

R-002-204.1

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**PLANT 9 CONTAMINATED PERCHED WATER  
REMOVAL ACTION WORK PLAN APRIL 1990**

**04/01/90**

**DOE-FMPC/USEPA**

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**PLAN**

PLANT 9  
CONTAMINATED PERCHED WATER

REMOVAL ACTION  
WORK PLAN

APRIL 1990

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## I. INTRODUCTION

This document provides a work plan describing the removal action which will be taken to address the uranium contaminated water found in Boring 1324 located near the southeast corner of Plant 9 at the Feed Materials Production Center (FMPC). This removal action is a component of Operable Unit #3. The work plan was prepared to satisfy the commitment to expand Removal Action No. 1 as stated in the Consent Agreement Under CERCLA Section 120 and 106(a) (hereafter called the "Consent Agreement") and is consistent with the requirements of 29 CFR 1910.120. A removal site evaluation has been generated and approved by the DOE which meets the requirements of the National Contingency Plan (NCP): Section 300.410 criteria for a time critical removal action. The scope of work herein delineates the plan which will be used to locate the source of water, the installation of a recovery well system and pumping of the extracted water to existing treatment facilities.

## II. BACKGROUND

### 1.0 Summary of the Potential Threat

The Production and Additional Suspect Areas Work Plan of the Feed Materials Production Center (FMPC) Remedial Investigation and Feasibility Study (RI/FS) includes a comprehensive plan to sample and characterize the soil, and the extent of perched water in the upper 20 feet of the soil under the FMPC production area. This depth is intentionally confined to the space sufficiently above the aquifer that exists under the FMPC so that penetration through the cover soil does not occur. In addition to systematic borings at 250 foot intervals across the entire production site, one phase of the RI/FS involves "focused" borings to explore suspect areas of contamination under the individual plants.

As part of the Production and Additional Suspect Areas Work Plan, several borings were installed in and around Plant 9 (see Figure 1). A water sample taken from focused Boring 1324 on January 17, 1990, was found to contain a total uranium concentration of 696,000 micrograms per liter (ug/l). While taking a second water sample from Boring 1324 on February 8, 1990, it was observed that the water level in the well recovered within 4 minutes. This supports the concept that a pool of water exists under the secondary containment enclosure located just west of Boring 1324 (see Figures 1 & 2).

### 2.0 Related Actions

A time critical removal action was approved by the U. S. Department of Energy (DOE), U. S. Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA) for the pumping and treating of uranium contaminated perched water from under FMPC buildings. The first action involved pumping water from under Plant 6. This action commenced on August 1, 1988 on a temporary basis and

a more permanent pumping system was placed in operation on November 6, 1989.

### 3.0 Roles of Participants

- A. The DOE is the lead agency for this removal action and will coordinate and execute this removal action. The state and local roles have been one of participation in the negotiations of the Consent Agreement and Technical Information Exchanges (TIE).
- B. USEPA and OEPA shall review, comment on the work plan, follow progress through TIE meetings and the Consent Agreement progress reports.
- C. Advanced Sciences, Inc. (ASI), as a subcontractor to DOE, is conducting the RI/FS program activities at the FMPC. ASI will also install a recovery well near Boring 1324.
- D. Westinghouse Materials Company of Ohio (WMC0), the Operating Contractor at the FMPC, will coordinate, manage, implement, monitor and prepare all reports associated with the removal action.

### 4.0 Proposed Removal Action

Install a recovery well near Boring 1324 to remove perched water and pump the water to existing FMPC wastewater treatment facilities. This effort will be undertaken to control the potential for vertical migration into the Great Miami Aquifer by reducing the hydrostatic head of the perched water.

## III. SUPPORT ACTIVITIES

Activities will be undertaken to provide planning, design, and management for the removal action.

### 1.0 Project Planning

Included in this activity will be the preparation of a detailed task listings and delineation of responsibilities to support the schedule given in Attachment 1. Also, a training schedule will be generated to ensure that the personnel involved in the scope of work will be trained in accordance with the Occupational Safety and Health Administration (OSHA) standards found in 29 CFR 1910.120.

### 2.0 Pumping System Design

A detailed design for a submersible pumping system with a liquid level control that is capable of removing water from a four-inch casing will be prepared. The pumping system will include provisions for the monitoring/metering of pump discharge, automatic start/stop

control, manual override of automatic control, and a sampling port on the discharge line.

### 3.0 Management of Project

WMC0 personnel will manage the project using FMPC-2201 Topical Manual, Project Management Procedures.

## IV. FIELD REMOVAL ACTIONS

Actions will be taken to investigate the source of perched water in Boring 1324, install a recovery well adjacent to Boring 1324 and install a pumping system to remove and transfer the water to existing facilities for treatment before discharge to the Great Miami River.

### 1.0 Perched Water Source Detection

The objective of this activity is to determine the source of perched water found in Boring 1324. Possible sources include leakage or overflow from the sump located in the secondary containment enclosure at the south corner of Plant 9 or leakage from two gravity lines which discharge to the sump (see Figure 2).

### 2.0 Install Recovery Well

The objective of this activity is to provide a recovery well for removing the uranium contaminated water. Boring 1324 cannot be pumped because it only has a two-inch well casing designed for obtaining water samples and checking water levels. The recovery well will be installed adjacent to Boring 1324 (see Figure 1) consistent with the procedures of the RI/FS Work Plan. The well will penetrate the same perched water zone as Boring 1324.

### 3.0 Install Pumping System

The objective of this activity is to install a pumping system in the new recovery well.

### 4.0 Pump Contaminated Water

The objective of this activity is to pump the contaminated water. This effort will be undertaken to control the potential for vertical migration of the contamination by reducing the hydrostatic head of the perched water. The uranium contaminated water will be pumped from the new recovery well into the adjacent sump (see Figure 1). Prior to start of pumping, the integrity of the sump will be addressed. Existing facilities will transfer the water from the sump to Plant 9, Plant 6, or Plant 8 for treatment.

**V. SAMPLING AND ANALYSIS PLAN**

Soil and water samples will be obtained during the boring of the recovery well by ASI for the parameters outlined in the Production and Additional Suspect Areas Work Plan of the FMPC RI/FS. Water samples from the pumping operation will be obtained by WMC0 personnel according to FMPC Standard Operating Procedure (SOP) and sent to the FMPC Laboratory for analysis of total uranium, total thorium, nitrates and pH. Samples from the pumping operations will be obtained weekly for the first month and monthly thereafter.

The sampling process will be in accordance with the Analytical Laboratories Quality Assurance Plan L.C.N.-QAP, October 1987, and its implementing procedures. Split samples of discharged water will be taken monthly during the first quarter of the pumping operation and quarterly thereafter. The split samples will be obtained by the WMC0 Environmental Monitoring Group according to the procedures and protocol specified in the RI/FS Work Plan (Revision 3) dated March, 1988. The split samples will be sent to a certified independent laboratory for verification of the analysis performed by the FMPC.

**VI. HEALTH & SAFETY PLAN**

The work to be performed will be consistent with the Health and Safety Plan prepared for this removal action. A copy of this plan is provided as Attachment 2 of this Work Plan. The plan identifies, evaluates, and controls all safety and health hazards. In addition, it provides for emergency response for hazardous operations. The plan is consistent with 29 CFR 1910.120.

Additional safety documentation will be prepared as necessary according to FMPC-2116 Topical Manual "Implementing FMPC Policies and Procedures for System Safety Analysis." FMPC-2116 has been prepared to implement DOE Order 5481.1B - Safety Analysis and Review System and DOE/OR-901 - Guidance for Preparation of Safety Analysis Reports.

**VII. QUALITY ASSURANCE PLAN**

Removal action activities will be conducted according to requirements of QAMS-005/80 as described in the FMPC Quality Assurance Plan (FMPC-2139, Rev. 2, March 15, 1990). Quality Assurance requirements of DOE Order 5700.6B will be implemented as described in FMPC-2139 for the appropriate QA Level, as determined by a Risk Assessment Report (RAR). These documents reinforce each other in a number of areas, whereas QAMS-005/80 highlights controls related to the monitoring and sampling activities of the project. Detailed requirements are implemented by the WMC0 Site Policies and Procedures Manual, FMPC-2054, by WMC0 Departmental Procedures, and by project specific procedures and plans as needed.

The FMPC Quality Assurance Plan establishes a systematic approach to provide confidence that the system will perform satisfactorily and safely. The Plan provides for QA surveillances to verify compliance and, if needed, corrective actions by use of Deviation and Corrective Action Reports (DCARs).

#### VIII. ASSUMPTIONS

1. No new regulatory assessments or permits required.
2. Removal actions that are time critical are completed in an expeditious manner without the need to prepare an EE/CA or a NEPA document. There is a requirement to prepare a final report of the action taken and to document the removal action in the Administrative Record File for Removal Number 1 Contaminated Water Under FMPC Buildings.
3. Organics and other chemical constituents which may be in the perched water will be addressed during removal system design.

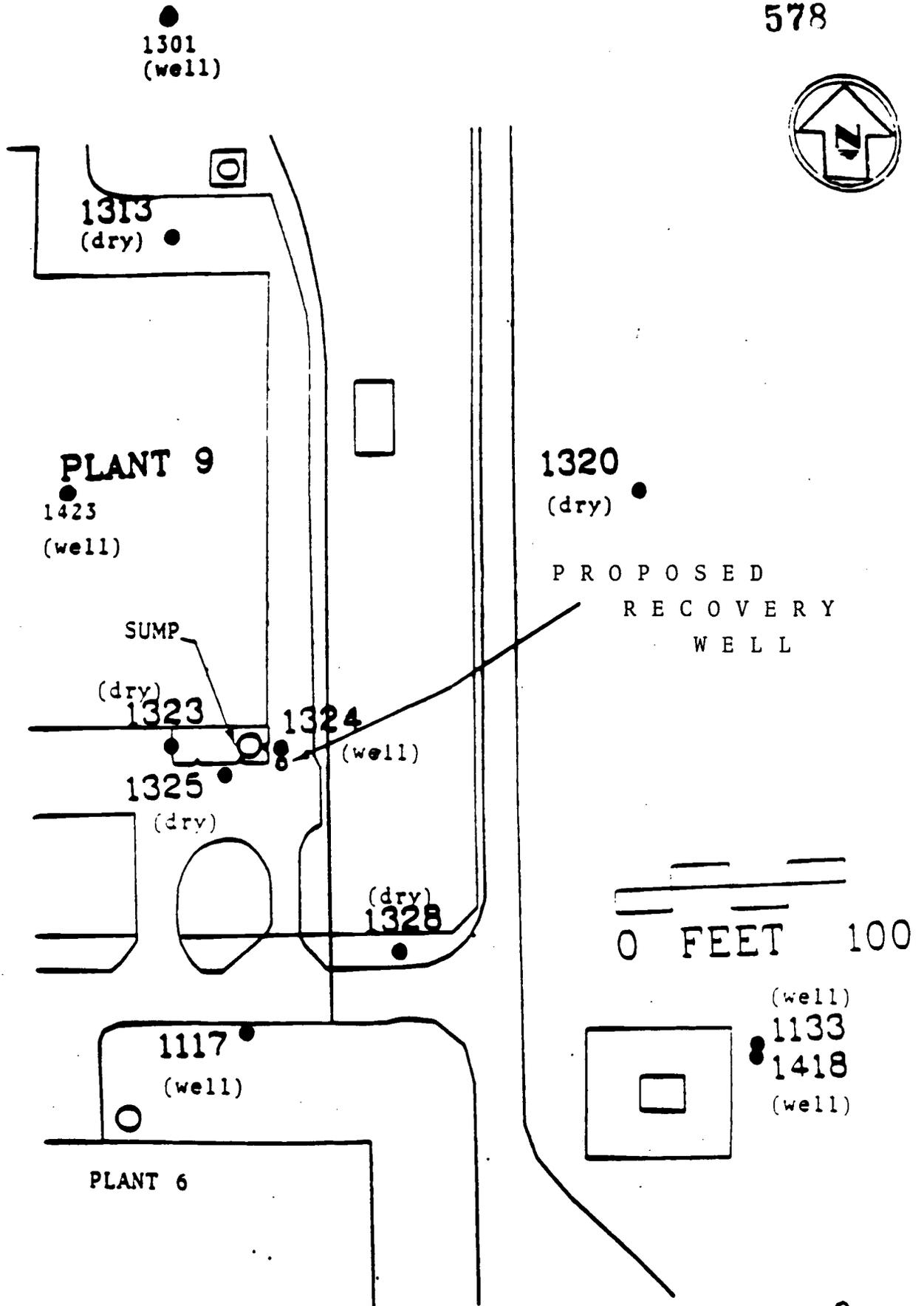


FIGURE 1



# Plant 9 Contaminated Groundwater Pumping

FMPC

Description	
Work Plan	(70 working days) <input type="text"/>
Design	(22 working days) <input type="text"/>
Contaminated Groundwater Source Detection	(85 working days) <input type="text"/>
Install Recovery Well	(44 working days) <input type="text"/>
Install Pumping System	(44 working days) <input type="text"/>
Pump Contaminated Water	(508 working days*) <input type="text"/>

NOTE 1 = Pumping will continue until implementation of the Record of Decision (ROD) is completed for Operable Unit No. 3 or until concentration of hazardous substance in water becomes insignificant as compared to background.

\*Or longer if required

ATTACHMENT 2

HEALTH AND SAFETY PLAN FOR THE PLANT 9  
CONTAMINATED PERCHED WATER REMOVAL ACTION

FEED MATERIALS PRODUCTION CENTER

April 1990

APPROVED by:

  
J. J. Volpe

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## 1.0 TASKS TO BE PERFORMED

The work to be performed involves determining the source of the perched water found in Boring 1324, providing a pumping system for removing the uranium contaminated perched water from the boring, and the actual operation of the pumping system.

The work to be performed will be at a well boring which will be provided by Advanced Sciences Incorporated/International Technology (ASI/IT). A separate Health and Safety Plan has been developed by ASI/IT for the actual drilling and completion of the well (ASI/IT, "Site Specific Hazard Assessment for Plant 9 - Boring 1311, 1312, 1315, 1319, 1322, January 2, 1990").

The contaminant source detection will:

<u>no</u>	Disturb Surface Soil	<u>yes</u>	Sample Surface Water
<u>no</u>	Disturb Subsurface Soil	<u>no</u>	Sample Lagoons
<u>no</u>	Use Heavy Equipment	<u>no</u>	Use Boat
<u>yes</u>	Enter Confined Space	<u>yes</u>	Involve Radioactivity
<u>yes</u>	Disturb Containerized Matter	<u>no</u>	Involve Trenches

The installation of the pumping system will:

<u>yes</u>	Disturb Surface Soil	<u>no</u>	Sample Surface Water
<u>yes</u>	Disturb Subsurface Soil	<u>no</u>	Sample Lagoons
<u>no</u>	Use Heavy Equipment	<u>no</u>	Use Boat
<u>no</u>	Enter Confined Space	<u>yes</u>	Involve Radioactivity
<u>no</u>	Disturb Containerized Matter	<u>yes</u>	Involve Trenches

The operation of the system for pumping the contaminated water will:

<u>no</u>	Disturb Surface Soil	<u>yes</u>	Sample Surface Water
<u>no</u>	Disturb Subsurface Soil	<u>no</u>	Sample Lagoons
<u>no</u>	Use Heavy Equipment	<u>no</u>	Use Boat
<u>no</u>	Enter Confined Space	<u>yes</u>	Involve Radioactivity
<u>no</u>	Disturb Containerized Matter	<u>no</u>	Involve Trenches

## 2.0 SITE HISTORY

The task will be performed at Plant 9 which is located within the FMPC property lines area. At present, the Plant 9 is routinely occupied. The production facility is not actively refining uranium at this time. Soils and groundwater near Plant 9 have the potential to be contaminated with uranium, its daughter products and thorium as a result of contaminant migration.

Plant 9 has been used for the purification of thorium metal (approximately 1955), production of thorium derbies and ingots (1955-1957), molten salt cleaning of uranium derbies (1965-1986), and decladding of uranium fuel cores. In addition to uranium, uranium compounds, thorium, and thorium compounds, chemicals that were possibly used, or believed to be present, in or around Plant 9 include asbestos (pipe and tank insulation and transite), hydrofluoric acid, nitric acid, lithium carbonate, magnesium oxide, potassium carbonate, potassium hydroxide, and sodium hydroxide. Other materials that are, or have been present, in and around Plant 9 include cleaners, cutting oils, lubricants, solvents, glues, paints, etc. These later materials are, or were, present in small quantities and should prove little potential hazard to the personnel involved in the work.

## 3.0 TASK SPECIFIC HAZARD ASSESSMENT

A walk-through survey of the tank area (see Figure 1) in Plant 9 indicated the potential hazards identified below. Prior to the initiation of the activities, a reassessment of the conditions will be conducted to ensure that conditions have not changed through the issuance of work permits. All newly identified hazards will be addressed with the Industrial, Radiological, Safety and Training (IRS&T) representative(s) to determine the degree of hazard and if any changes to the safety plan are needed.

### 3.1 Physical Hazards

- o Noise
- o Overhead Hazards
- o Underground Utilities

### 3.2 Radiation Hazards

The potential radiation hazard are from uranium (depleted to 2% enriched in U-235) and short lived decay products. Thorium content in affected areas is expected to be very low relative to uranium content. Therefore, the hazard potential from thorium is minimal.

### 3.3 Chemical Hazards

<u>Contaminant</u>	<u>Primary Hazard</u>	<u>Limit</u>	<u>Action Level</u>
Nitrogen Dioxide <sup>(1)</sup>	Inhalation	1 ppm (proposed)	0.5 ppm
Asbestos <sup>(2)</sup>	Inhalation	0.2 f/cc(OSHA TWA)	0.1 f/cc
Hydrofluoric Acid	Contact Skin/Eyes	---	---
Nitric Acid	Contact Skin/Eyes	---	---
Sodium Hydroxide	Contact Skin/Eyes	---	---
Uranium	Inhalation/Ingestion		5 x 10 <sup>-12</sup> uCi/ml

Data Sheets have been provided as attachments to this plan to provide additional information on these chemicals.

- (1) NO<sub>2</sub> may be produced if residual nitric acid is present in lines or sump.
- (2) No asbestos hazard present unless insulated lines or transite is damaged or disturbed (special permit required for asbestos work.)

## 4.0 MONITORING

### 4.1 Goals

During the contaminant source detection task, air monitoring will be performed as determined to be necessary at the time of issuance of the work permit(s) to ensure that exposure levels do not exceed established exposure limits.

### 4.2 Monitoring Equipment and Frequency of Monitoring

#### 4.2.1 Airborne Radioactivity

During the contaminant source detection and installation of the pumping system tasks, air samples will be taken in the general area of the work inside Plant 9 daily while work is in progress. Local or breathing zone samples will be taken in the vicinity of possible leaks of fluid systems as they are air-pressurized for hydrostatic testing.

#### 4.2.2 Radioactive Surface Contamination

During the contaminant source detection and installation of the pumping system tasks, weekly surveys for removable radioactive surface contamination will be performed in Plant 9 and the south sump area near the boring. Contamination surveys will be performed on potentially contaminated fluid systems, as they are opened, to ensure that adequate protective clothing is being worn and to verify radiological postings.

#### 4.2.3 Radiation Surveys

Area radiation surveys will be taken monthly in Plant 9.

#### 4.2.4 Chemical Hazard

Direct reading monitoring devices will be used to determine the concentration of NO<sub>2</sub> and/or other gases and vapors at the time of issuance of the work permit and thereafter as determined to be necessary by the Industrial Hygiene representative.

A HNu may be used periodically to test for organic vapors as determined to be necessary by the Industrial Hygiene representative. If organic vapors are detected, they will be treated as unknowns. The Breathing Zone action levels are listed in Section 4.3.

#### 4.2.5 Thermoluminescent Dosimetry (TLD)

TLDs will be worn by all workers.

#### 4.3 Action Levels

<u>Measurement</u>	<u>Level</u>	<u>Action</u>
Removable contamination on open surfaces	20,000 dpm/100 cm <sup>2</sup> (average)	Note 1
Airborne radioactivity (long lived)	5 x 10 <sup>-12</sup> uCi/ml	Note 1
HNU Meter (Breathing Zone)	Detection to 10 ppm (Note 2)	Note 1
	10-25 ppm	Supplied Air Respirator (SAR)
	>25 ppm	Withdraw
Nitrogen Dioxide (Breathing Zone)	0.5 ppm	Withdraw

#### Notes

- 1 Full-face air purifying respirators with combination HEPA filter and organic vapor, acid gas, fume cartridges.
- 2 1 ppm above background.

#### 5.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

All employees in the task exclusion area will wear the following personal protective equipment while performing the required tasks.

5.1 Contaminant Source Detection

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<u>ITEM</u>	<u>NEED</u>	<u>APPLICABILITY</u>
Air purifying respirator	No (Yes)	Required if action levels are exceeded or as specified by IRS&T representative
Cartridges: HEPA Combination Radiological/OV/AG	No (Yes)	Required if action levels are exceeded or as specified by IRS&T representative
Hard Hat	No	
Hearing Protection	No	
Inner Gloves	No	
Rubber/Latex Boots	Yes	As needed to prevent contact with liquids (e.g., sump & drains)
Leather-Palm Gloves	Yes	
Rubber/Nitrile Gloves	Yes	As needed to prevent contact with liquids (e.g., sump & drains)
Plain Tyvek	No	
PE Tyvek	No	
Process Coveralls	Yes	
PVC Gloves	No	
SAR	No	
Safety Glasses	Yes	Minimum Requirement
Safety Goggles/Face Shield	Yes	During hydrostatic testing, as needed to prevent contact with splash or particulates (e.g., cleaning/grinding on chemically contaminated drain lines)
Safety Shoes	Yes	Minimum Requirement
Saranex Tyvek	No	
Shoe Covers	No	

5.2 Installation of Pumping System

<u>ITEM</u>	<u>NEED</u>	<u>JUSTIFICATION</u>
Air purifying respirator	No (Yes)	Required if action levels are exceeded or as specified by the IRS&T representative.
Cartridges: HEPA Combination Radionuclide/organic vapor/acid gas	No (Yes)	Required if action levels are exceeded or as specified by the IRS&T representative.
Hard Hat	Yes	As needed for overhead work
Hearing Protection	Yes	During concrete breaking/cutting
Inner Gloves	No	
Rubber/Latex Boots	Yes	As needed to prevent contact with liquids (e.g., sumps, drains, pumping)
Leather-Palm Gloves	Yes	
Rubber/Nitrile Gloves	Yes	As needed to prevent contact with liquids (e.g., sumps, drains, pumping)
Plain Tyvek	No	
PE Tyvek	No	
Process Coveralls	Yes	
PVC Gloves	No	
SAR	No	
Safety Glasses	Yes	Minimum Requirement
Safety Goggles/Face Shield	Yes	During pump testing and as needed
Safety Shoes	Yes	Minimum Requirement
Saranex Tyvek	No	
Shoe Covers	No	

5.3 Operation of the Pumping System

<u>ITEM</u>	<u>NEED</u>	<u>JUSTIFICATION</u>
Air purifying respirator	No (Yes)	Required if action levels are exceeded or as specified by the IRS&T representative.
Cartridges: HEPA Combination Radionuclide/organic vapor/acid gas	No (Yes)	Required if action levels are exceeded or as specified by the IRS&T representative.
Hard Hat	Yes	As needed for overhead work
Hearing Protection	No	
Inner Gloves	No	
Rubber/Latex Boots	Yes	As needed to prevent contact with liquids (e.g., sumps, drains, pumping)
Leather-Palm Gloves	Yes	
Rubber/Nitrile Gloves	Yes	As needed to prevent contact with liquids (e.g., sumps, drains, pumping)
Plain Tyvek	No	
PE Tyvek	No	
Process Coveralls	Yes	
PVC Gloves	No	
SAR	No	
Safety Glasses	Yes	Minimum Requirement
Safety Goggles/Face Shield	Yes	During initial testing and as needed
Safety Shoes	Yes	Minimum Requirement
Saranex Tyvek	No	
Shoe Covers	No	

## 6.0 SITE CONTROL

### 6.1. Access

The work associated with this removal action will be within the FMPC controlled area. In addition, the work area related to this removal action will be posted as "RWP Required for Entry". This will establish the Exclusion Zone per 29 CFR 1910.120.

The Exclusion Zone is the zone of high potential hazard due to physical or chemical dangers. Access to the Exclusion Zone will be restricted by Radiological Safety to trained and certified employees, as regulated by 29 CFR 1910.120, who are required to enter in order to perform their job functions. There will be different Exclusion Zones for the various tasks. The Exclusion Zone will be marked with barrier tape or other easily recognizable devices. The zone may be expanded if airborne hazards are detected. All areas requiring the use of respiratory protection are included in the exclusion zone. Entrance shall be limited to one area and controlled by the supervisor in charge.

If necessary, Radiological Safety will establish a Contamination Reduction Zone, consisting of step-off pads, at the exit to the Exclusion Zone. This zone will be used for removal of disposable PPE and for cleaning of contaminated equipment.

#### 6.1.1 Radiological Postings

Radiological areas will be posted in accordance with DOE Order 5480.11. The following is a brief summary of posting requirements based on uranium:

Regulated Area	> 1000 dpm/100 cm <sup>2</sup> removable > 5000 dpm/100 cm <sup>2</sup> fixed and removable
Contaminated Area	> 10,000 dpm/100 cm <sup>2</sup> removable > 50,000 dpm/100 cm <sup>2</sup> fixed and removable
Airborne Radioactivity Area	> 2 x 10 <sup>-12</sup> uCi/ml
Respirator Area	> 5 x 10 <sup>-12</sup> uCi/ml

In addition, special postings may be added for access to areas: "RWP Required for Entry" or "Contact HP for Entry."

### 6.2 Bioassay Samples

WMCO personnel involved in this project are required to participate in a routine periodic urine assay program. Any suspected exposure to hazardous substances shall be reported and require additional sampling. Personnel are also required to wear a TLD at all times for radiological purposes.

### 6.3 Medical Monitoring

In accordance with 29 CFR 1910.120 OSHA requirements, all WMCO and WMCO subcontractor personnel are required to participate in a medical monitoring program which includes:

- o A baseline medical examination
- o Annual medical examination
- o Medical examinations may be required after exposures
- o WMCO respirator clearance for respirator users

Prior to the start of work, personnel involved in this project shall be identified by name and badge number. Each individual shall be subject to a medical surveillance approval by the Director, Medical Services. The approval statement shall certify that each individual is medically qualified to perform the work and is physically fit to wear PPE.

### 6.4 Training Requirements

All WMCO and WMCO subcontractor personnel assigned to the tasks will, as a minimum, meet the following training requirements:

- o Review of this health & safety plan for this work including site specified hazards and procedures. (This safety meeting(s) will be documented.)
- o WMCO radiation safety training
- o WMCO respiratory training and fit test or equivalent approved by WMCO Industrial Hygiene
- o 40-hour OSHA training
- o 8-hour annual refresher training
- o 8-hour supervisory training (for supervisors)
- o 24-hour supervised field experience

### 6.5 Safety Meetings

A safety meeting, which must be documented, shall be conducted prior to start of each day's work during the perched water source detection and the installation of the pumping system tasks. The meeting will cover the following applicable subjects:

- work operations.
- personnel protective equipment
- all monitoring data
- hazard communications
- monitoring tests and results
- decontamination
- task organization
- physical stress
- emergency procedures
- communications
- general safety
- housekeeping

## 7.0 EXPOSURE SYMPTOMS

Exposure to low levels of radioactivity does not produce acute exposure symptoms. Such exposures may cause delayed effects such as cancer. Since biological effects from radiation exposures are cumulative, exposures are to be kept as low as achievable. No treatment is anticipated for the predicted contaminants and concentrations. See Section 11 for contingency plans.

Exposure symptoms for inhalation of nitrogen dioxide (NO<sub>2</sub>) and for skin/eye contact with hydrofluoric acid, nitric acid, and sodium hydroxide are described on the attached data sheets.

## 8.0 SITE ENTRY PROCEDURES

During the perched water source detection and installation of pumping system tasks, the following procedures apply:

- o Identify exclusion zone, contamination reduction zone, and break area.
- o Perform daily safety meeting to familiarize team with site specific hazards.
- o Discuss alternate communications signals (if applicable).
- o Perform respirator check out and fit test prior to use.
- o Use buddy system. Teams of at least two individuals will be used for all activities within an exclusion zone.

Prior to the initiation of these work tasks, the following permits are required:

- Radiation Work Permit
- Penetration Permit
- Chemical/Hazardous Material Permit
- Work Permit

All personnel entering the Exclusion Zone shall be trained and certified to perform their assigned task as defined by 29 CFR 1910.120.

Entrance to the Exclusion Zone shall be controlled and at the approval of the supervisor in charge.

## 9.0 DECONTAMINATION

Equipment for decontamination of radiological or chemical hazards shall be kept available in the area surrounding the exclusion zone if such is determined necessary by supervisor or by either Radiation Safety or Industrial Hygiene prior to the initiation of the activity. As a minimum, the location of the nearest water for decontamination and eye washing shall be identified and its operability verified prior to start of work.

## 10.0 WASTES

Wastes include, but are not limited to:

- o Disposable PPE such as Tyvek coveralls, gloves booties.
- o Excess materials such as soil or concrete.

All potentially contaminated waste materials resulting from site activities will be collected and placed in drums or other containers. Disposable protective clothing will be placed in plastic bags and disposed of as compactible, potentially contaminated waste.

Drums or containers shall meet DOE 49 CFR Parts 171-178, EPA, 40 CFR Parts 264-265 and 300, and OSHA requirements. Hazard warning shall be immediately applied to all drums as specified by WMCO management/supervisors and Solid Waste Compliance.

## 11.0 CONTINGENCY PLANS

### 11.1 Incidents or Injuries Involving Possible Intake of Radiological or Chemical Substances by Employees

See statement on submission of urine samples for radiation exposures in Standard Operating Procedure (SOP) No. 11-C-245.

See HF Exposure statement in SOP No. 11-C-245.

Incidents or injuries involving potential intake of other hazardous substances shall be reported to supervisor and the WMCO Medical Section by the involved employee and an Incident Investigation Report completed by the involved employee.

### 11.2 Pre-Emergency Planning

During the training and pre-work safety meetings, all employees involved in this task shall be trained and reminded of the provisions of the plant emergency procedure, alarm signals and communications, evacuation routes and emergency reporting.

### 11.3 Lines of Authority

The supervisor in charge has the primary responsibility for the prevention of emergency conditions. In the event that an emergency does occur, the individual involved or observing the condition shall immediately notify a supervisor, the communication center or the Assistant Emergency Duty Officer (AEDO). The AEDO is responsible for ensuring that corrective actions have been implemented, the appropriate personnel notified, and reports completed as required.

### 11.4 Evacuation

In the event of an emergency which necessitates an evacuation of the Exclusion Area, the 2-2, 2-2 shall be sounded over the plant alarm system; a voice message will follow over the Emergency Message System instructing employees to go to their designated Rally Point (see Figure 2). Personnel shall immediately proceed to the Rally Point and participate in the accountability process. Personnel will follow instructions given by the Rally Point Coordinator. When an all-clear condition has been achieved, personnel will be released from the Rally Point.

### 11.5 Emergency Equipment

The following safety equipment, locations to be identified at safety meetings, is available for employee usage:

- |  |   |
|--|---|
| <input type="checkbox"/> fire extinguisher | <input type="checkbox"/> manual fire alarm      |
| <input type="checkbox"/> eye wash          | <input type="checkbox"/> two-way radio          |
| <input type="checkbox"/> safety shower     | <input type="checkbox"/> emergency SCBA units   |
| <input type="checkbox"/> telephone         | <input type="checkbox"/> respirators            |
| <input type="checkbox"/> spill drums       | <input type="checkbox"/> clean-up materials     |
| <input type="checkbox"/> absorbent         | <input type="checkbox"/> local evacuation alarm |
| <input type="checkbox"/> other - List      |   |

### 11.6 Emergency Notification

All emergencies shall be reported immediately. Emergencies can be reported by telephone dialing 6511; by contacting the communications center via two-way radio; or by pulling a manual fire alarm.

### 11.7 Fire, Explosion, or Medical Emergency

In the event of a fire, explosion or medical emergency, the communication center shall be notified immediately by manual fire alarm, two-way radio, or by calling 6511. The communication center operator will activate the emergency response team and dispatch them to your location. Personnel in the immediate area should evacuate to a safe position and await instructions.

## 11.8 Additional Information

### 11.8.1 Hospitals

The WCMO Medical Facility (Building 53) is the primary choice for on-site injuries. The WCMO ambulance will transport the injured to the nearest hospital if necessary. WCMO maintains an emergency response capability which includes an ambulance and Emergency Medical Technicians.

### 11.8.2 Emergency Telephone Numbers

Ambulance: 6511 or 6512  
 Hospital: 6511 or 6512  
 Fire: 6511 or 6512

<u>Name</u>	<u>Work</u>	<u>Radio</u>
<b>EMERGENCY RESPONSE</b>	<b>6511</b>	
Industrial Hygiene	6207	357
Radiation Safety	6889	355
Fire and Safety	6235	303
Leo Singleton	8908	709
Assistant Emergency Duty Officer (AEDO)	6431 or 6295	202

## 12.0 CONFINED SPACE ENTRY

A Confined Space Entry permit will be required for the perched water source detection task. A Confined Space Entry Permit will be obtained and its requirements followed. Permits will not be required for the installation of the pumping system and for the pumping of the contaminated water.

13.0 APPROVAL AND COMPLIANCE STATEMENT

This Health and Safety Plan was produced for the use of WMCO employees and WMCO subcontractors. It is intended for the FMPC and specifically for the following activities related to the Plant 9 removal action:

- Contaminant Source Detection
- Installation of Pumping System
- Pumping of the Contaminated Water

The undersigned person have read and understood this Health and Safety plan and agree to follow its provisions (See Note 1):

Name (lettered)	Signature	Date
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Note 1: Compliance with the provisions of this HASP may be audited through announced or unannounced site visits. Be sure that you are implementing the provisions of the safety plan and documenting the reasons for field actions/changes when they are necessary. Site visits may be performed:

\_\_\_ By WMCO

\_\_\_ By DOE

578

Sump

PLANT 9

Floor Drain Line

Seconda Contain Enclosu

Pad Drain

"Old" Dust Dust Collector Pad



(5)

(4)

(6)

(2)

(11)

(10)

(9)

(8)

(7)

(6)

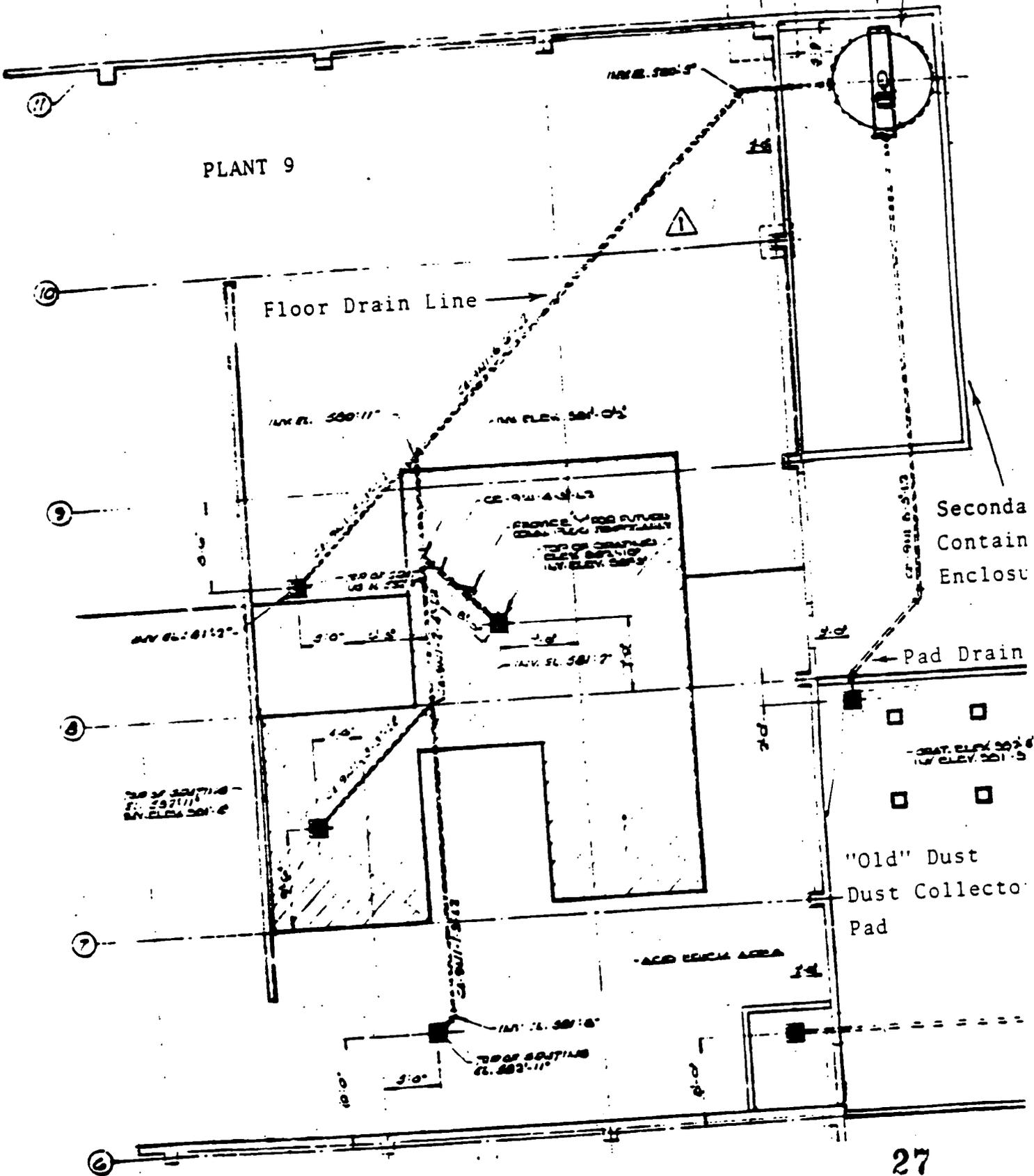
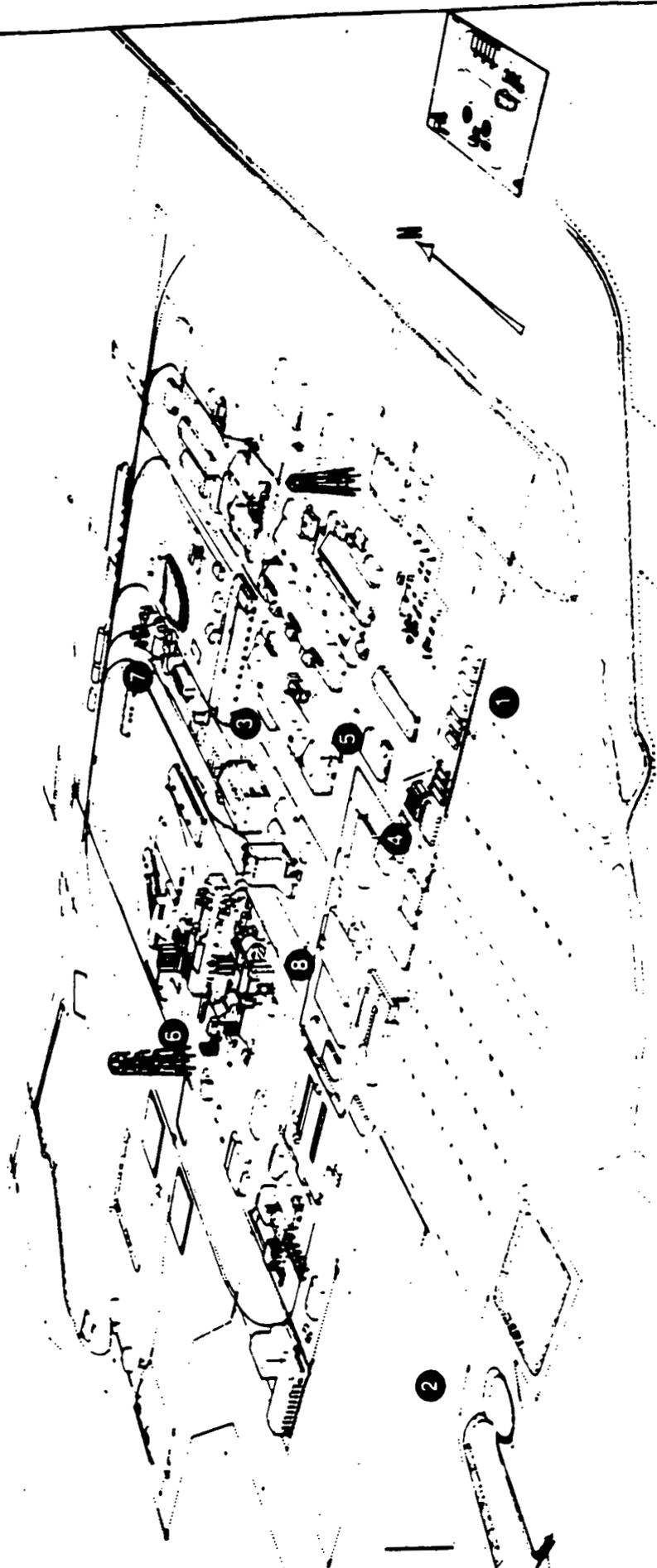


FIGURE 1

# FMPC RALLY POINTS



28 FIGURE 2

ATTACHMENTS

**SECTION I MATERIAL IDENTIFICATION**

**Chemical Name** Asbestos **CAS#** 1332-21-4  
**Synonyms** **Possible Occupational Exposure**  
 Amosite Anthrophyllite Miners and millers of ore  
 Actinolite Tremolite Manufacturers and users of asbestos-containing products such as brake shoes  
 Chrysotile UN 2212 (DOT) Repairers and demolishers of structures containing asbestos  
 Crocidolite UN 2509 (DOT)  
 Manufacturer: available from several sources.

**SECTION II INGREDIENTS AND HAZARDS**

**Permissible Exposure Limit**  
 0.2 fiber/cc — OSHA TWA (all forms) 2.0 fibers/cc — ACGIH TWA (other forms)  
 0.5 fiber/cc — ACGIH TWA (Amosite) 0.1 fiber/cc — NIOSH-recommended TWA (all forms)  
 2.0 fibers/cc — ACGIH TWA (Chrysotile) 0.5 fiber/cc — NIOSH-recommended 15-minute ceiling (all forms)  
 0.2 fiber/cc — ACGIH TWA (Crocidolite) Human Carcinogen (IARC, NTP, ACGIH); Animal Carcinogen (IARC)  
 CERCLA Hazard Rating — Toxicity 3 - Ignitability 0 - Persistence 3.  
 Immediately Dangerous to Life and Health Concentration — none specified

**SECTION III PHYSICAL DESCRIPTION**

Fibrous solid, ranging from long flexible fiber down to dust-like filler powder.  
 Asbestos can be white, gray, brown or blue in color.  
 Molecular Weight: Varies Specific Gravity: 2.5  
 Melting Point: Decomposes Flash Point: Nonflammable  
 Solubility in Water: Insoluble (breaks down slowly in hot water)  
 Upper Explosive Limit in Air, % by volume: nonflammable  
 Lower Explosive Limit in Air, % by volume: nonflammable

**SECTION IV INCOMPATIBILITIES AND STORAGE**

Incompatibilities: None  
 Store asbestos in closed containers (dust-tight) in a clean, secure area. Protect containers from damage. Do not open without proper control measures. Ensure containers are properly labeled.

**SECTION V HEALTH HAZARD AND PROTECTION DATA**

Target Organs	Route of Entry Into Body			
Lungs	Inhalation			
Respiratory System	Ingestion			
Gastrointestinal	Skin or Eye Contact			
<b>Symptoms</b>				
Coughing, Asbestosis	Mesothelioma	Respiratory Irritation	Pneumoconiosis	
Cyanosis Pleuritic Pain	Respiratory Cancer	Pleural Thickening	Finger Clubbing	
Dyspnea Skin Irritation	Respiratory Distress	Pulmonary Fibrosis	Weight Loss	

NOTE: Acute exposure may cause irritation and coughing. Chronic exposure may cause pulmonary fibrosis, a terminal pneumoconiosis called asbestosis which may appear as early as 13 years after exposure, but typically develops over 20-40 years. The incidence of pulmonary fibrosis and lung cancer in asbestos-exposed workers is synergistically increased by smoking.

**Protective Equipment Requirements**

29 CFR 1910.1001 Asbestos

Special clothing: The employer shall provide, and require the use of, special clothing, such as coveralls or similar whole-body clothing, head coverings, gloves and foot coverings for any employee exposed to airborne concentrations of asbestos fibers.

Medical examinations are required for asbestos workers (preplacement, periodic and termination examinations), 20-year recordkeeping required.

Employers are required to provide and ensure that employees use and/or follow these protective devices and measures; employees are required to use and/or follow them:

Posted warning signs.

Face shields, vented goggles or other appropriate protective equipment that complies with 1910.133 of this part.

Change rooms with two separate lockers or containers.

Routine changing of work clothing if there is a possibility that clothing may be contaminated.\*

**Protective Equipment Requirements (continued)**

Employees who are required to shower do so before breaks, lunch or leaving the contaminated area.

Showering after each shift prior to leaving premises.

Not smoking, eating or drinking in the work area.

\*Contaminated clothing should be sealed in a labeled plastic bag and laundered. Commercial laundries should be notified of the asbestos contamination.

Employers are required to provide engineering controls, i.e., negative-pressure ventilation with high-efficiency particulate air (HEPA) filtration, sealed enclosures for removal projects. (See EPA regulations for guidance.)

**Respirator Selection**

2 fibers/cc	Half-mask air-purifying respirator with a high-efficiency filter.
10 fibers/cc	Full face-piece air-purifying respirator with a high-efficiency filter.
20 fibers/cc	Air-purifying respirators with a high-efficiency filter. Supplied-air respirator operated in continuous-flow mode.
200 fibers/cc	Supplied-air respirator with a full face-piece operated in pressure-demand mode.
Greater than 200 fibers/cc	Supplied-air respirator with a full face-piece operated in pressure-demand mode equipped with an auxiliary positive pressure self-contained breathing apparatus.

**Firefighting**

Self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive-pressure mode.

Supplied-air respirator with full face-piece and operated in pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive-pressure mode.

**First Aid**

Skin Contact: Remove contaminated clothing and shoes immediately. Wash affected area with soap and water until no evidence of the substance remains. Get medical attention at once.

Eye Contact: Wash eyes immediately with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention at once.

Inhalation: Remove from area at once to fresh air. If breathing has stopped, perform artificial respiration. Get medical attention at once.

Ingestion: Get medical attention at once.

**SECTION VI REGULATIONS/OSHA**

OSHA Standard 29CFR1910.1200	Hazard Communication
OSHA Standard 29CFR1910.1001	Asbestos
OSHA Standard 29CFR1910.94	Ventilation
OSHA Standard 29CFR1910.134	Respiratory Protection
OSHA Standard 29CFR1910.20	Access to Employee Exposure and Medical Records
OSHA Standard 29CFR1910.132	Personal Protective Equipment
OSHA Standard 29CFR1910.141	Sanitation
OSHA Standard 29CFR1910.151	Medical Services and First Aid
OSHA Standard 29CFR1910.133	Eye and Face Protection

**SECTION VII EMERGENCY HANDLING OF HAZARDOUS MATERIALS**

**If Material Is On Fire or Involved in Fire:**

Extinguish fire using agent suitable for type of surrounding fire (material itself does not burn or burns with difficulty).

**If Material Is Not on Fire and Is Not Involved in Fire:**

Keep material out of water sources and sewers. Build dikes to contain flow as necessary.

**Personal Danger Situation Protection:**

Keep upwind. Wear boots, protective gloves and gas-tight goggles. Avoid breathing dust/vapors/fumes from material. Wash away any materials which may have contacted the body with copious amounts of water or soap and water.

**SECTION VIII SPILL, LEAK AND DISPOSAL PROCEDURES**

Adequately wet or mix with water to form a slurry. Seal material in a leak-tight container. Label containers as specified in 1910.1001. The SARA Act of 1986 requires that a release equal to or greater than the reportable quantity for this substance must be reported to the Local Planning Commission, the State Emergency Response Commission, and the National Response Center.

Contact the Ohio EPA for Emergency Spill Information: 1-800-282-9378.

Effective 1/87. For further chemical information contact the Resource Center at 1-800-282-3045, Ext. 7388.

CHEM REPORT  
05/23/1986

CHEM ID  
\*\*\*  
\* G034-86-0

CHEM NAME  
URANIUM COMPOUNDS

ENTRY INFORMATION  
05/23/1986

PREPARER	REVIEWER	ENTRY DATE	REVISED
*** * D. AUFRILL	J. BROWER	02/13/1985	05/16/1986

DOE CHEMICAL HAZARDS EMERGENCY MANAGEMENT SYSTEM  
05/23/1986

HEALTH AND SAFETY INFORMATION AUTHORITY

CHEMICAL NAME OR SYNONYM

\*\*\*  
\* URANIUM COMPOUNDS  
\* URANIUM INSOLUBLE COMPOUNDS  
\* URANIUM SOLUBLE COMPOUNDS  
\* G034-86-0

DISPOSAL

RECOVERY FOR REPROCESSING URANIUM IS THE PREFERRED METHOD FOR HANDLING WASTE URANIUM COMPOUNDS. SHIP TO LICENSED RECOVERY FACILITY. UNRECOVERED MATERIAL SHOULD BE HANDLED AND PACKAGED AS RADIOACTIVE WASTE SHIPPED TO AN APPROVED SITE BY AN APPROVED DISPOSAL FIRM.

DECOMPOSITION PRODUCTS

TOXIC GASES AND VAPORS (SUCH AS HYDROGEN FLUORIDE, NITROGEN OXIDES, AND CARBON MONOXIDE) MAY BE RELEASED WHEN URANIUM COMPOUNDS DECOMPOSE. SEE SPECIFIC COMPOUND.

ENVIRONMENTAL EFFECTS

NO CRITERIA SET, BUT EPA SUGGEST A PERMISSIBLE CONCENTRATION IN WATER OF 3 MG/L BASED ON HEALTH EFFECTS.

EMERGENCY PROCEDURES

PERSONS NOT WEARING PROTECTIVE EQUIPMENT AND CLOTHING SHOULD BE RESTRICTED FROM AREAS OF SPILLS UNTIL CLEANUP HAS BEEN COMPLETED. IF URANIUM COMPOUNDS ARE SPILLED: 1. VENTILATE AREA OF SPILL. 2. COLLECT SPILLED MATERIAL IN THE MOST CONVENIENT AND SAFE MANNER AND DEPOSIT IN SEALED CONTAINERS FOR RECLAMATION. LIQUID CONTAINING URANIUM OR INSOLUBLE COMPOUNDS SHOULD BE ABSORBED IN VERMICULITE, TRAY SAND, EARTH, OR A SIMILAR MATERIAL. SPILL AREAS MAY BE DECONTAMINATED USING A SOLUTION WITH A CHELATING AGENT SUCH AS EDTA.

FIRST AID

IF MATERIAL GET INTO THE EYES, WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER. GET MEDICAL AID. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THESE CHEMICALS.  
SKIN EXPOSURE - IF COMPOUND GET ON THE SKIN, PROMPTLY WASH THE CONTAMINATED SKIN USING SOAP AND MILD DETERGENT AND WATER. IF THEY PENETRATE THROUGH THE CLOTHING, REMOVE THE CLOTHING IMMEDIATELY AND WASH THE SKIN USING SOAP OR MILD DETERGENT AND WATER. IF IRRITATION IS PRESENT AFTER WASHING, GET MEDICAL ATTENTION.  
BREATHING - IF A PERSON BREATHEES IN LARGE AMOUNTS OF URANIUM COMPOUND MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.  
SWALLOWING - WHEN SOLIDS OR LIQUIDS CONTAINING URANIUM OR INSOLUBLE COMPOUNDS HAVE BEEN SWALLOWED, GIVE THE PERSON LARGE QUANTITIES OF WATER IMMEDIATELY. AFTER THE WATER HAS BEEN SWALLOWED, TRY TO GET THE PERSON TO VOMIT BY TOUCHING THE BACK OF THE THROAT WITH A FINGER. DO NOT MAKE AN UNCONSCIOUS PERSON VOMIT. GET MEDICAL ATTENTION IMMEDIATELY.

MANY URANIUM COMPOUNDS ARE FLAMMABLE. IF IN FIRE, URANIUM COMPOUNDS ARE NOT COMBUSTIBLE. IF IN FIRE, URANIUM COMPOUNDS MAY EMIT TOXIC PRODUCTS. SOME COMPOUNDS ARE WATER REACTIVE. SEE SPECIFIC COMPOUND.

## HEALTH HAZARD

HIGHLY TOXIC AND RADIOACTIVE. URANIUM COMPOUNDS ARE TOXIC IF THEY ARE INHALED, SWALLOWED, OR IF THEY COME IN CONTACT WITH THE EYES OR SKIN. URANIUM INSOLUBLE COMPOUNDS ARE LESS TOXIC THAN THE SOLUBLE COMPOUNDS. THEY ARE WEAKLY RADIOACTIVE AND ARE PRINCIPALLY ALPHA PARTICLE EMITTERS. THEY DO NOT CONSTITUTE A SIGNIFICANT EXTERNAL RADIATION AND CHEMICAL HAZARD. THEY MAY CAUSE AN INCREASE IN CANCER OF THE LYMPHATIC AND BLOOD-FORMING TISSUES IN MAN. PROLONGED CONTACT WITH THE SKIN MIGHT CAUSE RADIATION DAMAGE TO THE SKIN AND/OR SKIN RASH (DERMATITIS). PROLONGED INHALATION HAS CAUSED DAMAGE TO THE LUNGS OF ANIMALS. THEY ARE HIGHLY TOXIC TO THE KIDNEY AND LIVER.

## CHEMICAL INCOMPATIBILITIES

VARIES WITH COMPOUND.

## MEDICAL RECOMMENDATIONS

SPECIAL ATTENTION SHOULD BE GIVEN TO THE BLOOD, LUNGS, KIDNEY, AND LIVER IN PREEMPLOYMENT MEDICAL EXAMS. PERIODIC MEDICAL EXAM SHOULD INCLUDE A CHEST X-RAY, URINALYSIS, COMPLETE BLOOD COUNT AND CHEMISTRY.

## PHYSICAL DESCRIPTION

VARIES WITH COMPOUND.

## PROTECTION MEASURES

GOOD ENGINEERING CONTROLS SHOULD BE USED TO REDUCE ENVIRONMENTAL CONCENTRATION TO THE PERMISSIBLE EXPOSURE LEVEL (PEL). ABOVE THE PEL RESPIRATORY PROTECTION MUST BE WORN. AT A U CONCENTRATION OF 2.5 MG/M<sup>3</sup> OR LESS WEAR ANY FUME RESPIRATOR OR HIGH EFFICIENCY PARTICULATE RESPIRATOR APPROVED FOR RADIONUCLIDES, A SUPPLIED-AIR RESPIRATOR, OR A SCBA. EMPLOYEES SHOULD WEAR IMPERVIOUS CLOTHING, GLOVES, AND GOGGLES TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH SOLIDS OR LIQUIDS URANIUM OR INSOLUBLE COMPOUNDS. SKIN THAT BECOMES CONTAMINATED WITH URANIUM OR INSOLUBLE COMPOUNDS SHOULD BE PROMPTLY WASHED WITH SOAP OR MILD DETERGENT AND WATER. EATING AND SMOKING SHOULD NOT BE PERMITTED IN AREAS WHERE SOLIDS OR LIQUIDS CONTAINING URANIUM OR INSOLUBLE COMPOUNDS ARE HANDLED, PROCESSED, OR STORED. EMPLOYEES WHO HANDLE SOLIDS OR LIQUIDS CONTAINING URANIUM OR INSOLUBLE COMPOUNDS SHOULD WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

## SAMPLING METHODS

NO STANDARD MEASUREMENT METHODS FOR URANIUM COMPOUNDS HAVE BEEN PUBLISHED BY NIOSH. MAY BE SAMPLED USING A CELLULOSE ESTER FILTER AND ANALYZED BY ATOMIC ABSORPTION.

## SHIPPING INFORMATION

SHIP AS RADIOACTIVE MATERIAL. OTHER REQUIREMENTS VARY WITH COMPOUND, LEVEL OF RADIOACTIVITY, PROPORTION OF FISSIONABLE ISOTOPES AND AMOUNT SHIPPED.

## CHEMICAL CATEGORIES

05/23/1986

CATEGORY	CLASS NAME	CLASS CODE
***		
* CHEMICAL	URANIUM COMPOUNDS	
* HAZARD CODE	HEALTH	3
* HEALTH HAZARD	KIDNEY	
* PHYSICAL HAZARD	RADIOACTIVE	
* TRANSPORTATION	RADIOACTIVE	
CHEM NAMEX URANIUM COMPOUNDS		

## CHEMICAL ATTRIBUTES

05/23/1986

ATTRIBUTE	VALUE	UNITS	QUALITY	COMMENTS
***				
* HALF LIFE	4.500	10E9 YEARS		
* EXPOSURE LIMIT	0.050	MG/CM <sup>3</sup>	PEL	SOLUBLE U
* EXPOSURE LIMIT	0.200	MG/CM <sup>3</sup>	TUV	AS U
* EXPOSURE LIMIT	0.250	MG/CM <sup>3</sup>	PEL	AS INSOLUBLE

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SELECTED MATERIALS THAT ARE RELATED TO OR CONTAIN THE SUBSTANCE  
05/23/1986

CHEM NAME\* URANIUM COMPOUNDS

\*\*\*  
 \* URANIUM  
 \* URANIUM DICARBIDE  
 \* URANIUM DIOXIDE  
 \* URANIUM HEXAFLUORIDE  
 \* URANIUM HYDRIDE  
 \* URANIUM TETRAFLUORIDE  
 \* URANYL NITRATE

\*\*SODIUM HYDROXIDE\*\*  
\*\*SODIUM HYDROXIDE\*\*  
\*\*SODIUM HYDROXIDE\*\*  
\*\*SODIUM HYDROXIDE\*\*

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC  
CHEMICAL DIVISION  
1 REAGENT LANE  
FAIR LAWN NJ 07410  
(201) 796-7100

EMERGENCY CONTACTS  
GASTON L. PILLORI  
(201) 796-7100

DATE: 10/21/86  
PO NBR: N/A  
ACCT: 878202-02  
INDEX: 12-8628-90170  
CAT NO: 5318500

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SUBSTANCE IDENTIFICATION

SUBSTANCE: \*\*SODIUM HYDROXIDE\*\*  
CAS-NUMBER 1310-73-2

TRADE NAMES/SYNONYMS: CAUSTIC SODA; SODA LYE; LYE; WHITE CAUSTIC; CAUSTIC ALKALI; CAUSTIC SODA, BEAD; CAUSTIC SODA, DRY; CAUSTIC SODA, FLAKE; CAUSTIC SODA, GRANULAR; CAUSTIC SODA, SOLID; SODIUM HYDRATE; SODIUM HYDROXIDE, BEAD; SODIUM HYDROXIDE, FLAKE; SODIUM HYDROXIDE, DRY; SODIUM HYDROXIDE, SOLID; S-613 ASCARITE; S-318; S-320; S-612

CHEMICAL FAMILY:  
INORGANIC BASE

MOLECULAR FORMULA: NA-O-H MOL WT: 40.00

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=0 REACTIVITY=1 PERSISTENCE=0

COMPONENTS AND CONTAMINANTS

- PERCENT: 97 COMPONENT: SODIUM HYDROXIDE
- PERCENT: 0.50 COMPONENT: SODIUM CARBONATE
- PERCENT: .008 COMPONENT: SODIUM CHLORIDE
- PERCENT: <0.1 COMPONENT: SODIUM SULFATE
- PERCENT: 0.1 COMPONENT: POTASSIUM, CALCIUM, AND MAGNESIUM

OTHER CONTAMINANTS: SILICON DIOXIDE (0.03%) AND OTHER METALS (0.01%).

EXPOSURE LIMITS:

--2 MG/M3 ACCGIH CEILING; 2 MG/M3 NIOSH RECOMMENDED 15 MINUTE CEILING.

PHYSICAL DATA

DESCRIPTION: ODORLESS, WHITE OR OFF-WHITE HYGROSCOPIC SOLID.  
 BOILING POINT: 2534 F (1390 C) MELTING POINT: 605 F (318 C)  
 SPECIFIC GRAVITY: 2.1 VAPOR PRESSURE: 42 MMHG @ 1000 C  
 PH: 14 FOR A 5% AQ SOLN SOLUBILITY IN WATER: 42%  
 SOLVENT SOLUBILITY: ALCOHOL, GLYCEROL.

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:  
 NEGLIGIBLE FIRE AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.  
 FLASH POINT: NON-FLAMMABLE

FIREFIGHTING MEDIA:  
 DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR FOAM  
 (1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FOR LARGER FIRES, USE FLOODING QUANTITIES OF WATER.

FIREFIGHTING:  
 MOVE CONTAINERS FROM FIRE AREA IF POSSIBLE. COOL CONTAINERS EXPOSED TO FLAMES  
 WITH WATER FROM SIDE UNTIL WELL AFTER FIRE IS OUT (1984 EMERGENCY RESPONSE  
 GUIDEBOOK, DOT P 5800.3).

TOXICITY

1 1/2 24 HOURS EYE-MONKEY SEVERE IRRITATION; 50 MG/24 HOURS SKIN-RABBIT SEVERE  
 IRRITATION; 1% EYE-RABBIT SEVERE IRRITATION; 50 UG/24 HOURS EYE-RABBIT SEVERE  
 IRRITATION; 1 MG/24 HOURS EYE-RABBIT SEVERE IRRITATION;  
 CARCINOGEN STATUS: NONE.  
 SODIUM HYDROXIDE IS AN EYE AND MUCOUS MEMBRANE IRRITANT AND SEVERE SKIN  
 IRRITANT.

HEALTH EFFECTS AND FIRST AID

INHALATION:  
 ---CORROSIVE. 200 MG/M3 IS IMMEDIATELY DANGEROUS TO LIFE AND HEALTH.  
 ACUTE EXPOSURE- THE EFFECTS OF THE DUST OR MIST WILL VARY FROM MILD  
 IRRITATION OF THE NOSE TO SEVERE PNEUMONITIS DEPENDING ON THE  
 SEVERITY OF EXPOSURE. LOW CONCENTRATIONS MAY CAUSE SORE THROAT, COUGHING,  
 AND LABORED BREATHING. INTENSE EXPOSURES MAY RESULT IN DELAYED PULMONARY  
 EDEMA.

CHRONIC EXPOSURE- PROLONGED EXPOSURE MAY CAUSE BRONCHIAL IRRITATION,  
 COUGHING, BRONCHIAL PNEUMONIA, AND GASTROINTESTINAL DISTURBANCES.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING

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\*\*\*SODIUM HYDROXIDE\*\* PAGE 03 OF 06  
HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. KEEP AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

SKIN CONTACT:

CORROSIVE.  
ACUTE EXPOSURE- ON THE SKIN, SOLUTIONS OF 25 TO 50% MAY CAUSE THE SENSATION OF IRRITATION WITHIN ABOUT 3 MINUTES. WITH SOLUTIONS OF 4% THIS DOES NOT OCCUR UNTIL AFTER SEVERAL HOURS. IF NOT REMOVED FROM THE SKIN, SEVERE BURNS WITH DEEP ULCERATION MAY OCCUR. EXPOSURE TO THE DUST OR MIST MAY CAUSE MULTIPLE SMALL BURNS AND TEMPORARY LOSS OF HAIR.

CHRONIC EXPOSURE- REPEATED EXPOSURE MAY RESULT IN DERMATITIS.

FIRST AID- REMOVE CONTAMINATED CLOTHING WHILE RUNNING STREAMS OF WATER UNDER CLOTHING. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER (APPROXIMATELY 15-20 MINUTES) UNTIL NO EVIDENCE OF CHEMICAL REMAINS. FOR CHEMICAL BURNS, APPLY STERILE BANDAGE SECURELY, BUT NOT TOO TIGHTLY. GET MEDICAL ATTENTION.

EYE CONTACT:

CORROSIVE.  
ACUTE EXPOSURE- CONTACT MAY CAUSE DISINTEGRATION AND SLOUGHING OF CONJUNCTIVAL AND CORNEAL EPITHELIUM, CORNEAL OPACIFICATION, MARKED EDEMA AND ULCERATION; AFTER 7 TO 13 DAYS EITHER GRADUAL RECOVERY BEGINS OR THERE IS PROGRESSION OF ULCERATION AND CORNEAL OPACIFICATION. COMPLICATIONS OF SEVERE EYE BURNS ARE SYMBLEPHARON WITH OVERGROWTH OF THE CORNEA BY A VASCULARIZED MEMBRANE, PROGRESSIVE OR RECURRENT CORNEAL ULCERATION AND PERMANENT CORNEAL OPACIFICATION.

CHRONIC EXPOSURE- REPEATED OR PROLONGED VAPOR CONTACT AT LOW LEVELS OF EXPOSURE MAY CAUSE CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION.

INGESTION:

CORROSIVE.  
ACUTE EXPOSURE- SEVERE ABDOMINAL PAIN, CORROSION OF THE LIPS, MOUTH, TONGUE, AND PHARYNX, AND VOMITING OF LARGE PIECES OF MUCOSA. ASPHYXIA CAN OCCUR FROM SWELLING OF THE THROAT. PERFORATION OF THE ESOPHAGUS AND STOMACH CAN OCCUR. CASES OF SQUAMOUS CELL CARCINOMA OF THE ESOPHAGUS HAVE OCCURRED WITH LATENT PERIODS OF 12 TO 42 YEARS AFTER INGESTION; A RESULT TISSUE DESTRUCTION AND POSSIBLY SCAR FORMATION RATHER THAN THE RESULT OF DIRECT CARCINOGENIC ACTION.

FIRST AID- IF VICTIM IS CONSCIOUS, GIVE HIM LARGE QUANTITIES OF WATER IMMEDIATELY TO DILUTE THE ALKALI. DO NOT INDUCE VOMITING. GET MEDICAL ATTENTION IMMEDIATELY.

REACTIVITY

REACTIVITY:  
THE SUBSTANCE IS A STRONG BASE. IT REACTS EXOTHERMICALLY WITH WATER RELEASING CORROSIVE FUMES OF SODIUM HYDROXIDE.

## INCOMPATIBILITIES:

ACETALDEHYDE: RESULTS IN VIOLENT POLYMERIZATION OF ACETALDEHYDE.  
ACETIC ACID: MIXING IN A CLOSED CONTAINER INCREASES TEMPERATURE AND PRESSURE  
ACETIC ANHYDRIDE: MIXING IN A CLOSED CONTAINER INCREASES TEMPERATURE AND PRESSURE.  
ACROLEIN: RESULTS IN AN EXTREMELY VIOLENT POLYMERIZATION OF ACROLEIN.  
ACRYLONITRILE: VIOLENT POLYMERIZATION.  
ALLYL ALCOHOL: AS A BENZENE EXTRACT OF ALLYL BENZENESULFONATE WAS PREPARED FROM ALLYL ALCOHOL AND BENZENE SULFONYL CHLORIDE IN THE PRESENCE OF AQUEOUS SODIUM HYDROXIDE, UNDER VACUUM DISTILLATION TWO FRACTIONS CAME OFF, THEN THE TEMPERATURE ROSE TO 135 C, WHEN THE RESIDUE DARKENED AND EXPLODED.  
ALLYL CHLORIDE: IN CONTACT WITH DRY CAUSTIC SODA BEADS, HYDROLYSIS MAY TAKE PLACE PRODUCING ALLYL ALCOHOL.  
ALUMINUM: VIGOROUS REACTION WITH THE EVOLUTION OF FLAMMABLE HYDROGEN GAS.  
CHLORINE TRIFLUORIDE: VIOLENT REACTION.  
CHLOROFORM AND METHYL ALCOHOL: EXOTHERMIC REACTION.  
CHLOROHYDRIN: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
CHLORONITROTOLUENES: POSSIBLE EXPLOSION.  
CHLOROSULFONIC ACID: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
1,2-DICHLOROETHYLENE: MAY FORM SPONTANEOUSLY FLAMMABLE MONOCHLOROACETYLENE.  
ETHYLENE CYANOHYDRIN: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
GLYOXAL: MIXING IN A CLOSED CONTAINER INCREASES TEMPERATURE AND PRESSURE.  
HALOGENATED HYDROCARBONS: VIOLENT REACTION.  
HYDROCHLORIC ACID: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
HYDROFLUORIC ACID: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
HYDROQUINONE: RAPID DECOMPOSITION OF HYDROQUINONE WITH EVOLUTION OF HEAT.  
MALEIC ANHYDRIDE: EXPLOSIVE DECOMPOSITION.  
METALS: CORRODES METALS, REACTING TO FORM FLAMMABLE HYDROGEN GAS.  
NITRIC ACID: MIXING IN A CLOSED CONTAINER INCREASES TEMPERATURE AND PRESSURE  
NITROETHANE: FORMS AN EXPLOSIVE SALT.  
NITROMETHANE: FORMS AN EXPLOSIVE SALT.  
NITROPARAFFINS: THE NITROPARAFFINS, IN THE PRESENCE OF WATER, FORM DRY SALTS WITH ORGANIC BASES. THE DRY SALTS ARE EXPLOSIVE.  
NITROPROPANE: FORMS AN EXPLOSIVE SALT.  
OLEUM: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
PENTOL (3-METHYL-2-PENTEN-4-YN-1-OL): POSSIBLE EXPLOSION.  
PHOSPHORUS: PHOSPHORUS BOILED WITH ALKALINE HYDROXIDES YIELDS MIXED PHOSPHINES WHICH MAY IGNITE SPONTANEOUSLY IN AIR.  
PHOSPHORUS PENTOXIDE: EXTREMELY VIOLENT REACTION WHEN INITIATED BY LOCAL HEATING.  
B-PROPIOLACTONE: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
SULFURIC ACID: MIXING IN A CLOSED CONTAINER CAUSES AN INCREASE IN TEMPERATURE AND PRESSURE.  
TETRACHLOROBENZENE AND METHYL ALCOHOL: POSSIBLE EXPLOSION.  
TETRAHYDROFURAN: SERIOUS EXPLOSIONS CAN OCCUR.  
TRICHLOROETHYLENE: FORMATION OF EXPLOSIVE MIXTURES OF DICHLOROACETYLENE.  
WATER: CAUSTIC SODA BEADS IN CONTACT WITH WATER MAY GENERATE ENOUGH HEAT TO IGNITE ADJACENT COMBUSTIBLES.

DECOMPOSITION:  
MAY RELEASE TOXIC FUMES OF SODIUM OXIDE, WHICH CAN REACT WITH WATER OR STEAM TO PRODUCE HEAT AND FLAMMABLE HYDROGEN VAPORS.

POLYMERIZATION:  
NOT KNOWN TO OCCUR.

\*\*\*\*\*  
CONDITIONS TO AVOID  
\*\*\*\*\*

MAY BURN BUT DOES NOT IGNITE READILY. FLAMMABLE, POISONOUS GASES MAY ACCUMULATE IN TANKS AND HOPPER CARS. MAY IGNITE COMBUSTIBLES (WOOD, PAPER, OIL, ETC.).

\*\*\*\*\*  
SPILL AND LEAK PROCEDURES  
\*\*\*\*\*

SOIL SPILL:  
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

USE PROTECTIVE COVER SUCH AS A PLASTIC SHEET TO PREVENT MATERIAL FROM DISSOLVING IN FIRE EXTINGUISHING WATER OR RAIN.

WATER SPILL:  
ADD SUITABLE AGENT TO NEUTRALIZE SPILLED MATERIAL TO PH-7.

OCCUPATIONAL SPILL:  
DO NOT TOUCH SPILLED MATERIAL. STOP LEAK IF YOU CAN DO IT WITHOUT RISK. FOR SMALL SPILLS, TAKE UP WITH SAND OR OTHER ABSORBENT MATERIAL AND PLACE INTO CONTAINERS FOR LATER DISPOSAL. FOR SMALL DRY SPILLS, WITH CLEAN SHOVEL PLACE MATERIAL INTO CLEAN, DRY CONTAINER AND COVER. MOVE CONTAINERS FROM SPILL AREA. FOR LARGER SPILLS, DIKE FAR AHEAD OF SPILL FOR LATER DISPOSAL. KEEP UNNECESSARY PEOPLE AWAY. ISOLATE HAZARD AREA AND DENY ENTRY.

-----  
PROTECTIVE EQUIPMENT  
-----

VENTILATION:  
PROVIDE LOCAL EXHAUST VENTILATION SYSTEM TO MEET PERMISSIBLE EXPOSURE LIMITS.

RESPIRATOR:  
100 MG/M3- HIGH-EFFICIENCY PARTICULATE RESPIRATOR WITH A FULL FACEPIECE. SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE, HELMET, OR HOOD. SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.

200 MG/M3- POWERED AIR-PURIFYING RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER AND A FULL FACEPIECE.  
TYPE C SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET, OR HOOD OPERATED IN CONTINUOUS-FLOW MODE.

ESCAPE- DUST MASK, EXCEPT SINGLE-USE AND QUARTER-MASK RESPIRATORS. SELF-CONTAINED BREATHING APPARATUS.

FIREFIGHTING- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:  
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:  
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:  
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHALL PROVIDE AN EYE-WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - ALLIED FISHER SCIENTIFIC  
CREATION DATE: 01/21/85 REVISION DATE: 05/01/85

-ADDITIONAL INFORMATION-  
THE INFORMATION BELOW IS BELIEVED TO BE ACCURATE AND REPRESENTS THE BEST INFORMATION CURRENTLY AVAILABLE TO US. HOWEVER, WE MAKE NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, WITH RESPECT TO SUCH INFORMATION, AND WE ASSUME NO LIABILITY RESULTING FROM ITS USE. USERS SHOULD MAKE THEIR OWN INVESTIGATIONS TO DETERMINE THE SUITABILITY OF THE INFORMATION FOR THEIR PARTICULAR PURPOSES.



# Fisher Scientific Company

10010

Chemical Manufacturing Division  
P.O. Box 375 1 Reagent Lane  
Fair Lawn, NJ 07410

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MATERIAL SAFETY DATA SHEET (Adapted from USDL Form LSD-005-4)

(201) 796-71

## SECTION I. IDENTIFICATION OF PRODUCT

CHEMICAL NAME	Nitric Acid	FORMULA	HNO <sub>3</sub>
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SYNONYM OR CROSS REFERENCE

## SECTION II. HAZARDOUS INGREDIENTS

MATERIAL	NATURE OF HAZARD
Nitric Acid	Oxidizer, Corrosive

## SECTION III. PHYSICAL DATA

BOILING POINT	120°C	MELTING POINT	approximately -30°C
VAPOR PRESSURE (mm Hg)	unknown	SPECIFIC GRAVITY	1.42
VAPOR DENSITY (AIR = 1)	unknown	PERCENT VOLATILE BY VOLUME (%)	100%
WATER SOLUBILITY	complete	EVAPORATION RATE (ether = 1)	greater than
APPEARANCE	Colorless to yellow liquid		

## SECTION IV. FIRE AND EXPOSURE HAZARD DATA

FLASH POINT (method used)	NA	FLAMMABLE LIMITS	Uel	Le
		NA		
FIRE EXTINGUISHING MEDIA	NA			

SPECIAL FIRE-FIGHTING PROCEDURES Use self contained breathing apparatus as toxic vapors of NO<sub>x</sub> are liberated.

INITIAL FIRE AND EXPLOSION HAZARD Moderate fire hazard by chemical reaction with reducing agents, organic compounds.

## SECTION V. HEALTH HAZARD

THRESHOLD LIMIT VALUE 2ppm (air)

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HEALTH HAZARDS Causes severe burns to eyes and skin and respiratory tract. May be fatal if swallowed. Vapors hazardous and may cause nitrogen gas poisoning.

FIRST AID PROCEDURES Inhalation - remove patient to fresh air. Skin or eye immediately flush eyes or skin with water for at least 15 min. Ingestion give emetics. Give tap water, milk or milk of magnesia. Give whites of beaten with water. Call a physician.

See Disclaimer on reverse side.

## SECTION VI. REACTIVITY DATA

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STABILITY	UNSTABLE		CONDITIONS TO AVOID reaction with metals liberate hydrogen and oxides of nitro Reaction with organic compounds can c fi
	STABLE	X	

IMCOMBATIBILITY (material to avoid)

~~Metals, strong bases, organic compounds~~  
HAZARDOUS DECOMPOSITION PRODUCTS

Oxides of nitrogen

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

## SECTION VII. SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Neutralize with soda ash. Scoop up and place in a suitable container.

WASTE DISPOSAL METHOD

DISPOSE OF BY MEANS AS TO COMPLY WITH ALL LOCAL, STATE, AND FEDERAL REGULATIONS  
OR CONTACT AN APPROVED AND LICENSED DISPOSAL AGENCY.

## SECTION VIII. PROTECTION INFORMATION

RESPIRATORY PROTECTION (specify type)

Gas mask with canister for absorbing acid vapors.

VENTILATION	LOCAL		SPECIAL
	MECHANICAL (general)	fume hood	

PROTECTIVE GLOVES	rubber	EYE PROTECTION	safety glasses
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OTHER PROTECTIVE EQUIPMENT  
rubber apron

## SECTION IX. HANDLING AND STORAGE PRECAUTIONS

STORAGE AND HANDLING

Store protected from light.

## SECTION X. MISCELLANEOUS INFORMATION

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INFORMATION FURNISHED BY: Gaston L. Pillori	TITLE Manager of Quality Assurance
--	---------------------------------------

The above information is believed to be accurate and represents the best information currently available to us. However, WE MAKE NO WARRANTY OF MERCHANTABILITY OR ANY OTHER WARRANTY, EXPRESS OR IMPLIED, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for the particular purposes.

REV NO 0 DATE March 26, 1980

## MATERIAL SAFETY DATA SHEET

### IDENTIFICATION

**NAME**

Hydrofluoric Acid-Anhydrous

**GRADE**

Technical

**CHEMICAL FAMILY**

Inorganic Acid

**SYNONYMS**

Hydrogen Fluoride; HF; AHF

**FORMULA**

HF

**CAS NAME**

Hydrofluoric Acid

**CAS REGISTRY NO.**

7664-39-3

**I. D. NOS./CODES**

NIOSH Registry No. MW 7875000

**PRODUCT INFORMATION**

Phone (800) 441-9442

Medical Emergency Phone

(800) 441-3637

**MANUFACTURER/DISTRIBUTOR**

E. I. du Pont de Nemours &amp; Co. (Inc.)

**TRANSPORTATION EMERGENCY PHONE**

CHEMTREC (800) 424-9300

**ADDRESS**

Wilmington, DE 19898

### PHYSICAL DATA

**BOILING POINT, 760 mm Hg**

19.5°C (67.1°F)

**MELTING POINT**

-83.5°C (118.3°F)

**SPECIFIC GRAVITY**

~1 at 0°C (32°F)

**VAPOR PRESSURE**

775 mm Hg at 20°C (68°F)

1525 mm Hg at 40°C (104°F)

**VAPOR DENSITY**

3.0 at 25°C (Air=1)

**SOLUBILITY IN H<sub>2</sub>O**

100%

**pH INFORMATION**

~ 2.0 (2% Aqueous Solution)

**EVAPORATION RATE (BUTYL ACETATE=1)**

&gt;1

**FORM**

Liquid

**APPEARANCE**

Clear, fuming

**COLOR**

Colorless

**ODOR**

Acrid

HAZARDOUS COMPONENTS

MATERIAL(S)  
Hydrogen Fluoride

APPROXIMATE %  
100%

HAZARDOUS REACTIVITYINSTABILITY

Stable, if stored in proper (steel) container.

INCOMPATIBILITY

Reacts with most metals to give explosive hydrogen gas; with cyanides to give toxic hydrogen cyanide; with sulfides to give toxic hydrogen sulfide. Also corrodes glass and ceramics.

DECOMPOSITION

Will not occur

POLYMERIZATION

Non-hazardous endothermic polymerization may occur in both the liquid and gaseous phases.

FIRE AND EXPLOSION DATA

FLASH POINT Will not burn

AUTOIGNITION TEMPERATURE

Not applicable

FLAMMABLE LIMITS IN AIR, % BY VOL.

LOWER Not applicable

UPPER Not applicable

AUTODECOMPOSITION TEMPERATURE

Not applicable

FIRE AND EXPLOSION HAZARDS

HF (particularly in dilute aqueous solutions) will attack most metals, releasing potentially explosive hydrogen gas.

EXTINGUISHING MEDIA

Water, carbon dioxide (CO<sub>2</sub>) for fires in area.

SPECIAL FIRE FIGHTING INSTRUCTIONS

Keep upwind. If there is any possibility of direct contact, wear full acid suit with hood, boots and self-contained breathing apparatus. Do not get water into acid tanks - generates heat.

HEALTH HAZARD INFORMATION

PRINCIPAL HEALTH HAZARDS (Including Significant Routes, Effects, Symptoms of Over-Exposure)

Inhalation: LC50, 1-hour (rats) = 1276 ppm

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Extremely hazardous liquid and vapor. Causes severe burns. Anhydrous HF causes immediate and serious burns on contact; concentrations less than 50% may not produce symptoms for 8 hours or longer. Wearing clothing contaminated with HF (such as shoes, gloves) may result in painful delayed effects. HF vapor can cause skin irritation and delayed burns. Inhalation over-exposure may cause lung damage and pulmonary edema.

#### CARCINOGENICITY

HF is not listed as carcinogenic by IARC, NTP, OSHA, ACGIH or Du Pont.

#### EXPOSURE LIMITS (PEL (OSHA), TLV<sup>o</sup> (ACGIH), AEL (DU PONT), ETC.)

The OSHA Time Weighted Average (TWA) and ACGIH TLV<sup>o</sup>-TWA are 3ppm, 2.5 mg/m<sup>3</sup> (as F).

#### SAFETY PRECAUTIONS

Do not get in eyes, on skin, on clothing.  
Do not breathe vapor.  
Keep container closed.  
Wash thoroughly after handling.

#### FIRST AID

Speed in removing exposed personnel from the contaminated area and in removing HF from the skin or eyes is of primary importance. First aid must be started immediately, within seconds, in all cases of contact with hydrofluoric acid in any form. All potentially exposed workers and supervisors should be informed of first aid care for HF burns. First aid actions should be planned before beginning work with HF.

Medical assistance should be obtained promptly for all affected persons. The doctor should be informed in detail of the accident.

HF differs from other acids in that the fluoride ion readily penetrates the skin causing destruction of deep tissue layers including bone. Unlike other acids, which are rapidly neutralized, this process may continue for days.

#### Skin Contact:

Immediately shower with large quantities of water within seconds after contact or suspected contact, and completely remove all clothing while in the shower. Stay in the shower until all traces of HF have been thoroughly removed. Examination and treatment by a physician is recommended as quickly as feasible. It may be necessary to transport the victim to the nearest hospital emergency room. Remember also that concentrated HF causes immediate pain but dilute HF solutions may not cause redness, burning or pain until several minutes or even hours have elapsed.

#### Eye Contact:

Immediately flush the eyes with large quantities of water while holding the eyelids apart. Continue flushing for 15 minutes. Apply ice packs until a medical facility is reached. THE EYES WILL REQUIRE FURTHER TREATMENT--SEE NOTES TO THE PHYSICIAN - "EYE CONTACT", MAJOR and MINOR EXPOSURES.

#### Vapor Inhalation:

Immediately remove the victim to an uncontaminated atmosphere. Call a physician. Administer oxygen as soon as possible. Oxygen inhalation may

be repeated at half-hour intervals for a total of 3 or 4 hours or until no shortness of breath is present and the victim's normal skin color has returned. Keep the victim warm.

#### Ingestion:

Do not induce vomiting. Immediately drink a large quantity of milk or water with added milk of magnesia. Call a physician. Throat burns may cause severe swelling and require a tracheotomy (opening the windpipe). The victim should be admitted to the hospital and carefully attended.

#### Medical Supplies:

The following materials have been found to be useful and effective in the treatment of hydrogen fluoride burns, and should be on hand at the First Aid Station:

- Calcium gluconate gel--2.5%. This gel is prepared by mixing 3.5 grams of USP calcium gluconate powder with a 5 ounce tube of surgical water-soluble lubricant (e.g. K-Y Lubricating Jelly, Johnson & Johnson). The shelf life of the gel has not been determined. Storage of the gel has limitations and refrigeration may help.
- Calcium gluconate 10% for injection (standard ampule). Make 5% solution by mixing with an equal part of sterile physiological saline solution.
- One percent calcium gluconate in normal, sterile saline solution.
- Aqueous solution of benzalkonium chloride--0.13%. Benzalkonium chloride can be purchased as "Zephiran" (Winthrop) aqueous solution (1:750) or as "Zephiran" concentrate (17%) which must be diluted by mixing 1 fluid ounce (29.6 mL) of concentrate and 127 fluid ounces (3756 mL) of water to give 1 gallon (3785 mL) "Zephiran" solution (approximately 0.13%).
- Solution of 70% denatured ethyl alcohol
- Milk of magnesia powder
- 99% pure USP medical oxygen
- Ice cubes
- Gauze, compression dressing, eye patches
- Towels
- Basins of assorted sizes; shower facilities

#### NOTES TO THE PHYSICIAN

The choice of therapy following first aid measures is at the discretion of the attending physician. Selection of the best treatment will depend on the following factors:

- Concentration and temperature of the HF.

- Degree and extent of the burn.
- Areas of the body affected.
- First aid measures taken before physician's arrival.
- General condition of the victim.

The following method, using materials listed under MEDICAL SUPPLIES, have been effective in the treatment of HF burns. The methods are broken down by extent of exposure. Minor exposures are limited exposures to HF liquid and vapor. Major exposures are extensive exposures to HF liquid and vapor.

### MINOR EXPOSURES

#### **Skin Contact:**

Calcium Gluconate Gel (2.5%)--Topically applied gel must be rubbed in continuously until pain has completely subsided. Calcium gluconate gel should not be used until after thorough and complete washing of the skin with water.

Iced Solutions (As an alternate to the gel treatment above)--The burned area may be immersed in an iced aqueous solution of benzalkonium chloride, dissolved to a concentration of 0.13%. If immersion is not practical, compresses of the iced solution of benzalkonium chloride can be applied. (An iced solution of 70% denatured ethyl alcohol also may be used.) The treatment should be continued for intervals varying from 1-4 hours depending on pain and the appearance of the burn. Avoid freezing the tissues. Benzalkonium chloride and alcohol solution should not be used around the eyes since they may cause irritation and damage.

Topical Applications--After administering first aid, routine burn treatment including A&D Ointment, topical steroid cream or ointment may be applied.

#### **Eye Contact:**

Apply first aid measures as described, including immediate washing with large quantities of water. An eye specialist should be consulted immediately. A 1% calcium gluconate solution should be used to wash the eyes thoroughly for 5-10 minutes and then instilled every 2-3 hours as drops.

#### **Vapor Inhalation:**

Apply first aid measures. When in doubt, victim should be hospitalized and observed for signs of pulmonary edema or other respiratory distress. The hospitalization should cover a 48-hour period minimum and treatment with bronchial dilators, mechanical ventilation with Positive End-Expiratory pressure (PEEP) and supplemental oxygen, systemic steroids and antibiotics may be used as required. Beware of delayed onset of pulmonary edema.

#### **Ingestion:**

Apply first aid measures as described. Gastric lavage with lime water or milk may be performed, but only by a physician. Do not induce vomiting.

**MAJOR EXPOSURES****Skin Contact:**

All burned areas should have calcium gluconate 2.5% gel applied to them as a first aid measure. The application and massaging into the skin of HF burn jelly should be continued for 3 to 4 days, four to six times daily. Care should be taken to see that the personnel who apply the jelly, especially on the initial application, wear rubber gloves to prevent skin contamination with HF and the development of hand burns.

In cases of overexposure due to HF, as in skin burns of greater than approximately 25 square inches (160 cm<sup>2</sup>) in area, hypocalcemia may be present. Therefore, systemic administration of calcium gluconate may be necessary. Frequent monitoring of serum calcium, renal and hepatic functions is necessary.

**Calcium Gluconate Topical Injections** -When there is evidence of skin penetration as in second or third degree burns, a 5% calcium gluconate solution (the standard ampule is 10% for intravenous use) may be injected by infiltrating the skin and subcutaneous tissues in the same manner as the injection of a local anesthetic. Care should be taken to avoid over-dosing with calcium. All skin which has been exposed should be infiltrated including up to 1/4 inch (6 mm) around the area. This may prevent the development of severe burns.

Burns around the fingernail may require splitting the nail from the distal end in order to relieve pain and facilitate draining; prior to soaking with one of the above mentioned solutions.

**Surgical Excision** -Immediate excision of small areas burned with concentrated solutions of HF may prevent a painful, slow healing burn. Primary closure after excision or skin grafting if indicated, may provide more rapid healing and less scarring.

**Eye Contact:**

Immediate rapid washing of the eyes with large quantities of water for at least 15 minutes should be followed by ice packs. The ice pack should be used until a medical facility is reached. Here the eyes should be washed thoroughly with 1% calcium gluconate in normal, sterile saline for 5 to 10 minutes; thereafter, calcium gluconate in normal saline should be instilled every two to three hours for 48 to 72 hours. No oils or ointments should be used. Inflammation may be decreased by the use of corticosteroid solutions for ophthalmic use. An eye specialist should be consulted immediately.

**Vapor Inhalation:**

Persons exposed to HF by inhalation should immediately be given 100% oxygen by mask or catheter. As soon as possible, they should be given 2 1/2% to 3% calcium gluconate solution by inhalation, preferably by Intermittent Positive Pressure Breathing (IPPB) utilizing a nebulizer, or by nebulizer alone. The patient should be carefully watched for edema of the upper airway with respiratory obstruction and the airway maintained by tracheotomy or endotracheal intubation if necessary.

All those with a history of exposure who experience respiratory irritation should be immediately admitted to an intensive care unit and carefully watched for 24-48 hours. Delayed pulmonary edema is likely in patients with burns of the skin of face or neck.

If pulmonary edema develops, the patient should be placed in IPPB with Positive End-Expiratory Pressure (PEEP). The administration of respiratory care should be very closely supervised, including the continuing administration of calcium gluconate by inhalation.

Toxicity from pulmonary absorption of fluoride ion may rapidly develop in the liver and kidneys and may require more energetic measures of control, up to and including hemodialysis, if the blood urea nitrogen and potassium rise. Supportive care is necessary for all organ systems.

For more details on the handling of major HF exposures, see the article: M. A. Trevino et al., J. Occ. Med., 25, p. 861 (1983).

### PROTECTION INFORMATION

#### GENERALLY APPLICABLE CONTROL MEASURES

Use only with ventilation sufficient to keep vapor concentrations below the exposure limit. Use forced draft ventilation and scrubbers for fume control.

#### PERSONAL PROTECTIVE EQUIPMENT

Have available and wear as appropriate: chemical splash goggles; full-length face shield; "Neoprene" or PVC plastic gauntlet gloves; rubber shoes or boots with PVC or "Neoprene" soles; long sleeve coveralls; hard hat with brim. If there is any possibility of direct contact, wear full acid-proof suit with hood, boots, and self-contained breathing apparatus.

Protective equipment should not be worn or carried outside of operating area.

### DISPOSAL INFORMATION

#### AQUATIC TOXICITY

No definitive information is available. The estimated 96 hour LC 50 is 1-10 ppm.

#### SPELL, LEAK OR RELEASE

Evacuate area and keep upwind until gas has dispersed. Enter contaminated area only with full protective equipment and self-contained breathing apparatus. Dike spill. Dilute with water fog (direct addition of water or alkali causes heat and violent spattering). Neutralize with lime. Do not flush to sewer. Comply with Federal, State and local regulations on reporting releases.

#### WASTE DISPOSAL

Comply with Federal, State, and local regulations.

SHIPPING INFORMATIONDOT (172.101)

PROPER SHIPPING NAME Hydrogen  
Fluoride

HAZARD CLASS Corrosive Material

UN NO. 1052

DOT LABEL(S)  
Corrosive

DOT PLACARD (TT/TC)  
Corrosive

IMO (PAGE 8102-1)

PROPER SHIPPING NAME  
Hydrogen Fluoride, Anhydrous

HAZARD CLASS 8

UN NO. 1052

IMO LABEL(S) Corrosive  
Poison

DOT/IMO (172.102)

PROPER SHIPPING NAME Hydrogen  
Fluoride

HAZARD CLASS Corrosive Material, 8

UN NO. 1052

SUBSIDIARY RISK  
Poison

IATA/ICAO

Forbidden to ship via air

PROPER SHIPPING NAME  
Not applicable

HAZARD CLASS Not applicable

UN NO. Not Applicable

SUBSIDIARY RISK Not applicable

LABEL(S) Not applicable

PACKAGING GROUP NO. Not applicable

OTHER INFORMATION

REPORTABLE QUANTITY 5,000 lb/2,270 kg

SHIPPING CONTAINERS  
Tank cars, tank trucks, portable tanks

STORAGE CONDITIONS  
Keep away from heat, sparks, and flame. Keep container tightly closed.  
Drainage facilities should be constructed for containment of small spills.

ADDITIONAL INFORMATION AND REFERENCES

For further information, see Du Pont's Hydrofluoric Acid "Data Sheet" and Properties, Uses, Storage, and Handling Bulletin.

DATE OF LATEST REVISION/REVIEW: 5/85  
PERSON RESPONSIBLE FOR MSDS: J. C. WATTS, Du Pont Co., C&P Dept., Chestnut Run,  
Wilmington, DE 19898, (302) 999-4946

# Occupational Health Guideline for Nitrogen Dioxide

## INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

## SUBSTANCE IDENTIFICATION

- Formula:  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$
- Synonyms: Nitrogen tetroxide; NTO; dinitrogen tetroxide; nitrogen peroxide
- Appearance and odor: Dark brown fuming liquid or gas with a pungent, acrid odor.

## PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for nitrogen dioxide is a ceiling of 5 parts of nitrogen dioxide per million parts of air (ppm) (*Federal Register*, Vol. 43, No. 237, pp. 57601-03, 8 December 1978). This may also be expressed as 9 milligrams of nitrogen dioxide per cubic meter of air ( $\text{mg}/\text{m}^3$ ). NIOSH has recommended that the permissible exposure limit be reduced to a ceiling level of 1 ppm ( $1.8 \text{ mg}/\text{m}^3$ ) averaged over a 15-minute period. The NIOSH Criteria Document for Oxides of Nitrogen should be consulted for more detailed information.

## HEALTH HAZARD INFORMATION

- **Routes of exposure**  
Nitrogen dioxide can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed.
- **Effects of overexposure**  
Exposure to nitrogen dioxide may cause severe breathing difficulties which are usually delayed in onset and which may cause death. Recovery may be slow (2 to 3 weeks) with possible relapse and possible permanent lung damage. Pneumonia may occur. Irritation of the

eyes, nose, throat, and wet skin may occur with acute exposures.

- **Reporting signs and symptoms:**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to nitrogen dioxide.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to nitrogen dioxide at potentially hazardous levels:

1. **Initial Medical Examination:**

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory tract and cardiovascular system should be stressed.

—14" x 17" chest roentgenogram: Nitrogen dioxide causes human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Nitrogen dioxide is a respiratory irritant. Persons with impaired pulmonary function may be at increased risk from exposure. Periodic surveillance is indicated.

—Cardiovascular disease: Persons with cardiac disease may be at increased risk. An electrocardiogram should be performed on workers over 40 years of age and where indicated.

2. **Periodic Medical Examination:** The aforementioned medical examinations should be repeated on an annual basis or as otherwise indicated by the responsible physician.

- **Summary of toxicology**

Nitrogen dioxide gas is a respiratory irritant; it causes pulmonary edema and rarely, among survivors, bronchiolitis obliterans. Brief exposure of humans to concentrations of about 250 ppm causes cough, production of mucoid or frothy sputum, and increasing dyspnea. Within 1 to 2 hours the person may develop pulmonary edema with tachypnea, cyanosis, and fine crackles and wheezes throughout the lungs, and tachycardia. Alter-

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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natively, there may be only increasing dyspnea and cough over several hours, the symptoms then gradually subside over a 2- to 3-week period. The condition may then enter a second stage of abruptly increasing severity; fever and chills precede a relapse with increasing dyspnea, cyanosis, and recurring pulmonary edema. Death may occur either in the initial or second stage of the disease; a severe second stage may follow a relatively mild initial stage. The subject who survives the second stage usually recovers over 2 to 3 weeks; however, some do not return to normal, but experience varying degrees of impaired pulmonary function. The radiographic features in the acute initial stage vary from normal to those of typical pulmonary edema; most reports mention a pattern of nodular shadows on the chest film at the outset. The roentgenogram may then clear, only to show miliary mottling as the second stage commences, progressing to the development of a confluent pattern. Results of pulmonary function tests in the acute stage show reduction in lung volume and diffusing capacity; similar findings are recorded in the second stage. Pathologic examination of the acute lesion shows extensive mucosal edema and inflammatory cell exudation. The delayed lesion shows the histologic appearance of bronchiolitis obliterans; small bronchi and bronchioles contain an inflammatory exudate which tends to undergo fibrinous organization, finally obliterating the lumen. The effects expected in humans from exposure to nitrogen dioxide for 60 minutes are: 100 ppm, pulmonary edema and death; 50 ppm, pulmonary edema with possible subacute or chronic lesions in the lungs; 25 ppm, respiratory irritation and chest pain. A concentration of 50 ppm is moderately irritating to the eyes and nose; 25 ppm is irritating to some people.

## CHEMICAL AND PHYSICAL PROPERTIES

### • Physical data

1. Molecular weight: 46 and 92
2. Boiling point (760 mm Hg): 21 C (70 F)
3. Specific gravity (water = 1): 1.45 (liquid)
4. Vapor density (air = 1 at boiling point of nitrogen dioxide): 2.83
5. Melting point: -11.2 C (11.8 F)
6. Vapor pressure at 20 C (68 F): 720 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Miscible in all proportions (reacts to form nitric acid and nitric oxide)
8. Evaporation rate (butyl acetate = 1): Much greater than 1

### • Reactivity

1. Conditions contributing to instability: Elevated temperatures may cause cylinders to explode.
2. Incompatibilities: Contact with all combustible materials, chlorinated hydrocarbons, ammonia, and carbon disulfide may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as oxides of nitrogen) may be released when nitrogen dioxide decomposes.

4. Special precautions: Nitrogen dioxide will attack some forms of plastics, rubber, and coatings. **578**

### • Flammability

1. Not combustible, but strong oxidizing agent.

### • Warning properties

1. Odor Threshold: The AIHA *Hygienic Guide* reports an odor threshold of 5 ppm.

2. Eye Irritation Level: According to Grant, "the gas at a concentration in approximately 70 ppm in air causes irritation of the eyes and nose evident in guinea pigs, rabbits, monkeys, and dogs during the first hour of exposure. At this concentration the gas has been lethal to most of the animals if exposed for eight hours, and under these conditions corneal opacities have been produced in the rabbits. The corneas of rabbits that survived such exposures did not improve under observation during twenty days. However, the gas at concentrations up to 20 ppm in air and exposure of four hours has produced no significant effect on the corneas of rabbits. . . . Exposure of the same magnitude repeated daily for more than a month also has not been damaging to the eye." The *Documentation of TLV's* reports that according to Patty, 10-20 ppm "were mildly irritant to the eyes. . . ."

3. Other Information: The AIHA *Hygienic Guide* states that "exposures of relatively short duration to concentrations above 5 ppm produce cough and irritation of the respiratory tract."

4. Evaluation of Warning Properties: Through its odor and irritant effects, nitrogen dioxide can be detected slightly above the recommended permissible exposure limit. For the purposes of this guideline, therefore, nitrogen dioxide is treated as a material with adequate warning properties.

## MONITORING AND MEASUREMENT PROCEDURES

### • Ceiling Evaluation

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of nitrogen dioxide. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

### • Method

Sampling and analyses may be performed by collection of gas in a reagent-filled impinger with a subsequent spectrophotometric analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure nitrogen dioxide may be used. An analytical method for nitrogen dioxide is in the *NIOSH Manual of Analytical Methods*, 2nd Ed.,

## RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

## PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with liquid nitrogen dioxide.

• Clothing contaminated with nitrogen dioxide should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of nitrogen dioxide from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the nitrogen dioxide, the person performing the operation should be informed of nitrogen dioxide's hazardous properties.

• Where there is any possibility of exposure of an employee's body to liquid nitrogen dioxide, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

• Non-impervious clothing which becomes contaminated with nitrogen dioxide should be removed immediately and not reworn until the nitrogen dioxide is removed from the clothing.

• Employees should be provided with and required to use splash-proof safety goggles where there is any possibility of liquid nitrogen dioxide contacting the eyes.

• Where there is any possibility that employees' eyes may be exposed to liquid nitrogen dioxide, an eye-wash fountain should be provided within the immediate work area for emergency use.

## SANITATION

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• Skin that becomes contaminated with nitrogen dioxide should be immediately washed or showered to remove any nitrogen dioxide.

## COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to nitrogen dioxide may occur and control methods which may be effective in each case:

Operation	Controls
Use during metal surface treatment with nitric acid; in production of intermediates in manufacture of sulfuric acid, nitric acid, and fertilizers	Process enclosure; local exhaust ventilation; personal protective equipment
Liberation of fumes during engine maintenance, synthesis of dyes, manufacture of nitrocellulose paints, lacquers, and storage of silage in agricultural operations; production and handling of rocket propellants	Process enclosure; local exhaust ventilation; personal protective equipment
Liberation of fumes during detonation of explosives	Personal protective equipment
Use in chemical synthesis during nitration operations	Process enclosure; local exhaust ventilation; personal protective equipment

## EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

### • Eye Exposure

If liquid nitrogen dioxide or strong concentrations of nitrogen dioxide vapor get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

### • Skin Exposure

If liquid nitrogen dioxide or strong concentrations of nitrogen dioxide vapor get on the skin, immediately flush the contaminated skin with water. If liquid nitrogen dioxide or strong concentrations of nitrogen dioxide vapor penetrate through the clothing, remove the clothing immediately and flush the skin with water. Get medical attention immediately.

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#### • Breathing

If a person breathes in large amounts of nitrogen dioxide, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

#### • Swallowing

When liquid nitrogen dioxide has been swallowed and if the person is conscious, immediately give the person large amounts of water to dilute the nitrogen dioxide. Do not attempt to make the unconscious person vomit. Get medical attention immediately.

#### • Rescue

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

### SPILL AND LEAK PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

• If nitrogen dioxide is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill or leak to disperse gas.
2. If in the liquid form, allow to vaporize.
3. If in the gaseous form, stop flow of gas. If source of leak is a cylinder and the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, and repair the leak or allow the cylinder to empty.

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## RESPIRATORY PROTECTION FOR NITROGEN DIOXIDE

Condition	Minimum Respiratory Protection* Required Above 5 ppm	578
<b>Gas Concentration</b>		
50 ppm or less	<p>A chemical cartridge respirator with a full facepiece and cartridge(s) containing non-oxidizable sorbents and providing protection against nitrogen dioxide.**</p> <p>A gas mask with a chin-style or a front- or back-mounted canister containing non-oxidizable sorbents and providing protection against nitrogen dioxide.</p> <p>Any supplied-air respirator with a full facepiece, helmet, or hood.</p> <p>Any self-contained breathing apparatus with a full facepiece.</p>	
Greater than 50 ppm*** or entry and escape from unknown concentrations	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p> <p>A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</p>	
Fire Fighting	<p>Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.</p>	
Escape	<p>Any gas mask containing non-oxidizable sorbents and providing protection against nitrogen dioxide.</p> <p>Any escape self-contained breathing apparatus.</p>	

\*Only NIOSH-approved or MSHA-approved equipment should be used.

\*\*Nitrogen dioxide is an oxidizer and should not come in contact with oxidizable materials. Some cartridges and canisters may contain oxidizable materials, such as activated charcoal, and therefore should not be used to provide protection against nitrogen dioxide. Only non-oxidizable sorbents are allowed.

\*\*\*Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of nitrogen dioxide; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 50 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.