite a trivial exposure it is important that exposed subjects be maintained under medical surveillance for the first 48 hours post-exposure. If such are allowed to return home and acute pulmonary edema develops in a home environment during sleep it may not be possible to get the patient to resuscitative medical treatment in time. Others may be discharged at the scene after their names, addresses, and telephone numbers are recorded. Those discharged should be advised to seek medical care promptly if symptoms develop (see *Patient Information Sheet* below).

Emergency Department Management

Patients exposed only to nitrogen oxide gases do not pose risks of secondary contamination to rescuers. Patients whose clothing or skin is contaminated with liquid nitrogen oxides or nitric acid can secondarily contaminate response personnel by direct contact or through off-gassing vapors.

Most of the higher nitrogen oxides are eye, skin, and respiratory tract irritants. Initial respiratory symptoms after exposure to nitrogen oxides may be mild, but progressive inflammation of the lungs may develop several hours to days after exposure. Noncardiogenic pulmonary edema may develop even if initial pulmonary signs were minimal. Exposures may result in methemoglobinemia, depending upon the presence of nitric oxide (NO) in the gas mixture.

There is no antidote for nitrogen oxides. Treatment consists of respiratory and cardiovascular support. Methylene blue may be necessary to treat methemoglobinemia.

Decontamination Area

Previously decontaminated patients may be transferred immediately to the Critical Care Area. Others require decontamination as described below.

Be aware that use of protective equipment by the provider may cause fear in children, resulting in decreased compliance with further management efforts.

Because of their relatively larger surface area:body weight ratio, children are more vulnerable to toxicants absorbed affecting the skin. Also, emergency room personnel should examine children's mouths because of the frequency of hand-to-mouth activity among children.

ABC Reminders

Evaluate and support airway, breathing, and circulation. Administer supplemental oxygen as required. Children may be more vulnerable to corrosive agents than adults because of the relatively smaller diameter of their airways. In cases of respiratory compromise secure airway and respiration via endotracheal intubation. If not possible, surgically create an airway.

Treat patients who have bronchospasm with aerosolized bronchodilators. The use of bronchial sensitizing agents in situations of multiple chemical exposures may pose additional risks. Consider the health of the myocardium before choosing which type of bronchodilator should be administered. Cardiac sensitizing agents may be appropriate; however, the use of cardiac sensitizing agents

after exposure to certain chemicals may pose enhanced risk of cardiac arrhythmias (especially in the elderly).

Consider racemic epinephrine aerosol for children who develop stridor. Dose 0.25–0.75 mL of 2.25% racemic epinephrine solution in 2.5 cc water, repeat every 20 minutes as needed, cautioning for myocardial variability.

Patients who are comatose, hypotensive, or have seizures or ventricular arrhythmias should be treated in the conventional manner.

Basic Decontamination

Patients who are able may assist with their own decontamination. If the patient's clothing is wet with nitrogen oxides or nitric acid, remove and double-bag the contaminated clothing and all personal belongings.

Flush exposed skin and hair with water for 20 minutes (preferably under a shower). Use caution to avoid hypothermia when decontaminating children or the elderly. Use blankets or warmers when appropriate.

Begin irrigation of exposed eyes **immediately** and continue for at least 20 minutes. Remove contact lenses if easily removable without additional trauma to the eye. Continue irrigation while transporting the patient to the Critical Care Area.

If the patient has ingested a solution of nitrogen oxides or nitric acid, **do not induce emesis**. Do not administer activated charcoal. Activated charcoal is unlikely to be of benefit and may obscure endoscopic findings if GI tract irritation or burns are present. Patients who are conscious and able to swallow should be given 4 to 8 ounces of water or milk if not provided earlier.

Critical Care Area

Be certain that appropriate decontamination has been carried out (see *Decontamination Area* above).

ABC Reminders

Evaluate and support airway, breathing, and circulation as in *ABC Reminders* above. Administer supplemental oxygen as required. Children may be more vulnerable to corrosive agents than adults because of the relatively smaller diameter of their airways. Establish intravenous access in seriously symptomatic patients. Continuously monitor cardiac rhythm.

Patients who are comatose, hypotensive, or have seizures or ventricular arrhythmias should be treated in the conventional manner.

Inhalation Exposure

Administer supplemental oxygen by mask to patients who have respiratory symptoms. Treat patients who have bronchospasm with aerosolized bronchodilators. The use of bronchial sensitizing agents in situations of multiple chemical exposures may pose additional risks. Consider the health of the myocardium before choosing which type of bronchodilator should be administered. Cardiac sensitizing agents may be appropriate; however, the use of cardiac sensitizing agents after exposure to certain chemicals may pose enhanced risk of cardiac arrhythmias (especially in the elderly). Some clinicians recommend high doses of corticosteroids for seriously symptomatic patients, especially with severe bronchospasm; in patients with acute respiratory failure without bronchospasm, the value of steroids is unproven.

Consider racemic epinephrine aerosol for children who develop stridor. Dose 0.25–0.75 mL of 2.25% racemic epinephrine solution in 2.5 cc water, repeat every 20 minutes as needed, cautioning for myocardial variability.

Skin Exposure

If the skin was in contact with liquid nitrogen oxides or their solutions, chemical burns may occur; treat as thermal burns.

Because of their relatively larger surface area:body weight ratio, children are more vulnerable to toxicants affecting the skin.

Eye Exposure

Continue irrigation for at least 20 minutes. If liquid nitrogen oxides or nitric acid has been splashed in the eyes, irrigate until the pH of the conjunctival fluid has returned to normal. Test visual acuity. Examine the eyes for corneal damage and treat appropriately. Immediately consult an ophthalmologist for patients who have severe corneal injuries.

Ingestion Exposure

If the patient has ingested a solution of nitrogen oxides or nitric acid, **do not induce emesis**. Do not administer activated charcoal. Patients who are conscious and able to swallow should be given 4 to 8 ounces of water or milk if not provided earlier.

Consider endoscopy to evaluate the extent of gastrointestinal tract injury. Extreme throat swelling may require endotracheal intubation or cricothyroidotomy. Gastric lavage is useful in certain circumstances to remove caustic material and prepare for endoscopic examination. Consider gastric lavage with a small nasogastric tube if: (1) a large dose has been ingested; (2) the patient's condition is evaluated within 30 minutes; (3) the patient has oral lesions or persistent esophageal discomfort; and (4) the lavage can be administered within 1 hour of ingestion. Care must be taken when placing the gastric tube because blind gastric tube

placement may further injure the chemically damaged esophagus or stomach.

Because children do no ingest large amounts of corrosive materials, and because of the risk of perforation from NG intubation, lavage is discouraged in children unless intubation is performed under endoscopic guidance.

Toxic vomitus or gastric washings should be isolated, e.g., by attaching the lavage tube to isolated wall suction or another closed container.

Antidotes and Other Treatments

There are no antidotes for nitrogen oxide poisoning. Methylene blue (tetramethylthionine chloride) should be considered for patients who have signs and symptoms of hypoxia (other than cyanosis) or for patients who have methemoglobin levels >30%. Cyanosis alone does not require treatment. Methylene blue may not be effective in patients who have G6PD deficiency and may cause hemolysis.

The standard dose of methylene blue is 1 to 2 mg/kg body weight (0.1 to 0.2 mL/kg of a 1% solution) intravenously over 5 to 10 minutes, repeated in 1 hour if needed. The total initial dose should not exceed 7 mg/kg. (Doses greater than 15 mg/kg may cause hemolysis.) Clinical response to methylene blue treatment is usually observed within 30 to 60 minutes. Side effects include nausea, vomiting, abdominal and chest pain, dizziness, diaphoresis, and dysuria.

Consider exchange transfusion in severely poisoned patients who are deteriorating clinically in spite of methylene blue treatment. Intravenous ascorbic acid administered to severely poisoned patients has not proved to be effective.

Administration of steroids is thought by some physicians to reduce the likelihood of the development of bronchiolitis obliterans by reducing inflammation and therefore lung damage. Steroids should be started soon after exposure and continued for 8 weeks, then tapered gradually. The data on steroid use to prevent late sequelae (bronchiolitis obliterans) is anecdotal and somewhat controversial.

Laboratory Tests

The diagnosis of acute nitrogen oxide toxicity is primarily based on respiratory symptoms and establishing a history of exposure to nitrogen oxides. Routine laboratory studies for all exposed patients include CBC, glucose, and electrolyte determinations. Additional studies for patients exposed to nitrous oxides include determination

of methemoglobin levels. The condition of victims who have respiratory complaints should be evaluated with pulse oximetry (or ABG measurements), chest radiography, spirometry, and peak flow measurements. Pulse oximetry is not reliable if methemoglobin is present.

NO and NO_2 are metabolized to nitrite (NO_2^-) and nitrate (NO_3^-) and are excreted in the urine. The levels of these urinary metabolites are not medically useful but may be helpful in documenting exposure.

Disposition and Follow-up

Consider hospitalizing patients who have histories of significant inhalation exposure and are symptomatic.

Delayed Effects

Symptomatic patients should be observed in a controlled setting for 48 hours for delayed noncardiogenic pulmonary edema. All patients determined to have been exposed to nitrogen oxides should be advised that life-threatening symptoms may develop as late as several weeks after the exposure.

Patient Release

Patients who have been observed for several hours after minimal exposure and remain asymptomatic may be treated as outpatients. They should be advised to seek medical care promptly if symptoms develop (see *Nitrogen Oxides—Patient Information Sheet*). A patient whose symptoms resolve within 24 to 36 hours may be released with a follow-up appointment to assess pulmonary status.

Follow-up

Obtain the name of the patient's primary care physician so that the hospital can send a copy of the ED visit to the patient's doctor.

Close outpatient follow-up should be continued in patients who experienced significant respiratory compromise because these patients are at high risk of developing bronchiolitis obliterans within several weeks.

Patients who have corneal injuries should be reexamined within 24 hours.

Reporting

If a work-related incident has occurred, you may be legally required to file a report; contact your state or local health department.

Other persons may still be at risk in the setting where this incident occurred. If the incident occurred in the workplace, discussing it with company personnel may prevent future incidents. If a public health risk exists, notify your state or local health department or other responsible public agency. When appropriate, inform patients that they may request an evaluation of their workplace from OSHA

or NIOSH. See Appendices III and IV for a list of agencies that may be of assistance.

Nitrogen Oxides
Patient Information Sheet

This handout provides information and follow-up instructions for persons who have been exposed to nitrogen oxides.

What are nitrogen oxides?
Nitrogen oxides are a mixture of gases that each contain nitrogen and oxygen. Nitrogen oxides are formed naturally when fossil fuels (e.g., coal, oil, gas, kerosene) are burned and when silage containing nitrate fertilizer ferments in storage silos. They are also formed during electric arc welding, electroplating, and engraving. They are part of airborne smog and are partly indirectly responsible for the burning eyes, nose, and throat caused by air pollution, through formation of the intensely irritating compound peroxyacetylnitrate, PAN.

What immediate health effects can be caused by exposure to nitrogen oxides?
Breathing low levels of nitrogen oxides may cause brief, nonspecific symptoms such as cough, shortness of breath, tiredness, and nausea. However, even if removed from exposure, a person who has breathed nitrogen oxides can develop more serious lung injury over the next 1 to 2 days. Exposure to massive concentrations can cause sudden death due to lung injury and suffocation or choking. Generally, the more serious the exposure, the more severe the symptoms.

Can nitrogen oxide poisoning be treated?
There is no antidote for nitrogen oxide poisoning. Treatment for exposure usually involves giving the patient oxygen and medications to make breathing easier.

Are any future health effects likely to occur?
A single small exposure from which a person recovers quickly may not cause delayed or long-term effects. After a serious exposure or repeated exposures, a patient may develop asthma or other lung conditions.

What tests can be done if a person has been exposed to nitrogen oxides?
Specific tests for the presence of nitrogen oxides in blood or urine generally are not useful to the doctor. If a severe exposure has occurred, blood and urine analyses and other tests may show whether damage has been done to the lungs, heart, and brain. Testing is not needed in every case.

Where can more information about nitrogen oxides be found?
More information about nitrogen oxides can be obtained from your regional poison control center; your state, county, or local health department; the Agency for Toxic Substances and Disease Registry (ATSDR); your doctor; or a clinic in your area that specializes in occupational and environmental health. If the exposure happened at work, you may wish to discuss it with your employer, the Occupational Safety and Health Administration (OSHA), or the National Institute for Occupational Safety and Health (NIOSH). Ask the person who gave you this form for help in locating these telephone numbers.

Follow-up Instructions

Keep this page and take it with you to your next appointment. Follow *only* the instructions checked below.

[ ] Call your doctor or the Emergency Department if you develop any unusual signs or symptoms within the next 48 to 72 hours, especially:

- coughing or wheezing
- difficulty breathing, shortness of breath, or chest pain
- weakness, fatigue, or flu-like symptoms
- increased redness or pain or a pus-like discharge in the area of a skin burn

[ ] No follow-up appointment is necessary unless you develop any of the symptoms listed above.
[ ] Call for an appointment with Dr. _____ in the practice of _____.
When you call for your appointment, please say that you were treated in the Emergency Department at _____ _____ Hospital by _____ and were advised to be seen again in _____ days.
[ ] Return to the Emergency Department/ _____ Clinic on (date) _____at _____ _____ AM/PM for a follow-up examination.
[ ] Do not perform vigorous physical activities for 1 to 2 days.
[ ] You may resume everyday activities including driving and operating machinery.
[ ] Do not return to work for _____ days.
[ ] You may return to work on a limited basis. See instructions below.
[ ] Avoid exposure to cigarette smoke for 72 hours; smoke may worsen the condition of your lungs.
[ ] Avoid drinking alcoholic beverages for at least 24 hours; alcohol may worsen injury to your stomach or have other effects.
[ ] Avoid taking the following medications: _____
[ ] You may continue taking the following medication(s) that your doctor(s) prescribed for you: __
_____
_____
[ ] Other instructions: _____
_____
_____

- Provide the Emergency Department with the name and the number of your primary care physician so that the ED can send him or her a record of your emergency department visit.

- You or your physician can get more information on the chemical by contacting: _____ _____ or _____, or by checking out the following Internet Web sites: ___ _____; _____.

Signature of patient _____ Date _____

Signature of physician _____ Date _____