WORK PLAN FOR DECONTAMINATION, DEMOLITION AND REMOVAL OF SOLID WASTE MANAGEMENT UNIT (SWMU) COMPONENTS IN BUILDING 730 (FORMERLY BUILDING 338)

AT

IPARK 84
FORMER IBM EAST FISHKILL FACILITY

FEBRUARY 2020

PREPARED FOR:

JESSICA LACLAIR
NEW YORK STATE DEPT. OF ENVIRONMENTAL CONSERVATION
DEPT. OF ENVIRONMENTAL REMEDIATION
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WALDEN ENVIRONMENTAL ENGINEERING, PLLC

Industry Leader in Environmental Engineering Consulting

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Sent via email to jess.laclair@dec.ny.gov

February 4, 2020
iPARK0118.36

Jessica LaClair
Environmental Engineer
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-7013

Re: iPark 84
Former IBM East Fishkill Facility
Work Plan for Decontamination, Demolition and Removal of Solid Waste Management Unit (SWMU) Components in Building 730 (Formerly Building 338)

Dear Ms. LaClair:

Walden Environmental Engineering, PLLC (Walden) is submitting this Solid Waste Management Unit (SWMU) Removal Work Plan on behalf of iPark East Fishkill LLC (iPark/Owner), the owner of Building 730 (formerly Building 338) at the iPark 84 Former IBM East Fishkill Facility located in Hopewell Junction, New York. This Work Plan outlines the steps that will be taken to ensure compliance with the Interim Site Management Plan (ISMP) while this project takes place.

Notification

In accordance with the Interim Site Management Plan (ISMP), the New York State Department of Environmental Conservation (NYSDEC) and International Business Machine Corporation (IBM) must be notified fifteen (15) days before the SWMU removal activities begin. Submittal of this report shall serve as Walden's notification to the NYSDEC, New York State Department of Health (NYSDOH) and IBM of plans to remove SWMU components in Building 730. The Building 730 SWMU removal work is expected to take place in February 2020 upon NYSDEC and NYSDOH approval of this Work Plan.

Project Description

Historically, tetramethylammoniumhydroxide (TMAH) was utilized during Multi-Layer Ceramics (MLC) operations that took place within Buildings 330C, 330D, 338, and 339. Reportedly, TMAH was diluted in Building 730 prior to being supplied to Buildings 330C and 330D via overhead piping. TMAH waste was then collected and pumped back to Building 730 for reclamation treatment, and then transferred to Building 339 where it was held before being disposed of off-site. The majority of the MCL tools associated with TMAH were decommissioned, decontaminated, and removed on behalf of Global Foundries in 2015 as documented in the *Certification of SWMU Closure Report* prepared by Arcadis, dated April 6, 2016. This SWMU removal scope of work will follow the procedures outlined in the 2016 Arcadis report which were previously approved by NYSDEC.

Walden understands that iPark shall enter into an agreement with a Contractor to complete the scope of work outlined herein related to the removal of SWMU components in certain locations within Building 730 based on tenant needs and potential tenant interest. Refer to Figure 1 for the overall Site Plan. As outlined in Table 1and Figure 2, the removal work to be performed includes but is not limited to the following:

- Clean, remove and dispose of one (1) 1,500-gallon Industrial Waste (TMAH) Transfer Tank (Tank # 3388, in the vicinity of column Q41) and integral connected piping;
- Remove, clean, and dispose of the Waste TMAH overhead transfer piping and vents associated with Tank #3388 to the point of the main overhead lines for the building.
- Cap all cut overhead lines at the boundary of the work space.
- During Site reconnaissance, Walden observed an open tub structure that contains sediment material. The location of this structure in the vicinity of column N43-N44 is consistent with the location of Tank #3504, a former TMAH wastewater tank that was previously decommissioned in 2015 as detailed in the *Certification of SWMU Closure Report* (April 6, 2016). The material in this tank bottom was sampled on January 31, 2020 to characterize it for disposal. This material will be removed and disposed of during the Tank #3388 SWMU removal activity.

The removal work is specific to these SWMUs and SWMU components located in Building 730 (as shown in Table 1 and Figure 2). If it is determined that additional SWMU removal is needed, no such removal shall be performed until the added scope is evaluated by the Owner and Walden, and NYSDEC and NYSDOH are advised of and approve such work. The removal and decontamination of the SWMUs are to be planned and executed concurrently.

SWMU Removal

The SWMU Removal activities shall include the following actions:

1. Throughout the performance of the work, the work area will be secured with caution tape and temporary physical barriers to prevent unauthorized access.

2. Prior to the start of removal, it will be confirmed that the SWMUs are disconnected from electricity and compressed air feeds, as applicable. If not done prior to mobilization, electricians employed by iPark shall disconnect the SWMUs from electricity. Additionally, the work area will be appropriately prepared to allow for the containment and collection of drained fluid and rinse water.

3. Tank #3388, the remaining portion of decommissioned Tank #3504, and the associated wastewater transfer piping, drainage piping, and vents will be decontaminated through the removal of TMAH wastewater and solids.

4. During removal, the listed SMWUs shall be sized to approximately five feet or less and decontaminated to the extent required to meet the decontamination criteria specified below.

5. SWMUs removed from Building 730 shall be segregated for non-hazardous waste disposal based on meeting the decontamination criteria specified below, or for hazardous waste disposal based on failing to meet the decontamination criteria specified below. All SWMU removal shall be completed prior to any future interior demolition activities in Building 730 that could lead to combining or obscuring the SWMU materials with demolition debris.

6. Spill prevention measures shall be implemented throughout the performance of this work. If a spill of residue and/or residual fluid does occur, the materials will be promptly recovered and the building slab or other impacted surface shall be decontaminated. These recovery and decontamination actions shall be implemented with effective methods (e.g., rags, water, power-wash, wet/dry vacuum, etc.). All spills and drips from SWMU components being relocated for decontamination along all SWMU transport pathways shall be addressed in the same manner. All waste generated from cleanup activities shall be disposed of in accordance with source waste stream requirements described below in “Decontamination”.

7. Any remaining pipe ends left in place shall be capped with correctly sized caps or other cap materials approved in advance by iPark. The capped ends shall be labeled with the

wastewater name on the remaining pipe if existing labels are not visible within 10 feet of the capped end.

Decontamination

Decontamination of the SWMUs may be accomplished through flushing, draining, suction pumping, removal of solids by hand tools where necessary, and final rinsing. Immediately prior to decommissioning the Tank #3388 TMAH system and the remaining portion of decommissioned Tank #3504, the components will be sufficiently rinsed and drained. Subsequently, the Contractor will remove residual water and light solids from the sumps and tanks for transfer to the on-site wastewater treatment facility.

Prior to initiating SWMU decontamination, the Contractor shall prepare a temporary decontamination station at locations approved by iPark that will collect and manage the wastewater and solid waste generated from draining and decontaminating the SWMUs. TMAH wastes shall be handled as Industrial/Acid water and solid waste.

The wash water shall be segregated based on its original source. It is anticipated that all wash and wastewater generated from the removal and decontamination activities will be placed into an appropriate wastewater lift station that remains within the building, or placed into drums or a tanker truck for transfer to the on-site wastewater treatment facility. This disposal will be done in accordance with the requirements of the on-site wastewater treatment plant that is owned by Global Foundries. In order to obtain such permission from Global Foundries, laboratory testing may be required. If the wastewater does not meet specifications for discharge into the existing system, all wastewater and wash water shall be containerized in 55-gallon drums and appropriately disposed of off-site.

The Contractor shall decontaminate all SWMU components referenced above, including all tank components and piping. The decontamination will be considered successful once it meets the decontamination standards described below, as verified by inspection and testing by Walden. Decontamination methods selected by Contractor may include flushing, pressure washing, use of surfactants, rags, hand tools, wet/dry vacuum, and rinsing with treated facility water.

Decontamination requirements are as follows:

1. Cover the floor in the decontamination stations and in the tank and piping removal areas with 6-mil (minimum) polyethylene sheeting and provide adequate measures to control and recover any wash water spilled or generated during draining, removal and decontamination.

2. Decontaminate all SWMU components identified above designed as secondary containment for SWMU piping and tanks using any effective combination of wet rags, scrapers, scrub brushes, and low-pressure or high-pressure wash and rinse water as needed, and remove all existing standing water as well as wash water and rinse water from the decontaminated floors for disposal via waste systems approved by iPark and Global Foundries for the specific waste/wastewater.

3. Use only treated building water (from an available tap) as the source for decontamination wash water and rinse water.

4. Decontamination shall be performed in accordance with the requirements of the NYSDEC. Decontamination efforts will be considered complete when the following criteria are met:

    a. For SWMUs that handled only D002 hazardous waste (characteristic of corrosivity), decontamination will be complete when:
        i. Surface test results for pH of SWMU surfaces are within the neutral range of 5.0-8.0, based on field tests with pH test strips on surfaces lightly wetted with facility water (facility water at the site typically ranges from pH 5.5-6.5).
        ii. SWMU surfaces are cleaned to a clean debris surface as defined in 6 NYCRR Part 376.4(g). A “clean debris surface" means the surface, when viewed without magnification, shall be free of all visible contaminated soil and hazardous waste except that residual staining from soil and waste consisting of light shadows, slight streaks, or minor discolorations, and soil and waste in cracks, crevices, and pits may be present provided that such staining and waste and soil in cracks, crevices, and pits shall be limited to no more than 5% of each square inch of surface area.”
        iii. If SWMU surfaces cannot be visually inspected as described in Part 376.4(g), rinse water samples will be collected and analyzed for the hazardous constituent(s) handled by the SWMU. Decontamination will be complete when the rinse water meets Class GA Groundwater Standards; or
        iv. Where the clean debris standard or rinse water standard cannot be met, or items cannot be fully inspected (such as clogged valves and piping), the affected materials will be profiled for hazardous waste disposal and managed accordingly.

    b. Building surfaces indicating visible evidence of residues from SWMU waste transfer piping systems during their removal will be rinsed and inspected.

Decontamination will be complete when the SWMU surfaces meet the criteria listed above, including the criteria for meeting neutral pH. If the surfaces are to remain in place following demolition, and the decontamination criteria have not been met, alternative methods (e.g., scarification, encapsulation) will be proposed.

   c. On-site decontamination activities will be periodically observed and documented by a Walden field representative as discussed below. Walden will conduct representative real-time pH testing of SWMU components, inspect SWMU materials for clean-debris determination, and collect rinsate samples if needed.

5. Any SWMU component or part that fails to meet the decontamination standards described above shall be re-cleaned by Contractor until the standards are met as determined by Walden.

6. Decontamination wash water from Acid/Industrial Waste SWMUs shall be containerized and properly disposed of. This wash water may be discharged to the on-site waste system for treatment (if approved by Global Foundries) or be profiled and appropriately disposed of off-site.

7. The Contractor shall provide all drums and both hazardous waste and non-hazardous labels required to complete this Scope of Work, and shall label the drums with the name of the generator, date of generation and waste content in accordance with all RCRA requirements.

8. The Contractor shall move all waste-containing drums or other containers to a loading area designated by iPark and Walden. The Contractor shall load all waste to be disposed of into appropriate transportation containers. The loading area must be decontaminated following export activities.

SWMU Removal Project Oversight and Certification

Walden will provide periodic field oversight during the Building 730 SWMU removal activities to ensure proper execution of the procedures detailed in this Work Plan. When Walden is on-site, the Health and Safety Plan (HASP) included in Attachment A will be implemented and Walden will ensure that the work practices and health and safety monitoring detailed in the HASP are implemented. Note that the Contractor will be responsible for the health and safety of its on-site workers and implementing the Contractor's HASP at all times when Walden is not on-site.

CAMP air monitoring is not anticipated during the SWMU removal work as it does not involve intrusive activities that would disturb soil beneath the slab and no dust is expected to be generated during the work. If at any time intrusive activity is required or visible dust generation occurs, the SWMU removal work will be halted, NYSDEC and NYSDOH will be notified, and Walden will implement air monitoring in accordance with a CAMP approved by the State. SWMU removal activity will resume upon implementation of CAMP monitoring.

Walden anticipates providing full-day on-site oversight during the first two (2) days of SWMU removal work, and then full-day oversight every three (3) days for the duration of the work as appropriate. The oversight schedule may be modified depending on the planned work activities or as requested by iPark.

Walden will inspect all SWMU material prior to and during removal activities to verify Tank #3388 and the remaining portion of previously decommissioned Tank #3504 have been emptied prior to testing. Due to the caustic nature of TMAH, real time screening with Hydrion® pH test strips will be performed prior to disposing of SWMU components. Walden will conduct methodical testing of decontaminated waste TMAH system tank interiors, pump inlets and outlets, and waste transfer piping at the outlets or cut section ends using pH test strips to verify that decontamination requirements are met. Testing will be performed on wet rinsed surfaces. The location, date and ID number for each pH sample collected will be recorded in the field book.

When on-site, Walden will collect wastewater samples for laboratory analysis to verify proper handling, discharge to Global Foundries' wastewater treatment plant (as appropriate), or any other disposal required depending on the wastewater characteristics. Walden will also document its observations of the work performed by the Contractor.

Upon completion of the project and receipt of all disposal manifests for wastes and SWMU components disposed of off-site, Walden will prepare a certified SWMU removal/closure report documenting the Building 730 SWMU removal activities and associated waste handling and disposal. The certification report will be submitted to IBM for inclusion in their annual Periodic Review Report. A copy of the Building 730 SWMU removal certification report will be submitted to NYSDEC and NYSDOH.

Regulations Applicable to SWMU Removal Work

This Scope of Work must be performed in accordance with all Federal, State, and Local Laws. Contractor shall assume full responsibility and liability for the compliance with all applicable regulations pertaining to work practices, transportation, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The regulations and requirements applicable to the work include but are not limited to the following:

- U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) regulations:
    - Respiratory Protection (29 CFR 1919.134),
    - Occupational Noise Exposure (29 CFR 1910.95),
    - Access to Employee Exposure and Medical Records (29 CFR 1910.1020),
    - Hazard Communication (29 CFR 1910.1200),
    - Specifications for Accident Prevention Signs and Tags (29 CFR 1910.145),
    - Confined Space Entry (29 CFR 1910.146),
    - Control of Hazardous Energy (29 CFR 1910.147),
    - Eye Protection (29 CFR 1910.133),
    - Spills and Releases (29 CFR 1910.12),
    - Fall Protection (29 CFR 1910.66 and 29 CFR 1926.500),
    - Flammable Liquid Storage Requirements (29 CFR 1910.106),
    - Hazardous waste operations and emergency response (29 CFR 1910.120),
    - Respiratory Protection (29 CFR 1910.134) and,
    - General Requirements (Personal Protective Equipment) (29 CFR 1910.132).

- Transportation laws under the authority of the U.S. Department of Transportation:
    - Hazardous Substances Title 49 Part 171 and 172 of the Code of Federal Regulations.

- Environmental Protection laws under the authority of the U. S. Environmental Protection Agency (EPA):
    - Hazardous Waste Management Systems: General (40 CFR 260),
    - Identification and Listing of Hazardous Waste (40 CFR 261),
    - Generators of Hazardous Waste (40 CFR 262),
    - Transporters of Hazardous Waste (40 CFR 263),
    - Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264, 265),
    - Land Disposal Restrictions (40 CFR 268),
    - Clean Air Act of 1990 (as amended), and
    - Clean Water Act of 1972 (as amended).

If you have any questions or require any additional information, please call (516) 624-7200.

Very truly yours,
Walden Environmental Engineering, PLLC

Nora M Brew

Nora M. Brew, P.E.
Senior Project Manager

cc: M. Buckley, iPark
C. Monheit, iPark

Figure 1 – Site Plan
Figure 2 – SWMU Removal Areas
Table 1 – Summary of SWMU Removal to be Conducted in Building 730
Attachment A – Health and Safety Plan

Z:\iPark0118\iPark0118.44 - Bldg 338\iPark Building 730 (338) SWMU Removal Work Plan 2.4.2020.doc

SITE PLAN

SCALE: 1" = 60'-0"

SCALE: 1"=60'

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Engineering

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REVISION		
No.	DATE	COMMENTS

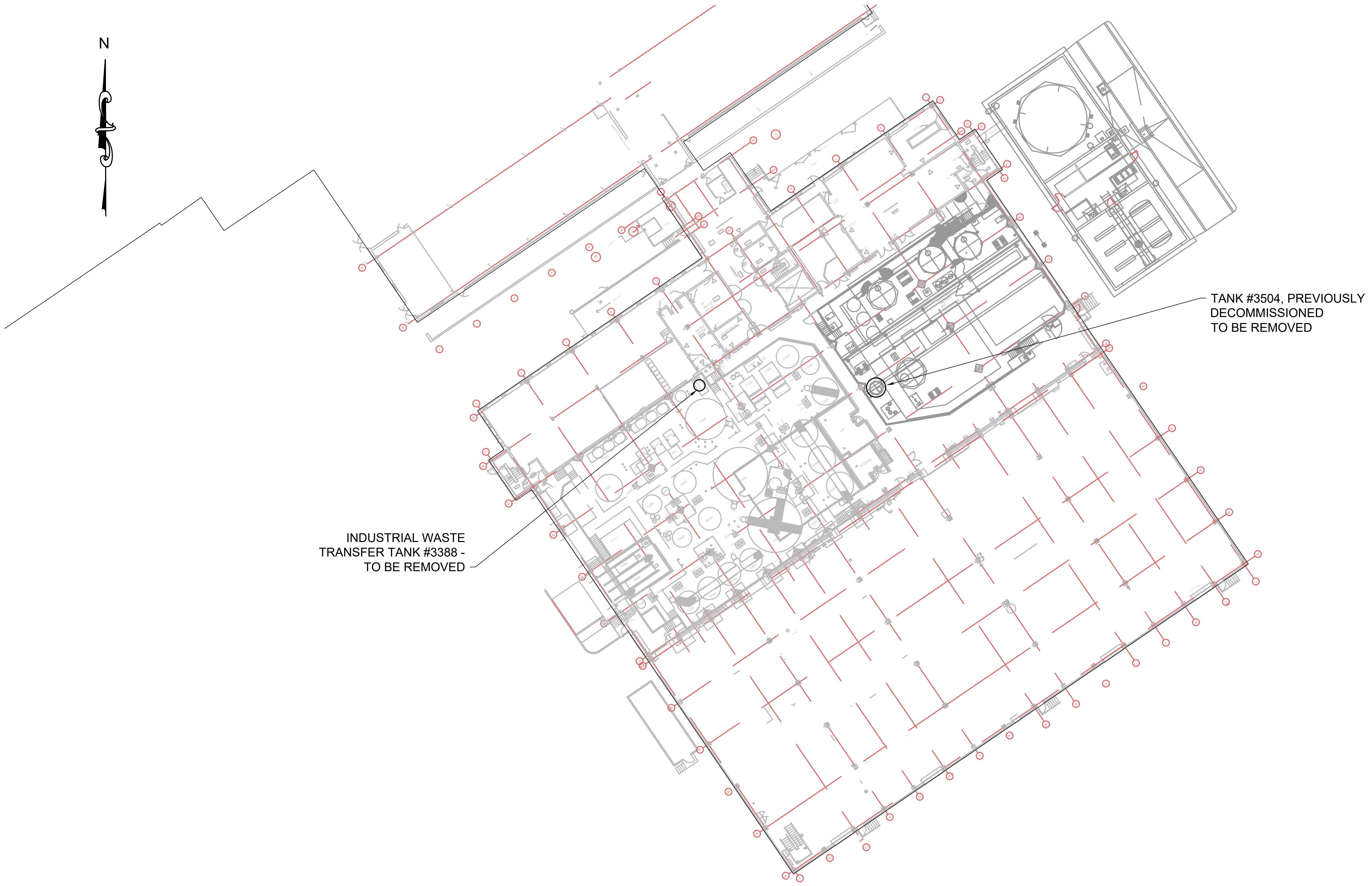
FOR: BUILDING 730 (FORMER 338)
iPark 84 Campus
2070 State Route 52
Hopewell Junction, NY 12533

DESIGNED BY: NMB
DRAWN BY: EJK
APPROVED BY: JMH
SCALE: AS NOTED

DRAWING TITLE:
SITE PLAN
BUILDING 338 - SWMU REMOVAL

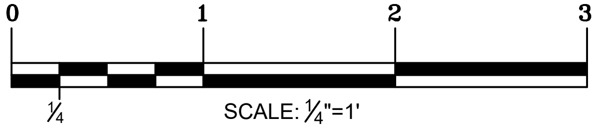
JOB NO: IPARK118.44
DATE: 2/3/20
11x17
CAD FILE NAME: Z:\iPark0118\iPark0118.44 - Bldg 338\Bldg 730 formerly 338-SWMU Removal.dwg

FIGURE NO: 1
SHEET NO: 1 OF 2
ISSUED
REVISION NO: 0



BLDG 730 (FORMERLY 338)
SWMU REMOVAL

SCALE: $\frac{1}{4}$" = 1'-0"



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REVISION		
No.	DATE	COMMENTS

FOR: BUILDING 730 (FORMER 338)
iPark 84 Campus
2070 State Route 52
Hopewell Junction, NY 12533

DRAWING TITLE:
WORK AREA LOCATION
BUILDING 338 - SWMU REMOVAL

FIGURE NO: 2

ISSUED

REVISION NO: 0

DESIGNED BY: NMB
DRAWN BY: EJK
APPROVED BY: JMH
SCALE: AS NOTED
JOB NO: IPARK118.44
DATE: 2/3/20
11x17
SHEET NO: 2 OF 2
CAD FILE NAME: Z:\iPark0118\iPark0118.44 - Bldg 338\Bldg 730 formerly 338-SWMU Removal.dwg

iPark 84
East Fishkill, New York

Table 1
Summary of SWMU Removal to be Conducted in Building 730 (Formerly 338)

ECOL ID #	Description	Location	Status	Associated Drainage Piping (Linear Feet)	Associated Vent Piping (Linear Feet)
IW Tansfer Tank #3388	1,500-gallon TMAH tank and associated piping	Column Q41	Active	approx. 50 ft	approx. 50 ft

Additional Items to be Removed:

Item	Description	Location
Tank #3504	Bottom of previously decomissioned tank structure containing with tank bottom materials	Column N-43 and N-44

Note: Refer to Figure 2 for additional details

ATTACHMENT A

HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

AT

iPARK 84
FORMER IBM EAST FISHKILL FACILITY

FEBRUARY 2020

PREPARED FOR:
iPARK EAST FISHKILL LLC
200 NORTH DRIVE
HOPEWELL JUNCTION, NEW YORK 12533

PREPARED BY:
WALDEN ENVIRONMENTAL ENGINEERING, PLLC
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<u>Attachments</u>

1.0 INTRODUCTION

Walden Environmental Engineering, PLLC (Walden) employees may be exposed to risks from site-related hazardous conditions while performing field activities at the iPark 84 Site (the Former IBM East Fishkill Facility, the “Site” or “Facility”) located in Hopewell Junction, New York (refer to **Attachment A**) which is owned by iPark East Fishkill LLC (“iPark” or “Owner”). Walden’s policy is to minimize the possibility of work-related injury through aware and qualified supervision, health and safety training, medical monitoring and the use of appropriate personal protective equipment (PPE). Walden has established a guidance program to implement this corporate policy in a manner that protects personnel to the maximum reasonable extent.

This Health and Safety Plan (HASP) applies to all Walden personnel, iPark representatives, subcontractors, the New York State Department of Environmental Conservation (NYSDEC), the New York State Department of Health (NYSDOH), and any other individuals on the job-site where operations involve actual or potential physical and chemical hazards that have been identified by Walden or others during activities including but not limited to the following:

- Shallow soil sampling;
- Sediment sampling;
- Groundwater sampling;
- Construction or demolition work that disturbs surface or subsurface soils, groundwater, sediment, etc. at the Facility; and
- Construction or demolition work involving equipment, piping, etc. currently or formerly containing hazardous materials or wastes at the Facility.

This HASP is also intended to inform and guide all personnel (Walden employees and/or owner representatives, subcontractors or State/local regulatory agency representatives) entering the exclusion zone, ensuring that each person sign and acknowledge the Site hazards on the Acknowledgement Form, provided in Section 9.0. Walden and/or the owner’s subcontractors are retained as independent contractors and, as such, are responsible for ensuring the safety of their employees.

Walden may require that its personnel take certain precautions in accordance with this HASP, and Walden requests that others protect their personnel in a manner that they deem necessary or sufficient.

This HASP is based on the best available information to date. Should a conflict occur between this document and any other related Health and Safety Plans, Operating Procedures, regulations, etc., workers shall follow the most stringent/protective requirements. HASP Supplements will be generated, as necessary, to address any new information, change in conditions or activities. While it is not possible to discover, evaluate, and protect in advance against all possible hazards which may be encountered throughout the course of this project, adherence to the requirements of this HASP will significantly reduce the potential for occupational injury.

2.0 SCOPE

2.1 Generic Scope

This HASP is intended to be utilized during removal of solid waste management units (SWMUs) and any intrusive work performed at the Facility, including but not limited to the following:

- Cleaning/demolition/removal of SWMUs and associated piping and troughs;
- Removal/installation/modification of piping and drainage structures;
- Collection of waste water samples;
- Collection of soil samples via hand auger or similar methods;
- Installation of soil borings;
- Collection of groundwater samples;
- Collection of soil gas and sub-slab vapor samples;
- Collection of air samples;
- Non-hazardous and hazardous soil/solids management;
- Non-hazardous and hazardous liquid management;
- Real-time air monitoring using instrumentation;
- Cutting and handling of concrete slabs;
- Construction, installation and maintenance of engineering controls to reduce chemical exposure;
- Excavation;
- Stockpiling;
- Grading;
- Trenching;
- Interior building renovations;
- Installation of pavement and concrete; and
- General site construction and building activities.

Previous site investigations have identified soil, soil vapor and groundwater contamination at various locations at the Facility associated with historic site activities. Contaminants associated with the site include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and inorganics. Therefore, precautions shall be taken to prevent exposure to contaminants and ensure that appropriate and safe procedures are followed when potentially contaminated media and hazardous materials and wastes may be encountered and handled during the work. Work at the Facility shall be performed by employees who are properly trained and experienced in dealing with the hazards which may arise from these types of tasks, which are defined as toxic effects, including threshold limit values (TLVs), immediately dangerous to life and health (IDLH), reactivity, stability, flammability, and operational hazards with sampling, decontaminating, etc.

2.2 Project-Specific Scope of Work

iPark is removing solid waste management units (SWMUs) in certain locations within Building 338 based on tenant needs and potential tenant interest. The SWMU removal work is detailed in the "Work Plan for Decontamination, Demolition and Removal of Solid Waste Management Unit (SWMU) Components in Building 338" (Walden, February 2020). The work includes but is not limited to the following:

- Clean, remove and dispose of one (1) 1,500-gallon Industrial Waste (tetramethylammonium hydroxide, "TMAH") Transfer Tank (Tank # 3388) and integral connected piping;
- Remove, clean, and dispose of the Waste TMAH overhead transfer piping and vents associated with Tank # 3388 to the point of the main overhead lines for the building.
- Cap all cut overhead lines at the boundary of the work space.
- During Site reconnaissance, Walden observed an open tub structure that contains sediment material. The location of this structure is consistent with the location of Tank #3504, a former TMAH wastewater tank that was previously decommissioned in 2015. This material will be removed and disposed of during the Tank #3388 SWMU removal activity.

2.3 Equipment

The following equipment may be utilized during work at the Facility:

- Hand auger;
- Portable generator;
- Battery;
- Peristaltic pump;
- Bailer;
- Water quality meter;
- Water level indicator;
- Scrub brush;
- Photoionization detector (PID);
- MultiRAE multi-gas meter;
- Ventilation devices (fans);
- Concrete saw;
- 55-gallon drums, both metal and plastic;

- Plastic chemical totes;
- Excavation machinery (e.g. mini-excavator);
- Hand shovels;
- Plastic sheeting;
- Air sampling canisters;
- Water sampling containers;
- Soil/Solids sampling containers;
- Chemical-resistant, leather, and/or cut-resistant gloves; and
- Miscellaneous hand tools (screwdriver, socket driver).

2.4 Site Access

The Facility includes occupied and unoccupied building spaces and undeveloped areas. Authorized Facility owner personnel, tenants and subcontractors have access to buildings at the Facility depending on security clearance designations. In the event of an emergency, personnel and subcontractors should assemble at a predetermined assembly area, designated by the Site Safety Officer (SSO) for the task.

Access to work areas will be denied to the general public via the SSO or designated personnel, thus establishing the perimeter of controlled work areas, minimizing potential exposure to unauthorized individuals, protecting the public from hazards and preventing vandalism. All equipment and materials will be secured during non-work hours. Continuous communication (via portable radios, hand signals, telephones, etc.) shall be maintained between the SSO and key personnel associated with this project at all times during field operations.

2.5 Controlled Work Areas

Controlled work areas will be established prior to and for each work area, depending on the task, and shall float (move around) depending on the tasks being performed on any given day. Each controlled work area will consist of three (3) zones: the exclusion zone, the contaminant reduction zone and the support zone based on the degree of danger present. To the extent possible, the support and contaminant reduction zones will be established outside of the exclusion zone.

2.5.1 Exclusion Zone

The exclusion zone consists of the primary activity area, as defined by the SSO. Only personnel directly involved with performance of a job task within that area and meeting the required qualifications (40 Hour HAZWOPER trained) may be allowed entry. Before entering the exclusion zone, all personnel must be familiar with emergency response procedures, Site safety locations, first aid and communication equipment, and the locations of the map to the hospital and the list of emergency telephone numbers. Attempts will be made so that equipment and site activities taking place in the exclusion zone are situated so that personnel are upwind of potential contaminant sources.

2.5.2 Contaminant Reduction Zone

The contaminant reduction zone shall be located between the exclusion zone and the support zone. In this area authorized personnel (those with 40 Hour HAZWOPER training) will don protective equipment, as needed in the exclusion zone. When exiting the restricted area, personnel will remove contaminated PPE.

2.5.3 Support Zone

The support zone shall extend beyond the exclusion and contaminant reduction zones, where other support activities shall occur, such as first aid, equipment supply, etc., and where vendors, subcontractors and inspectors, and the like, shall be allowed. The support zone shall be established prior to commencement of activities and shall serve as the entry point for controlling access.

Trespassers shall be immediately escorted outside of these established areas and all work within these areas shall halt until the trespasser has been removed.

3.0 ORGANIZATIONAL STRUCTURE

The following Walden personnel are the main parties involved with the project at hand.

POSITION/TITLE	NAME/AFFILIATION	PHONE NUMBER/PAGER
Project Manager(s)	Joseph M. Heaney III, P.E.	516-624-7200 (Office)
	Nora Brew, P.E.	516-732-5378 (Mobile)
	Ted Nitza, P.E.	260-416-6188 (Mobile)
Site Safety Officer(s)	Kerri Wright	845-207-3043 (Mobile)
	Erica Johnston	631-521-1266 (Mobile)
	Louis Goldstein	845-406-8242 (Mobile)

3.1 Project Manager

The Project Manager has the responsibility and authority to direct all operations related to this project. The Project Manager is responsible to observe and provide guidance to employees, subcontractors and visitors with regard to safe work behavior and safety training, discuss deviations from the work plan and any safety issues that arise, assist the SSO with the development and implementation of corrective actions for Site safety deficiencies, the implementation of this HASP and ensuring compliance.

3.2 Site Safety Officer

A qualified SSO will be continuously on the jobsite during the period of work and will have the authority to receive and execute any directions given by the owner representative in the absence of the Project Manager. The SSO will establish the necessary controlled work areas. The SSO will ensure that task areas are kept in a clean condition, free of rubbish and all undue accumulations and surplus materials while the work progresses. The SSO and/or Project Manager shall guarantee that all employees are fit for duty and that material and equipment is protected to prevent damage to employees and visitors, as well as, at the end of each work day, all rubbish and unused materials are removed and any damage done is repaired. These individuals will enforce this HASP, ensuring required safety equipment is on-site, clean and operable.

The SSO will coordinate all relevant health and safety issues, and may conduct specialized training and compliance inspections, as required. It will be the duty of the SSO to provide emergency training to associated personnel and, in the event of an emergency situation, to inform the local authorities as to the nature of the incident. In case of an emergency incident, the SSO will be contacted immediately. The SSO is to work with the Project Manager to develop and implement any corrective actions that may be necessary.

The Project Manager and the SSO are responsible for periodically reviewing the HASP and its Attachments and any Supplements and, as necessary, amending them to keep current with new or changing conditions.

3.3 Employees

Employees are responsible for understanding and abiding by the policies and procedures specified in this HASP and other applicable safety policies, and clarifying those areas where understanding is incomplete; providing feedback to health and safety management relating to omissions and modifications in the HASP or other safety policies; and, notifying the SSO, in writing, of unsafe conditions and acts. Each employee shall sign this HASP (Section 9.0) in acknowledgement of such.

The health and safety authority of each employee assigned to the Facility includes the right to refuse to work and/or stop work authority when the employee feels that the work is unsafe (including subcontractors), or where specified safety precautions are not adequate or fully understood; the right to refuse to work on any task where the safety procedures specified in this HASP or other safety policies are not being followed; the right to contact the SSO at any time to discuss potential concerns; the right and duty to stop work when conditions are unsafe, and to assist in correcting these conditions.

3.4 Subcontractors

Subcontractors shall submit to the SSO a copy of their own health and safety plan or shall review and sign this document acknowledging acceptance and understanding of the information contained herein. Subcontractors are responsible for assigning specific work tasks to their employees. Subcontractors shall provide qualified employees equipped with the necessary PPE and training required for the task. Each subcontractor is responsible for compliance with the regulatory requirements that pertain to those services. Each subcontractor is expected to perform operations in accordance with their own unique safety policies and procedures, or those documented herein, in order to ensure that hazards associated with the performance of the work activities are properly controlled. Copies of any required safety documentation/certification for a subcontractor's work activities will be provided to Walden for review prior to the start of onsite activities, if required. Hazards not listed herein but known to any subcontractor must be identified to Walden prior to commencing any on-site activity. The Project Manager and SSO have the authority to halt any subcontractor operations, and to remove any subcontractor or subcontractor employee for failure to comply with established health and safety procedures or for operating in an unsafe manner.

3.5 Visitors

Authorized visitors requiring entry to any work location on-site shall be briefed by the SSO on the hazards present prior to entry and acknowledge receipt of this briefing by signing this HASP. Visitors shall be escorted at all times within the controlled zones and shall be responsible for compliance with all health and safety policies. All visitors shall hold the appropriate qualifications, training and PPE which are required for entry to any controlled work area. Should a visitor requiring entry to an exclusion zone fail to meet the qualifications for that zone, all work activities within the exclusion zone shall halt while the visitor is within the controlled zone.

4.0 EMERGENCY RESPONSE

Site personnel must be prepared in the event of an emergency. Emergencies can take many forms including: illnesses, injuries, chemical exposure, fires, spills, leaks, releases of harmful contaminants, or sudden changes in the weather. Walden employees shall not participate in any emergency response where there are potential safety or health hazards (i.e., fire, explosion or chemical exposure); their actions will thus be limited to evacuation. Predetermined safe areas shall be determined and relayed by the SSO to all on-site personnel at the start of each shift and will be based on prevailing wind direction. Evacuation routes established by work area locations will be highlighted on a Site map and periodically reviewed. As the work areas change, the evacuation route and map will be altered accordingly, and the new route will be reviewed.

Emergency telephone numbers and a map to the nearest hospital shall be on-hand at the Facility. The hospital with an emergency room closest to the Facility is St. Luke's Cornwall Hospital at 70 Dubois Street, Newburgh, New York 12550. A map of the route to St. Luke's Cornwall Hospital is provided herein as **Attachment B**. Personnel shall be familiar with the emergency procedures, and the locations of safety, first aid and communication equipment.

4.1 Emergency Facilities and Telephone Numbers

COMPANY	NAME	PHONE #
Walden Project Manager(s)	Joseph M. Heaney III, P.E.	516-624-7200 (Office)
	Nora Brew, P.E.	516-732-5378 (Mobile)
	Ted Nitza, P.E.	260-416-6188 (Mobile)
Walden Site Safety Officer(s)	Kerri Wright	845-207-3043 (Mobile)
	Erica Johnston	631-521-1266 (Mobile)
	Louis Goldstein	845-406-8242 (Mobile)
iPark	Mike Buckley	203-430-9211 (Mobile)
Emergency Response	Police/Fire/Medical	911
St. Luke's Cornwall Hospital		845-568-2305
NYSDEC Spill Hotline		518-457-7362
American Association of Poison Control Centers		800-222-1222

First Aid Kit Locations: Within work vehicles on-site; Walden office on Facility grounds.

Fire Extinguishers: Walden office on Facility grounds and various locations throughout the Facility; the fire extinguisher location nearest to the work area will be identified before work commences.

4.2 Response Procedures

A communication network shall be established prior to commencement of any on-site tasks. At least one (1) on-site person shall have a phone accessible and in good working order at all times. Hand signals shall be used in instances when verbal communication is not feasible. The Project Manager, followed by the SSO, will immediately coordinate any and all emergency situations with the proper local medical/emergency organizations and personnel at the Facility. In the event of a fire, use of fire-fighting equipment available on-site may be administered, if appropriate; removing or isolating flammable or other hazardous materials that may contribute to the fire will be performed. The personnel on-site will coordinate evacuation procedures (if necessary) and remain a safe distance away from the area of health and safety concern. Personnel on-site may need to perform basic first aid as warranted by the emergency situation. Personnel with suspected neck or back injuries must not be moved. A detailed written report of the emergency situation will be provided within 24 hours to Walden by the Project Manager or SSO. Site security and control will be enforced by the SSO with consent for undertaken measures from the Project Manager. The SSO is responsible for pre-emergency planning, as well as emergency recognition and prevention.

4.3 First Aid Kit and Medical Emergencies

A basic first aid kit will be maintained and readily available (never locked up) at the Facility and within easy access to work areas (in personnel vehicles on-site). At a minimum, the first aid kit will include the following as per ANSI Z308.1-1978: aspirin, bandage compresses, adhesive/triangular bandages (to keep wounds clean), medical tape, gauze, scissors, tweezers, sterilization lotion/cream, eye dressing, and antibacterial lotion/soap or pads. Items are to be replaced as they are used. Sterile items must be wrapped, sealed and used only once. Reusable items, such as scissors and tape, shall be kept clean. Should plentiful amounts of clean water not be available, eye flush shall be utilized. The number of first aid kits on-site shall be:

Number of Persons Assigned to the Facility	Minimum First Aid Supplies
1-5	10 Package Kit
6-15	16 Package Kit
16-30+	24 Package Kit

Professional medical assistance is to be called in the event of a medical emergency. In the event of a medical emergency:

- Stay calm and seek help, do not delay in calling for more assistance;
- Do not provide medical assistance unless you are trained to do so;
- Do not move the injured party unnecessarily;
- Do not attempt to remove any object that may have impaled the victim;
- Check to ensure the victim has an open airway, is breathing and has a heartbeat (if not, immediate action is required prior to taking care of any additional injuries);
- Promptly control any bleeding;
- Treat the injured party gently and keep them calm and quiet, reassuring them that additional help is on the way;
- Do not administer any food or drink and never provide the injured party with alcohol;
- Gather as much information as you can about the accident/injury and the victim's condition and be prepared to report that to first responders, as well as any medical actions already taken; and
- Let emergency responders do their job and aid them in keeping others out of their way.

4.3.1 Burns

For minor burns (redness or blisters over a small area), flush the wound with cold water and apply a sterile dressing; do not use butter or similar substance on any burn and do not break open blisters.

For major burns (white or charred skin; redness or blisters over a large area; burns on face, hands or genital area), cover the wound with sterile dressing and seek immediate emergency medical attention.

In the event of a chemical burn (spilled liquid or dry chemical on skin), promptly seek medical attention. For a liquid chemical burn, flush the wound with large amounts of water immediately and keep the water at a gentle flow. For dry chemical burns, brush off as much as possible before flushing with water. In both instances, flush the wound for at least five (5) minutes before covering with sterile dressing. Never use anything but water on a burned area and do not break open blisters.

4.3.2 Eye Wounds

Should an individual find/feel they have a foreign object in their eye, do not rub the eye; have them pull their upper eyelid over their lower eyelid or run plain water over the eye. If the object persists, cover both eyes with a gauze dressing and aid them in seeking immediate emergency medical attention.

If the eye is wounded (eyelid or eyeball; pain; history of blow to eye area; discoloration), seek immediate emergency medical attention and apply loose sterile dressing over both eyes. For bruising, a cold compress or ice pack should be used to relieve pain and reduce swelling. Do not try to remove any imbedded object or apply any pressure to an injured eye.

If the eye has sustained a chemical burn, seek immediate emergency medical attention. Flush the open eye (it may be necessary to hold the patient's eyelid open) immediately with water for at least ten (10) minutes, twenty (20) minutes if the substance was alkali. Cover both eyes with sterile dressing. Never put anything but water in the eye.

4.4 Fire: Hazards, Prevention, Protection and Extinguishers

Many potential ignition hazards may exist on-site, including internal combustion engines, combustible materials and smoking. Combustible materials shall be kept well away from the exhaust of any internal combustion engine powered equipment. Smoking is prohibited except in designated areas, as determined by the SSO. Operations which constitute a fire hazard shall be identified as such, with signs conspicuously posted, stating: "No Smoking or Open Flame". Flammable gases and liquids shall be stored and handled in approved containers, places and as per the requirements described on the applicable Safety Data Sheet (SDS).

All employees who will use a fire extinguisher shall be trained on the use and hazards involved with firefighting initially and annually thereafter. All fire extinguishers shall be visually inspected monthly for general condition and adequate charge and serviced, tested, and certified by qualified personnel at least annually. Fire extinguisher inspection and maintenance are the responsibility of the Facility owner. Records of the annual maintenance check must be maintained. Only those employees designated as capable of using fire extinguishers shall be allowed to do so. Extinguishers shall be located and identified for easy accessibility.

It is imperative to use the proper extinguisher for a fire, as using the wrong one can spread the fire. Portable extinguishers shall be suitable for ABC class fires. The following table provides further information on types of fire extinguishers and their use:

Class	Distribution	Notes
A ("A" on a green triangle)	75’ or less travel distance between the employee and the extinguisher	Use on wood, paper, trash
B ("B" on a red square)	50’ or less travel distance between hazard area and the employee	Use on flammable liquid, gas
C ("C" on a blue circle)	Based on the appropriate pattern for the existing Class A or Class B hazards	Use on electrical fires
D ("D" on a yellow star)	75’ or less travel distance between the combustible metal working area and the extinguisher or other containers of Class D extinguishing agent	Use on combustible metals

4.4.1 Fire Prevention

The best method of protection against fire is prevention. The following rules are to be adhered to in an effort to prevent fire:

- Smoking is prohibited except in designated areas, as determined by the SSO. All smoking materials are to be totally extinguished and placed in appropriate receptacles;
- SDS’s shall be referred and adhered to prior to the moving, handling and storage of any chemical product;
- In order to prevent accidental ignition of combustible materials, heat producing equipment is to be properly maintained and operated as per the manufacturer’s instructions;
- All chemicals and combustibles must be stored in approved containers;
- Materials that severely react or combust when mixed must not be stored near each other;
- Chemical spills must immediately be cleaned, particularly in the case of spilled combustible or reactive materials. Damaged containers and cleaning materials must be properly disposed;
- Combustible materials and refuse must be segregated and kept from sources of ignition;
- All employees shall be made aware of the locations of fire extinguishers and hydrants and access to those resources shall be kept clear;
- The SSO shall notify all employees of any unusual fire hazard condition; and
- Good housekeeping practices are to be followed.

4.4.2 Fire Protection

All personnel shall be notified if a fire occurs; the local fire department shall also be notified. When notifying the local fire department: remain calm and speak clearly and slowly; give the exact location of the fire and describe the situation; give a phone number for the location you are calling from; and, do not hang up until you are told to do so.

4.5 Evacuation Procedures

In the event of an emergency which necessitates evacuation of the work area, personnel will notify other personnel verbally or otherwise. All personnel will immediately evacuate the work area, keeping upwind of smoke, vapors or spill location, to a predetermined safe area, without regard for equipment. The predetermined safe area will be specified to all personnel by the SSO prior to the start of field work. Personnel will not re-enter the area until all health and safety issues return to a satisfactory level. The SSO is responsible for selecting the most effective evacuation route, as well as designating safe distances and places of refuge. The SSO shall conduct a roll call to ensure that all personnel have been evacuated safely.

Evacuation procedures in case of personal injury of personnel will be conducted as follows:

- Another team member (buddy) should signal the SSO that the injury has occurred;
- A field team member trained in first aid can administer treatment to an injured worker;
- The victim should then be transported to the nearest emergency room (see **Attachment B**). If necessary, an ambulance should be called to transport the victim; and
- The SSO is responsible for making certain that an Accident Report Form is completed. This form is to be submitted to the Project Manager. Follow-up action should be taken to correct the situation that caused the accident.

If a member of the field crew demonstrates symptoms of chemical exposure, the procedures outlined below shall be followed:

- Another team member (buddy) is to remove the individual from the immediate area of contamination if it is safe for them to do so. The buddy shall communicate to the SSO (via voice/hand signals) about the chemical exposure. The SSO will then contact the appropriate emergency response agency;
- Precautions must be taken to avoid exposure of other individuals to the chemical;
- If the chemical is on the individual's clothing, the chemical shall be neutralized or removed if it is safe to do so;

- If the chemical has contacted the skin, the skin shall be washed with copious amounts of water; and
- In case of eye contact, an emergency eye wash is to be used. Eyes should be washed for at least fifteen (15) minutes.

All chemical exposure incidents must be reported in writing to the Project Manager. The SSO is responsible for completing the accident report.

4.6 Spill Containment

In an effort to prevent spills, all hazardous material will be stored in appropriate containers and the tops/lids will be placed back on the containers after use. Hazardous materials brought on-site shall come with the appropriate SDS (the SDS sheets for chemicals that are most likely to be encountered on-site are attached to this HASP in **Attachment C**), will be stored appropriately, with labels, and away from moving equipment. Containers will be lifted/moved utilizing equipment appropriate for the task and secured and handled in a manner which minimizes spillage and reduces the risk of personal injury. At least one (1) spill response kit shall be available at the Facility.

All environmental spills or releases of hazardous materials are to be immediately reported to the SSO and dealt with according to the chemical manufacturers recommended procedures, which can be found on the SDS. The SDS for chemicals/contaminants identified during historic site investigations and known to be associated with the Facility are provided in **Attachment C; an SDS for TMAH is also included.** If any materials brought on-site during the work come with an SDS, that SDS will be added to **Attachment C**.

4.7 Incident Reporting

If an accident, fire, or release of toxic materials occurs during the course of work, the Project Manager shall be telephoned immediately and receive written notification within 24 hours. That notification shall include the following information:

- Name, organization, telephone number, and location of the Contractor;
- Name and title of the person(s) reporting;
- Date and time of the accident/incident;
- Location of the accident/incident (i.e. site location, facility name);
- Brief summary of the accident/incident giving pertinent details including type of operation ongoing at the time of the accident/incident;
- Cause of the accident/incident, if known;

- Casualties (fatalities, disabling injuries);
- Details of any existing chemical hazard or contamination;
- Estimated property damage and effect on contract schedule;
- Action taken by Contractor to ensure safety and security; and
- Other damage or injuries sustained, public, or private.

If any employee of a subcontractor is injured, documentation of the incident will be recorded in accordance with the subcontractor's procedures; however, copies of all documentation (which at a minimum must include the OSHA Form 301 or equivalent) must be provided to the SSO within 24 hours after the accident has occurred. All accidents/incidents will be investigated. Copies of all subcontractor accident investigations will be provided to the SSO within five (5) days of the accident/incident.

5.0 GENERAL HEALTH AND SAFETY REQUIREMENTS

All personnel shall conduct themselves in a safe manner and maintain a working environment that is free of additional hazards.

5.1 Qualifications and Training

All personnel performing work at the Facility must be qualified for their assigned project task, as determined by the Project Manager. They must meet the training and medical monitoring requirements necessary for the task and as described herein. If possible, exposure above an OSHA permissible exposure limit (PEL) has or is expected to occur, employees must be required to receive supplemental medical testing to document any symptoms that may be specific to the particular materials present.

Training programs instruct employees on the intent of the OSHA standards, health and safety principles and procedures, proper operation of monitoring instruments, use of personal protective equipment, decontamination, and specific emergency plans. All personnel are required to remain current in all of their required training and evaluate their need for additional training when there is a change in work. In addition to the general health and safety training programs, personnel will be required to complete any supplemental task specific training (e.g. OSHA 40 Hour HAZWOPER training) developed for the tasks to be performed. Administration and compliance with the requirements for additional task-specific training will be the responsibility of the Project Manager. Any additional required training that is completed will be documented and tracked in the project files. Additional training will be provided to any employees responsible for responding to emergencies.

A copy of this HASP will also be made available to all personnel for review. All employees on-site will sign the Record of HASP Acknowledgement form (refer to Section 9.0) to verify they have reviewed this Plan. Any subcontractors involved in implementing the work plan will be required to acknowledge that their employees have received adequate training.

All on-site personnel involved with the project will attend a pre-entry briefing on the contents of this HASP, including chemical and physical hazards associated with the Facility. The initial health and safety briefing will consist of the following information:

- Names of personnel and alternates responsible for worker safety and health;
- Injury, illness, and other potential project hazards;
- Safe use of engineering controls and equipment on-site;
- Work practices by which the employee can minimize risks from hazards;

- Selection, use, care, and maintenance of PPE; and
- Standard operation safety procedures.

Documentation of all training, testing and medical monitoring certificates (if applicable) will be maintained by Walden.

5.1.1 Hazardous Communication Training (29 CFR 1910.1200)

Hazardous materials that may be encountered as existing on-site environmental or physical/health contaminants during the work activities are addressed in this HASP and their properties, hazards and associated required controls will be communicated to all affected employees and subcontractors, as per OSHA's Hazard Communication Standard. All personnel shall be briefed on the hazards of any chemical product they use and shall be aware of and have access to all SDS; these employees must be 40 Hour HAZWOPER trained.

All containers on-site shall be properly labeled in compliance with the Globally Harmonized System to indicate their contents. Labeling on any containers not intended for single day, individual use shall contain additional information indicating potential health and safety hazards (flammability, reactivity, etc.). SDS for chemicals/contaminants known to be associated with the Facility are provided in **Attachment C**. If any materials brought on-site during the work come with an SDS, that SDS will be added to **Attachment C**.

5.1.2 Visitor Training

All visitors to work areas will be informed of the hazards and necessary personal protective equipment associated with those areas, should they require entry to controlled work areas. Visitors shall also be briefed on emergency procedures.

5.2 General Safety

The SSO shall inspect work areas prior to commencement of daily activities. The SSO will take all corrective measures necessary to perform safe work at the Facility. All inspections and corrective measures will be documented and communicated to Site workers at the initial safety meeting and subsequent safety meetings.

Employees will practice contamination avoidance to include not walking through puddles or mud unnecessarily, avoiding kneeling on the ground or leaning on equipment whenever possible, or setting equipment on the ground while outside. Weather conditions that may escalate potential hazards, such as lightning, rain or extreme temperatures, will be recorded in the project files.

Employees will use extreme caution in inclined areas. Ground surfaces may be wet and slippery and may have hazardous objects protruding from the surface.

Dependent on the season in which the work will be performed, employees should exercise caution when encountering animals (e.g. snakes, spiders, bees, wasps, ticks, mosquitoes, ants, etc.) at the Facility. Employees who are known to be highly sensitive to insect stings should carry a “sting kit” and notify the SSO. All employees are encouraged to use permethrin (0.5%) clothing repellent and DEET (30%) skin repellent for protection against ticks and mosquitoes.

Hearing protection devices will be available to be worn by all field personnel in work areas where noise levels are at or above 85 decibels (dBA). The use of hearing protection devices when the noise levels exceed 85 dBA on an 8-hour average is a condition of employment.

5.2.1 Tailgate Safety Meetings

The SSO will conduct an informational safety meeting at the start of each workday to ensure that all on-site personnel (those entering the exclusion, contaminant reduction and support zones) understand changing conditions and daily operating procedures, and to address safety questions and concerns; these topics shall typically require ten (10) minutes to discuss and shall be recorded in the field notebook. Additional meetings may be conducted, as required. Attendance is mandatory and an attendance record shall be kept by the SSO. Any person who observes safety concerns or potential hazards that have not been addressed in the daily safety meeting should immediately report observations/concerns to the SSO. Meetings will include pertinent information regarding the day’s work and include, but will not be limited to, the following:

- The whereabouts of any hazardous chemicals near specific work areas;
- Methods used to detect the presence or release of hazardous chemicals;
- The physical and chemical health hazards of the Facility;
- Protective measures such as safe work practices, emergency procedures, and PPE;
- Details regarding the proper use of protective measures and SDS’s;
- Target activities for the day’s work;
- Changes in observed exposure levels; and
- Staff changes (e.g., due to vacations, reassignments, etc.) and responsibilities.

5.2.2 Housekeeping

During project activities, work areas will be continuously policed for identification of excess trash and unnecessary debris. Excess trash and debris will be collected and stored in an appropriate container (e.g., plastic trash bags, garbage can, roll-off bin) prior to disposal. All electrical equipment must be grounded.

5.2.3 Hazardous, Solid or Municipal Waste

If hazardous, solid, and/or municipal wastes are generated, the waste shall be accumulated, labeled, and disposed of in accordance with all applicable Federal, State and/or local regulations. If equipment or materials that will be used (i.e., calibration gases, lithium batteries, etc.) need to be shipped but fall under criteria that define them as hazardous materials under Department of Transportation (DOT) regulations 49 Code of Federal Regulations (CFR) Parts 171-177, then they must be shipped in accordance with those regulations by an individual who is certified as having been "function-specific" trained, as required under the DOT regulations.

5.2.4 Smoking, Eating and Drinking

Eating, drinking, or smoking is permitted only in designated areas in the support zone. An exception is made for the replacement of fluids as a preventive measure for heat stress. Workers will first wash hands and face immediately after leaving controlled work areas (and always prior to eating or drinking).

5.2.5 Personal Hygiene

The following personal hygiene requirements will be observed:

- No contact lenses shall be worn in the exclusion zone without the use of additional eye protection;
- If work is to be performed outdoors on a building perimeter, protective clothing that is loose fitting and covers arms and legs to protect against sunlight during times of high levels of ultraviolet exposure (May through September) shall be worn; hats, sunscreen that provides UVA and UVB protection and sunglasses shall also be donned, as appropriate;
- A water supply meeting the following requirements will be utilized:
    - *Potable Water* - An adequate supply of potable water will be available for personnel consumption. Potable water can be provided in the form of water bottles, canteens, water coolers, or drinking fountains. Where drinking fountains are not available, individual-use cups will be provided as well as adequate disposal containers. Potable water containers will be properly identified in order to distinguish them from non-potable water sources; and
    - *Non-Potable Water* - Non-potable water may be used for job tasks and cleaning activities only. Non-potable water will not be used for drinking purposes or for

hand washing. All containers of non-potable water will be marked with a label stating: "***Non-Potable Water - Not Intended for Drinking Water Consumption***".

- Access to nearby toilet facilities shall be maintained; and
- Employees will be provided washing facilities (e.g., buckets with water and soap). The use of water and hand soap (or similar substance) will be required by all employees following exit from the exclusion zone, prior to breaks, and at the end of daily work activities.

5.2.6 Stop Work Authority

All employees have the right and duty to stop work when conditions are unsafe and to assist in correcting these conditions. Whenever the SSO determines that workplace conditions present an uncontrolled risk of injury or illness to employees, immediate resolution shall be sought. Stop work shall be immediately binding on all affected employees and subcontractors. Upon issuing the stop work order, the SSO shall implement corrective actions so that operations may be safely resumed. Resumption of safe operations is the primary objective; however, operations shall not resume until the SSO and Project Manager concur that workplace conditions meet acceptable safety standards.

5.2.7 Severe Weather

Severe weather can occur with little warning. Employees will be vigilant for the potentials for storms, lightning, high winds, and flash flood events. The SSO will be attentive to daily weather forecasts for the project area each morning. For activities occurring outdoors, the following conditions will be observed:

- Condition #1 – Storm threat within 24 hours: stow non-essential gear indoors and maintain a six (6) hour weather watch; and
- Condition #2 – Storm threat within 12 hours: securely lash down all moveable gear, drums, pipes, tools, etc. and maintain a three (3) hour weather watch.

5.3 Communication Procedures

Personnel will be informed of all known Facility hazards during an initial safety meeting and will be kept informed of hazards discovered during work activities.

- Personnel within the exclusion zone will remain in constant communication or within sight of other personnel. Failure of communication requires evacuation of the exclusion zone until communication is reestablished;

- The emergency signal will be one of the following:
    - Any blast from a pressurized air horn or vehicle horn; and
    - Verbal notification.
- The following standard hand signals will be used:
    - Hand gripping throat -- Out of air and cannot breathe;
    - Grip buddy’s wrist -- Leave area immediately;
    - Both hands on buddy’s waist -- Leave area immediately;
    - Hands on top of head -- Need assistance;
    - Thumb down -- No/negative; and
    - Thumb up -- Yes/I am OK/I am alright.

5.4 Hazard Communication

SDSs, along with a list of those materials covered by the SDSs, will be available to all personnel (including subcontractors) for all hazardous substances brought on-site. SDS for chemicals/ contaminants known to be associated with the Facility are provided in **Attachment C**. SDS’s for materials later brought on-site shall come with an SDS, which is to be included in **Attachment C**. Any employee or subcontractor intending to bring a hazardous material onto the job-site must first provide a copy of the SDS to the SSO for review and filing. Should an SDS be necessary but not available for the material in question, the material may not be brought onto the Facility.

All containers on-site shall be properly labeled to indicate their contents. Labeling on any containers not intended for single-day, individual use shall contain additional information indicating potential health and safety hazards (flammability, reactivity, etc.). Prior to starting work, personnel, including any subcontractors, will be briefed by the SSO regarding hazardous chemicals and their properties, hazards and associated required controls present at the work-site that personnel could use or be exposed to.

5.5 Medical Monitoring

OSHA has established requirements for a medical surveillance program designed to monitor and reduce health risks for employees who may potentially be exposed to hazardous materials. The medical surveillance program has been designed to provide baseline medical data for each employee involved in hazardous material operations. Each employee must undergo testing and training, and a determination of his/her ability to wear PPE and carry out certain tasks. Medical examinations must be administered during pre-employment, on an annual basis, upon employment termination, and as warranted for potential chemical exposure. These examinations shall be provided by employers without cost or loss of pay to the employee. In accordance with 29 CFR 1910.1020, medical surveillance records should be maintained for thirty (30) years past employment and shall be available to the employee, owner, or regulatory agencies, as required.

Due to potential exposure to hazardous materials, all contractors, employees, subcontractors and other prime contractors involved in Facility activities within the exclusion zone will be informed about the medical monitoring program meeting specifications of 29 CFR Part 1926.1153. Each contractor shall assume the responsibility of maintaining a medical surveillance program (if needed) as well as maintaining personnel medical records, as regulated by 29 CFR 1910.1020, for all personnel, including subcontractors, who will be on-site. Subcontractors working on the job must provide the SSO with documentation on their medical monitoring programs.

5.6 Logs, Reports and Record Keeping

Walden shall keep a permanently bound logbook containing as a minimum the following information:

- Agency property number, facility name, address, location and project duration;
- Contractor name, address, phone number;
- A list of Contractor personnel assigned to the project; and
- A day-to-day record of personnel entering the work area, short description of the day's work, and a record of any significant or unusual events occurring during the course of work, including but not limited to inspections, observations, unusual incidents, (e.g. damage, unexpected visitors, etc.). The project narrative is to be kept by the Project Manager.

The SSO and Project Manager will ensure that all records are kept up to date and maintained in accordance with applicable regulations. The following items will be recorded in the daily field log in waterproof, permanent ink:

- Daily list of field personnel;
- Record of all visitors;
- Training logs;
- Levels of PPE worn by workers and, as appropriate, visitors;
- Exposure work-hours and a log of occupational injuries and illnesses;
- Accident investigations;
- Daily record of all first aid treatments not otherwise reportable; and
- Daily health and safety inspection report.

6.0 HAZARD ASSESSMENT

This section identifies the general and activity-specific hazards associated with Facility operations and what should be implemented to reduce the hazards; identifies general physical hazards that can be expected; and presents a summary of documented or potential chemical hazards that may be encountered during the work, as well as biological hazards. Every effort must be made to reduce or eliminate these hazards. Those which cannot be eliminated must be guarded against by using engineering controls and/or personal protective equipment.

6.1 Physical Hazards

The following physical hazards may be associated with the project at hand:

6.1.1 Site Mobilization/Demobilization

Mobilization and demobilization activities may cause health injuries during traffic accidents. Manual materials handling and manual site preparation may cause blisters, sore muscles and joints, and skeletal injuries. It may also present the potential for eye hazards, contusions and lacerations. Slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, slips and falls.

Underground utilities must be identified before commencing any subsurface work.

6.1.2 General Work Activities

Tasks required for this project may involve exposure to slipping/tripping/falling, manual lifting, noise, heat/cold stress, electrical, hand and power tools, operation of motorized vehicles, and other physical hazards associated with activities including soil and groundwater investigation, construction, building renovations, etc. All work at this Facility will be conducted during daylight hours, or with adequate lighting provided for indoor work.

Slipping/Falling: Slips, trips and falls are the most common workplace incidents and can result in serious injuries, even death. General housekeeping of the Site, PPE, attention to your surroundings, minimizing distractions and warding off fatigue can all help to minimize risk of slips, trips and falls. Work areas shall be kept free of any materials, obstructions and substances that could cause a hazardous situation. Workers shall ensure clear footing and avoid obstructions, holes, protruding objects or other tripping hazards and look out for uneven, unstable and slippery terrain. Designated routes shall be taken, not shortcuts, and makeshift substitutes of equipment must not be used. Workers are prohibited from horse-play and shall ensure a clear path prior to carrying/moving equipment.

Manual Lifting: Lifting/carrying of equipment and materials may cause strains, particularly back injuries, fatigue and over-exertion. Proper lifting techniques should be exercised; bend at the knees, let your legs do the lifting, do not twist while lifting, bring the load as close to you as possible prior to lifting, be sure there is a clear walking path, use mechanical devices for heavier objects, team lift.

Noise: The operation of certain equipment (e.g., generator, nearby construction work, etc.) may result in momentary high noise levels which could result in temporary to permanent hearing loss and interference in communication. Hearing protection (e.g. ear plugs, ear muffs) will be used as necessary; as a rule of thumb, if it becomes necessary to shout at someone three (3) feet away, hearing protection should be worn.

Eye Protection: All Facility-related operations involving possible eye injury (chemical splash, etc.), must have approved eye wash units readily available. Protective eyewear shall be donned in Level D, when directed by the SSO.

Heat Stress: Monitoring of personnel wearing personal protective clothing should commence when the ambient temperature is 72°F or above. Monitoring frequency should increase as ambient temperature increases or as slow recovery rates are observed. Heat stress monitoring should be performed by the SSO, who shall be able to recognize symptoms of heat stress; refer to **Attachment D**.

Proper training and preventive measures will aid in averting loss of worker productivity and serious illness. Heat stress prevention is particularly important because once a person suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat-related illness. To avoid heat stress, the following steps should be taken:

- Adjust work schedules;
- Mandate work slowdowns as needed;
- Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided;
- Provide shelter (air conditioned, if possible) or shaded areas to protect personnel during rest periods; and
- Maintain workers' body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e. eight (8) fluid ounces (0.23 liters) of water must be ingested for approximately every eight (8) ounces (0.23 kg) of weight lost. When heavy

sweating occurs, encourage workers to drink more. The following strategies may be useful:

- Maintain water temperature between 50° and 60°F (10° to 16.6°C);
- Provide small disposal cups that hold about four ounces (0.1 liter);
- Have workers drink sixteen (16) ounces (0.5 liter) of fluid (preferably water or dilute drinks) before beginning work;
- Urge workers to drink one (1) or two (2) cups every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight; and
- Train workers to recognize the symptoms of heat-related illness.

Should an employee display signs of heat exhaustion (fatigue, weakness, profuse sweating, normal temperature, pale clammy skin, headache, cramps, vomiting, fainting), they are to be immediately removed from the hot area and lay down with their feet raised. Their clothing should be loosened or removed and cool, wet clothes applied. If the victim is not vomiting, they should be encouraged to take small sips of water.

Should an employee display signs of heat stroke (dizziness, nausea, severe headache, hot and dry skin, confusion, collapse, delirium, coma and death), seek immediate emergency medical attention. Remove the victim from the hot area and remove clothing, lay them down and cool their body (shower, cool wet clothes); do not give stimulants to the victim. Refer to **Attachment D** for further instruction.

Cold Stress: Cold stress is a result of cold, wetness, and wind. A worker's susceptibility to cold stress can vary according to their physical fitness, degree of acclimatization to cold weather, age, and diet. If work on this project occurs during winter months, thermal injury due to cold exposure can become a problem for on-site personnel. A cold-stress monitoring program shall be implemented, as appropriate. Workers should be aware of the local cold exposure hazard (frostbite) and the overall cold exposure hazard (hypothermia). Refer to **Attachment E** for further information on Cold Stress.

To prevent cold-related illness:

- Educate workers to recognize the symptoms of frostbite and hypothermia;
- Identify and limit known risk factors;
- Assure the availability of enclosed, heated environments on or adjacent to the Site;
- Assure the availability of dry changes of clothing;
- Assure the availability of warm drinks; and

- Start oral temperature recording at the Site:
    - At the SSO or Project Manager's discretion when changes in a worker's performance or mental status are suspected;
    - At a worker's request;
    - As a screening measure, two (2) times per shift, under unusually hazardous conditions (e.g. wind chill less than 20°F or wind chill less than 30°F with precipitation); and
    - As a screening measure whenever any worker at the Facility develops hypothermia.

Electrical: Hazards associated with electricity include shock, electrocution, burns, fires and explosions, as well as trip and fall hazards from power cords, and including electrical hazards and exposure to carbon monoxide from the use of portable generators. No work is to be performed on electrical equipment or near any part of an electrical circuit unless the worker is protected against shock by guarding or de-energizing and grounding the circuit. Ground Fault Circuit Interrupters (GFCIs) are required for portable tools. Extension cords shall be rated for hard or extra hard use and must be capable of grounding. All cords shall be inspected prior to use for wear and exposed wiring, strain, rips, tears, cuts or burns; defective cords shall be taken out of commission. Generators shall be fueled only after being shut down and allowed to cool, in addition, portable generators shall not be utilized indoors; the exhaust is to pointed downwind from workers.

Hand and Power Tools: The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, sparks, fire, abrasions, contusions and electrocution, or being exposed to harmful dusts, fumes, mists, vapors or gases. Ground Fault Circuit Interrupters are required for portable tools. Workers shall confirm that all tools are in proper operating condition and that they are used in accordance with applicable manufacturers' recommendations. All appropriate PPE must be provided and utilized throughout the duration of applicable tasks.

Operation of Motorized Vehicles: Moving vehicles can be a danger whether one is within or outside of a vehicle. Distracted drivers, drivers under the influence of drugs/alcohol, tired drivers can all lead to injury, damage or death. Only authorized workers may operate motorized vehicles. Site conditions may include off-road surfaces and operation should be performed according to ground conditions. Authorized drivers must comply with all applicable state laws while operating the vehicle and possess the appropriate qualifications. Loads shall be secured and within the appropriate weight limit for the vehicle (including the number of passengers). Vehicles shall be inspected prior to use and taken out of commission if deemed unsafe. The vehicles shall be properly maintained. Operators are not to be distracted, should wear seatbelts anytime a vehicle is in motion and headlights shall be used during operation. Operation by an employee who has recently partaken in consumption of alcoholic beverages and/or illegal drugs is prohibited.

6.2 Chemical Hazards

Previously identified chemicals used at various locations throughout the Facility, thus potentially contained in soil and groundwater, include:

Chemical	**OSHA Permissible Exposure Limit (PEL), 8-Hour Time-Weighted Average (TWA)**	**OSHA Short-term Exposure Limit (STEL)**
Tetrachloroethylene	25 ppm*	100 ppm
Trichloroethylene	25 ppm	100 ppm
1,2-Dichloroethene	200 ppm	n/a
Vinyl Chloride	1 ppm	n/a
Freon-113	500 ppm	n/a

*ppm = parts per million

In addition, the following site-related chemicals may be encountered during the SWMU removal work. General information on these chemicals is included in Attachment C:

- Tetramethylammonium hydroxide (TMAH)
- Hydrogen Chloride
- Sodium Hydroxide
- Sulfuric Acid
- Hydrofluoric Acid
- Nitric Acid
- Methanol
- Ethylene Glycol
- Acetic Acid
- Acetone
- Isopropanol
- 1,2-Propanediol
- Butyl Acetate
- Ethanol
- Potassium Hydroxide
- General Solvent Wastewater

The major route of exposure to these contaminants will be respiratory in nature, however dermal exposure is also possible. Inhalation of vapors and contaminated dusts would provide the mechanism for respiratory exposure. Skin contact with soils and groundwater would result in dermal exposure. Facility-related work will use engineering controls, work practices, air monitoring and personnel protective equipment to reduce the amount of potential exposure. The tasks to be performed covered under this HASP present a low health risk for inhalation and dermal exposure given the anticipated potential to encounter contaminated material. Restricting access to controlled work areas, staying upwind of potential sources, adhering to personal hygiene practices and wearing proper safety equipment will reduce risk of injuries.

During construction, excavation, sampling and soil management activities, air monitoring shall be performed with a PID and/or multi-gas meter to determine if workers are at risk for chemical exposure. Air monitoring equipment shall be calibrated daily and noted in a log book. Air monitoring shall be performed by trained Walden individuals, only. If concentrations exceed the TWA values listed in the table above, the SSO shall immediately instruct the workers to stop work. Once everyone is removed from the work area, the SSO shall consider the following measures, listed in order from most desirable to least desirable:

- Installation of engineering controls (e.g. ventilation, containment of source);
- Administrative controls; and
- Donning of PPE; upgrading PPE.

The SSO shall decide which of the above options are feasible and make a rational decision based on available resources. Workers shall not be allowed back into the work zone until the chemical hazard is properly mitigated, with no exceptions. Refer to Section 7.2 below for further information.

6.3 Biological Hazards

Potential biological hazards include illnesses and/or injuries transmitted by animals, insects, and pathogenic agents.

6.3.1 Animals

During operations at the Facility, animals such as dogs, pigeons, sea gulls, mice, and rats may be encountered. Contact with such animals can cause rabies (dog's or squirrel's bite); Hantavirus (rat and mice droppings); psittacosis, crytococcosis, and histoplasmosis (dried bird droppings). Workers will use discretion and avoid all contact with animals.

6.3.2 Insects

Bees, wasps, hornets, mosquitoes, ticks and spiders may be present at the Facility. Some individuals may have severe allergic reactions to an insect bite or sting that can result in a life-threatening condition. In addition, mosquito bites may lead to St. Louis encephalitis or West Nile encephalitis. Personnel that have been bitten or stung by an insect during work at the Facility should notify the SSO or Project Manager of such an incident immediately. Workers will wear protective clothing and footwear, apply insect repellent prior to work, and avoid contact while outside with bushes, tall grass, or brush to the extent possible. Field personnel who may have insect allergies should provide this information to the SSO or Project Manager in advance and will have allergy medication on-hand.

6.3.3 Blood-borne Pathogens

Blood-borne pathogens (BBPs) include diseases that can be transmitted by contact with blood or other bodily fluids as well as contaminated items which may be encountered (e.g., used syringes, medical pads, etc.). Universal precautions shall be used when administering first aid. Good hygiene practices and proper decontamination of non-disposable PPE will minimize potential for transmission of BBPs.

7.0 EXPOSURE MONITORING

The following is a discussion of the hazards presented to worker personnel during work at this Facility from on-site physical and chemical hazards known, suspected or anticipated to be present on-site at the time this HASP was prepared.

7.1 Noise

Noise levels are measured in units of dBA, which matches the response of the human ear, and are measured on the A-scale of a standard sound level meter at slow response. Normal conversation produces a noise level of 60 dBA, while power tools often produce levels between 90-110 dBA. If two people standing an arm's length apart must raise their voices to talk, the noise level is over 85 dBA. Noise levels above 140 dBA cause pain immediately and produce hearing damage. Decibels are a logarithmic scale, meaning that 100 dBA is ten (10) times as loud as 90 dBA, 100 times as loud as 80 dBA, and 1,000 times as loud as 70 dBA.

Hearing protection (disposable or reusable type) will be utilized by any on-site personnel potentially exposed to either continuous or impact noise levels exceeding 90 dBA (slow response) for an 8-hour work shift. Should employees be exposed to such sound levels, all feasible administrative and engineering controls shall be utilized. If such controls fail to reduce sound levels within the specified sound levels provided in the table below, PPE shall be provided and used to reduce sound levels within the levels provided in the table. A sound is considered if the variations in noise level involve maxima intervals of one (1) second or less. Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

Permissible Noise Exposure Table

Duration Per Day (Hours)	Sound Level (dBA)
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110
0.25	115

7.1.1 Hearing Conservation Program

In all cases where the sound levels exceed the values shown in the table above, a continuing, effective hearing conservation program shall be administered. The program shall equip employees with the knowledge and hearing protection devices necessary to safeguard themselves from occupational hearing loss. The program shall consist of the following elements:

- Monitoring of employee noise exposures;
- The institution of engineering, work practice, and administrative controls for excessive noise;
- The provision of each overexposed employee with an individually fitted hearing protector with an adequate noise reduction rating;
- Employee training and education regarding noise hazards and protection measures;
- Baseline and annual audiometry;
- Procedures for preventing further occupational hearing loss by an employee whenever such an event has been identified; and
- Record keeping.

7.2 Chemical Contaminants

OSHA Permissible Exposure Limits (PEL) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) may be exceeded during soil and groundwater investigative activities or when contaminated media are exposed or disturbed during construction or other activities, including SWMU removal. Even though the anticipated risk of exposure to chemical contaminants is considered to be low for the activities covered under this HASP, these activities will be closely monitored and evaluated to determine potential for exceeding standards and the need to implement control measures to protect personnel and the environment.

7.2.1 Air Monitoring

Direct reading instruments will be used in active work areas in order to enable rapid field decisions regarding levels of respiratory protection, as well as indicate the need for increased monitoring frequency at the edge of the exclusion zone. Walden staff will conduct air monitoring during SWMU removal and all intrusive activities.

A MiniRAE or equivalent PID, which is calibrated daily and adjusted to give maximum sensitivity to the contaminants of concern will be used to monitor the air on a continuous basis while SWMU removal and intrusive activities are performed. Should the meter read 0.5 parts per million (ppm) or greater above background in the breathing zone for more than one (1) minute and the source of the reading is unknown, work will be stopped until PPE is upgraded; the same holds true if the meter reads greater than five (5) ppm above background levels in the breathing zone for more than thirty (30) continuous seconds.

PPE requirements and upgrade thresholds are summarized in the tables presented below.

Personal Protective Equipment Requirements Table

Location	Level of Protection/Tasks	Description
Support Zone	D	Steel toe boots and work clothes
Exclusion Zone and Contaminant Reduction Zone	To be determined by the site safety officer based on contamination present	
	D (modified)	Steel toe boots, nitrile or latex gloves, hard hat, safety glasses
	C	Full face respirator fitted with organic vapor cartridge and Level D PPE.
	B	Positive pressure, pressure demand self-contained breathing apparatus or positive pressure, pressure demand supplied air and Level C PPE.

Air Monitoring Action Levels Table

Instrument	Hazard Monitored	Instrument Reading	Action Required
PID	Organic Vapors	0.5 ppm or greater above background in the breathing zone for 1 minute and the source of the reading is unknown. 5 ppm or greater above background in the breathing zone for 30 continuous seconds	PPE will be upgraded to Level C. Stop work. Evaluate the source and upgrade Level C to Level B.
Combustible Gas Indicator	Explosive Vapors	>10% LEL	Explosion hazard! Withdraw from the area immediately until LEL <10%.
Oxygen Meter	Oxygen	<19.5% O_2	Stop work and withdraw from area until oxygen levels increase.

The following are examples of actions that can be implemented in addition to PPE upgrades to reduce the potential for contaminant release and exposure:

- Cover areas of exposed soils;
- Increase ventilation; and
- Install measures to contain areas of contaminant release.

7.3 Calibration

Any exposure monitoring instruments used will be calibrated at the beginning of each work shift, in accordance with the manufacturer's recommendations. If the owner's manual is not available, the personnel operating the equipment will contact the applicable office representative, rental agency or manufacturer for technical guidance for proper calibration. If equipment cannot be pre-calibrated to specifications, operations requiring monitoring for worker exposure will be postponed or temporarily ceased until this requirement is completed.

8.0 PERSONAL PROTECTIVE EQUIPMENT

The purpose of PPE is to provide a barrier, which will shield or isolate individuals from the chemical and/or physical hazards that may be encountered during work activities. The level of worker protection can be increased or reduced if determined by an employee exposure assessment. Until an employee exposure assessment is complete, the following procedures and PPE shall be made available:

- Head protection;
- Foot protection;
- Hand protection;
- Eye protection;
- Hearing protection; and
- Respiratory protection.

By signing this HASP (Section 9.0) the employee agrees to having been trained in the use, limitations, care and maintenance of the PPE to be used by the employee at this project. If training has not been provided, request same of the SSO for the proper training before signing.

8.1 Head Protection

Workers and individuals within work areas where overhead work is being performed must wear protective helmets. The protective helmets will reduce the potential for permanent injury to the head from falling and/or sharp edged objects. The head protection shall comply with the ANSI and the International Safety Equipment Association (ISEA) latest standard ANSI/ISEA Z89.1-2014, "Industrial Head Protection".

8.2 Foot Protection

All personnel and individuals in the work areas will wear steel-toed or equivalent protective footwear to help prevent foot injuries from falling or rolling objects, objects piercing the footwear sole, and/or exposure to electrical hazards. The footwear will be properly secured to the feet at all times. Protective footwear will comply with the American National Standard for Safety-Toe Footwear, Z41.1-1967.

8.3 Hand Protection

All workers entering the work areas will use hand protection to prevent injuries caused from exposure, abrasions, lacerations, and burns of any type. The performance characteristics of the hand protection will reflect the task(s) of the individual worker. If worn, protective disposable clothing will cover the hand protection as much as possible.

8.4 Eye Protection

All workers and individuals within the work areas will use appropriate eye protection to reduce the potential of damage caused by splashing, falling or flying objects/materials. The eye protection should fit securely on the face so the objects/materials will not enter from any side of the protection (goggles that seal to the face using an elastic headband are recommended). Eye protection will comply with ANSI/ISEA Z87.1-2015 Standards.

8.5 Hearing Protection

All workers and individuals within the work areas will use appropriate hearing protection if operations produce noise levels that exceed levels given in the permissible noise exposure table provided in Section 7.1. Exposure to impulsive or impact noise should not exceed 140 dBA peak sound pressure level. Hearing protection will be recommended if either continuous or impact noise levels exceed 90 dBA (slow response) for an 8-hour work shift. If unable to carry out conversation at an arm length or at three (3) feet distance, hearing protection such as ear plugs or muffs will be used. Hearing protection selected must control employee exposures to comply with OSHA permissible noise standards if noise levels exceed OSHA permissible noise levels. Where disposable earplugs are selected, sufficient supplies will be maintained on-site to allow for multiple changeovers per day, per worker. A non-“roll-down” type earplug, such as the E-A-R Pod Plug, should be considered to reduce the potential for ear canal contamination.

8.6 Respiratory Protection

All personnel and individuals in the work areas will wear respiratory protective equipment when needed, to help prevent exposure to any fumes, vapors, dust, and other respiratory hazards that may be encountered during on-site activities. The respirators (if needed) will be properly fitted and employees who wear or may wear respiratory protection will undergo fit-testing. Respiratory protection will comply with applicable National Institute for Occupational Safety and Health (NIOSH) and American Society for Testing and Materials (ASTM) International Standards depending on the type of PPE to be worn.

During work activities including, but not limited to, saw-cutting of concrete and the operation of power tools such as jackhammers, grinders or drills on concrete or cement (none presently anticipated as part of the SWMU removal work), personnel will wear protective equipment to prevent the inhalation of dust and silica particles.

8.7 PPE Program

PPE will be required when work activities generate and/or involve known or suspected atmospheric vapors, gases, liquids, or particulates at or above satisfactory health and safety levels or regulatory action limits. Protective equipment shall be ANSI/ISEA/NIOSH-approved.

For the work covered under this HASP, PPE should typically comprise Level D or Level C protection. Should air monitoring indicate that Level D fails to meet protection requirements, work shall be stopped and PPE shall be upgraded to Level C. Level D PPE consists of:

- Standard work uniform with coveralls or tyvek, as needed;
- Steel-toe and steel shank work boots;
- Hard hat;
- Gloves, as needed;
- Safety glasses; and
- Hearing protection, as needed.

Level C PPE consists of:

- Full face respirator fitted with appropriate organic vapor cartridge and Level D PPE.

8.7.1 Inspections

Before use of protective clothing, all personnel shall determine that the clothing material is correct for the specified task at hand. The clothing is to be visually inspected for imperfect seams, non-uniform coatings, tears and malfunctioning closures.

Before using gloves, they are to be checked for pinhole leaks. It is imperative that any equipment found to be defective be replaced immediately.

8.7.2 Donning/Doffing of Personal Protective Equipment

The following information is to provide on-site personnel with helpful hints that, when applied, make donning and doffing of PPE a safer and more manageable task:

- Have a “buddy” check your ensemble to ensure proper donning before entering controlled work areas. Without mirrors, the most obvious discrepancies can go unnoticed and may result in a potential exposure situation;
- Never perform personal decontamination with a pressure washer;
- Decontamination of equipment with water and a detergent shall be performed while PPE is still worn; and

- PPE will be removed and personnel will thoroughly wash their hands prior to leaving the Facility.

All PPE is to be bagged and contained in the proper receptacle prior to proper off-site disposal.

9.0 RECORD OF HASP ACKNOWLEDGEMENT

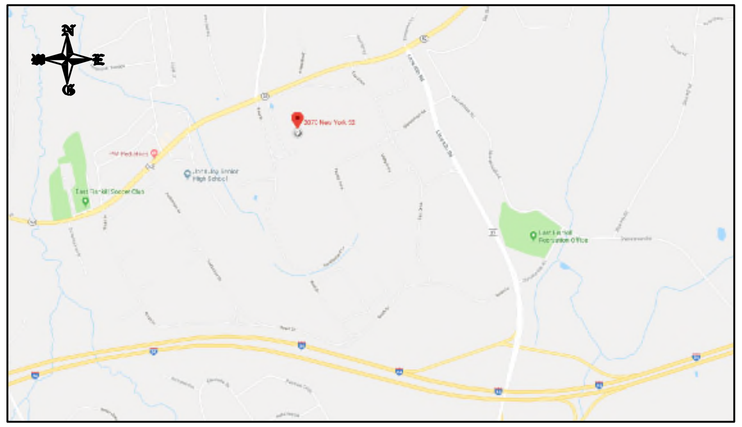
I certify that I have thoroughly read and fully understand the information in this HASP for SWMU removal and intrusive activities performed at the iPark 84 Facility. I understand the associated potential health and safety hazards and issues.

I certify that I have been trained in the use, care, and limitations of the PPE that could be used.

My signature below is official record that I comply with provisions of the HASP and federal, state, and local health and safety regulations and guidelines.

Printed Name	Signature	Representing	Date

ATTACHMENT A
iPARK 84 FACILITY SITE MAP



SITE LOCATION

NOT TO SCALE

SOURCE: GOOGLEMAPS.COM

SITE BASEMAP: CHAZAN ENGINEERING, LAND SURVEYING & LANDSCAPE ARCHITECTURE CO. D.P.C. POUGHKEEPSIE, NY (XBASE-SVY_51421-00.DWG 8/10/15); PARCELS: XSUBD_51539-00.DWG.

SCALE: 1"=800'

SITE PLAN

1" = 800'-0"

LEGEND

▬	PROPERTY LINE

WALDEN ENVIRONMENTAL ENGINEERING, PLLC
16 Spring Street
Oyster Bay, New York 11771
P: (516) 624-7200 F: (516) 624-3219
WWW.WALDENENVIRONMENTALENGINEERING.COM

Walden Environmental Engineering

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		REVISION
NO	DATE	COMMENTS
0	1/22/19	HEALTH & SAFETY PLAN

FOR:
iPARK CAMPUS
2070 ROUTE 52
Hopewell Junction, New York

DRAWING TITLE:
HEALTH AND SAFETY PLAN
iPARK CAMPUS

DRAWING NO: 1

ISSUED

REVISION NO: 0

DESIGNED BY: LL
APPROVED BY: JMH
DRAWN BY: LTG
SCALE: AS NOTED
JOB NO: iPARK0118.23
DATE: January 22, 2019
11x17
SHEET NO: 1 OF 1
CAD FILE NAME: Z:\iPark0118\iPark0118.23 - HASP for slab cutting - Country Produce 330C\HASP\Site Plan1.dwg

ATTACHMENT B
EMERGENCY ROOM DIRECTIONS

Google Maps

2070 NY-52, Hopewell Junction, NY 12533 to St Luke's Cornwall Hospital

Drive 15.4 miles, 22 min

Map data ©2018 Google 2 mi

2070 NY-52

Hopewell Junction, NY 12533

Get on I-84 from NY-52 E and Lime Kiln Rd

5 min (2.4 mi)

1. Head southeast toward North Dr
   Restricted usage road

443 ft

2. Slight left onto North Dr
   Restricted usage road

52 ft

3. Turn right onto West Dr
   Restricted usage road

0.2 mi

4. Turn right onto NY-52 E

0.5 mi

5. Turn right onto Lime Kiln Rd

1.1 mi

6. Use the right 2 lanes to take the I-84 W ramp

0.5 mi

Follow I-84 to NY-32 S/N Plank Rd in Balmville. Take exit 10S from I-84

11 min (11.3 mi)

7. Merge onto I-84

11.1 mi

8. Take exit 10S for NY-32 toward US-9W S/Newburgh

0.2 mi

Take Robinson Ave and Dubois St to your destination in Newburgh

6 min (1.7 mi)

9. Turn right onto NY-32 S/N Plank Rd (signs for Route 9w S)

0.2 mi

10. Use the right 2 lanes to turn right onto Robinson Ave

0.9 mi

11. Turn left onto South St

0.3 mi

12. Turn right onto Dubois St

0.3 mi

13. Turn left

246 ft

14. Turn left

Destination will be on the left

125 ft

St Luke's Cornwall Hospital

70 Dubois St, Newburgh, NY 12550

ATTACHMENT C
SAFETY DATA SHEETS & GENERAL CHEMICAL INFORMATION

SAFETY DATA SHEET

Version 6.2
Revision Date 06/17/2019
Print Date 01/05/2020

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Tetramethylammonium hydroxide solution

Product Number : 331635
Brand : Sigma-Aldrich

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Synthesis of substances

1.3 Details of the supplier of the safety data sheet

Company : Sigma-Aldrich Inc.
3050 Spruce Street
ST. LOUIS MO 63103
UNITED STATES

Telephone : +1 314 771-5765
Fax : +1 800 325-5052

1.4 Emergency telephone number

Emergency Phone # : +1-703-527-3887

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Acute toxicity, Oral (Category 2), H300
Acute toxicity, Dermal (Category 2), H310
Skin corrosion (Category 1), H314
Serious eye damage (Category 1), H318
Specific target organ toxicity - single exposure (Category 1), Central nervous system, H370
Specific target organ toxicity - repeated exposure, Dermal (Category 1), thymus gland, Liver, H372
Short-term (acute) aquatic hazard (Category 2), H401
Long-term (chronic) aquatic hazard (Category 2), H411

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H300 + H310	Fatal if swallowed or in contact with skin.
H314	Causes severe skin burns and eye damage.
H370	Causes damage to organs (Central nervous system).
H372	Causes damage to organs (thymus gland, Liver) through prolonged or repeated exposure in contact with skin.
H411	Toxic to aquatic life with long lasting effects.

Precautionary statement(s)

P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P262	Do not get in eyes, on skin, or on clothing.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P273	Avoid release to the environment.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P310 + P330	IF SWALLOWED: Immediately call a POISON CENTER/doctor. Rinse mouth.
P301 + P330 + P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P302 + P350 + P310	IF ON SKIN: Gently wash with plenty of soap and water. Immediately call a POISON CENTER or doctor/ physician.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P310	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Immediately call a POISON CENTER/doctor.
P305 + P351 + P338 + P310	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER/doctor.
P307 + P311	IF exposed: Call a POISON CENTER or doctor/ physician.
P362	Take off contaminated clothing and wash before reuse.
P391	Collect spillage.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

Rapidly absorbed through skin.

SECTION 3: Composition/information on ingredients

3.2 Mixtures

Molecular weight : 91.15 g/mol

Component	Classification	Concentration
Tetramethylammonium hydroxide		
CAS-No. 75-59-2 EC-No. 200-882-9	Acute Tox. 2; Acute Tox. 1; Skin Corr. 1B; Eye Dam. 1; STOT SE 1; STOT RE 1; Aquatic Acute 2; Aquatic Chronic 2; H300, H310, H314, H318, H370, H372, H401, H411 Concentration limits:	>= 30 - < 50 %

	>= 25 %: Acute Tox. 1, H310; 6.25 - < 25 %: Acute Tox. 2, H310; 1.25 - < 6.25 %: Acute Tox. 3, H311; 0.625 - 1.25 %: Acute Tox. 4, H312;	

For the full text of the H-Statements mentioned in this Section, see Section 16.

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.Continue rinsing eyes during transport to hospital.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Carbon oxides, Nitrogen oxides (NOx), Hydrogen chloride gas

5.3 Advice for firefighters

Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information

No data available

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Wear respiratory protection. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.
For personal protection see section 8.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

6.3 Methods and materials for containment and cleaning up

Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.
Storage class (TRGS 510): 6.1A: Combustible, acute toxic Cat. 1 and 2 / very toxic hazardous materials

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters
Contains no substances with occupational exposure limit values.

8.2 Exposure controls

Appropriate engineering controls
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Personal protective equipment

Eye/face protection
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact

with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 480 min
Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid
b)	Odour	No data available
c)	Odour Threshold	No data available
d)	pH	> 13 at 20 °C (68 °F)
e)	Melting point/freezing point	No data available
f)	Initial boiling point and boiling range	No data available
g)	Flash point	> 100 °C (> 212 °F) - closed cup
h)	Evaporation rate	No data available

i)	Flammability (solid, gas)	No data available
j)	Upper/lower flammability or explosive limits	No data available
k)	Vapour pressure	23.33 hPa at 20 °C (68 °F)
l)	Vapour density	No data available
m)	Relative density	No data available
n)	Water solubility	No data available
o)	Partition coefficient: n-octanol/water	No data available
p)	Auto-ignition temperature	No data available
q)	Decomposition temperature	No data available
r)	Viscosity	No data available
s)	Explosive properties	No data available
t)	Oxidizing properties	No data available

9.2 Other safety information

No data available

SECTION 10: Stability and reactivity

10.1 Reactivity

No data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

No data available

10.4 Conditions to avoid

No data available

10.5 Incompatible materials

Aluminium, Alkali metals, Strong oxidizing agents, Acids, Acid chlorides, Acid anhydrides, Halogens

10.6 Hazardous decomposition products

Hazardous decomposition products formed under fire conditions. - Carbon oxides, Nitrogen oxides (NOx), Hydrogen chloride gas
Other decomposition products - No data available
In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
No data available

Inhalation: No data available

LD50 Dermal - Rat - 449 mg/kg
LD50 Dermal - Rat - 112 mg/kg
Dermal: No data available

No data available

Skin corrosion/irritation
No data available

Serious eye damage/eye irritation
No data available

Respiratory or skin sensitisation
No data available

Germ cell mutagenicity

No data available

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is on OSHA’s list of regulated carcinogens.

Reproductive toxicity
No data available
No data available

Specific target organ toxicity - single exposure
No data available

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available

Additional Information
RTECS: Not available

Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin., Symptoms of exposure may include burning sensation, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting., Inhalation of vapors may cause:, pulmonary edema, spasm, inflammation and edema of the bronchi, spasm, inflammation and edema of the larynx, To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

SECTION 12: Ecological information

12.1 Toxicity

No data available

Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 3.0 mg/l - 48 h

12.2 Persistence and degradability

No data available

12.3 Bioaccumulative potential

No data available

12.4 Mobility in soil

No data available

12.5 Results of PBT and vPvB assessment

PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.
Toxic to aquatic life with long lasting effects.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product

Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging

Dispose of as unused product.

SECTION 14: Transport information

DOT (US)

UN number: 1835 Class: 8 Packing group: II
Proper shipping name: Tetramethylammonium hydroxide solution
Reportable Quantity (RQ):
Poison Inhalation Hazard: No

IMDG

UN number: 1835 Class: 8 Packing group: II EMS-No: F-A, S-B
Proper shipping name: TETRAMETHYLAMMONIUM HYDROXIDE SOLUTION

IATA

UN number: 1835 Class: 8 Packing group: II
Proper shipping name: Tetramethylammonium hydroxide, solution

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SECTION 15: Regulatory information

SARA 302 Components

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards

Acute Health Hazard

Massachusetts Right To Know Components

No components are subject to the Massachusetts Right to Know Act.

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Tetramethylammonium hydroxide	75-59-2	2007-03-01
Chloride	-	

SECTION 16: Other information

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

The branding on the header and/or footer of this document may temporarily not visually match the product purchased as we transition our branding. However, all of the information in the document regarding the product remains unchanged and matches the product ordered. For further information please contact mlsbranding@sial.com.

Version: 6.2 Revision Date: 06/17/2019 Print Date: 01/05/2020

Thermo Fisher
SCIENTIFIC

SAFETY DATA SHEET

Creation Date 22-Sep-2009 **Revision Date** 23-Jan-2018 **Revision Number** 3

1. Identification

Product Name **cis-1,2-Dichloroethylene**

Cat No. : **AC113380000; AC113380025; AC113380100; AC113380500**

Synonyms cis-Acetylene dichloride.

Recommended Use Laboratory chemicals.
Uses advised against Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 2
Acute oral toxicity	Category 4
Acute Inhalation Toxicity - Vapors	Category 4
Skin Corrosion/irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Danger

Hazard Statements
Highly flammable liquid and vapor
Harmful if swallowed
Harmful if inhaled
Causes serious eye irritation
Causes skin irritation
May cause respiratory irritation

Precautionary Statements
Prevention
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Avoid breathing dust/fume/gas/mist/vapors/spray
Keep away from heat/sparks/open flames/hot surfaces. - No smoking
Keep container tightly closed
Ground/bond container and receiving equipment
Take precautionary measures against static discharge
Do not eat, drink or smoke when using this product
Response
Call a POISON CENTER or doctor/physician if you feel unwell
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor/physician if you feel unwell
Skin
IF ON SKIN: Wash with plenty of soap and water
Take off contaminated clothing and wash before reuse
If skin irritation occurs: Get medical advice/attention
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Ingestion
Rinse mouth
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Fire
Explosion risk in case of fire
Fight fire with normal precautions from a reasonable distance
Evacuate area
Storage
Store in a well-ventilated place. Keep cool
Store in a closed container
Store locked up
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
cis-1,2-Dichloroethylene	156-59-2	97

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Obtain medical attention.

Inhalation	Move to fresh air. Obtain medical attention. If not breathing, give artificial respiration.
Ingestion	Do not induce vomiting. Obtain medical attention.
Most important symptoms and effects	Breathing difficulties. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Water spray. Carbon dioxide (CO_2). Dry chemical. Use water spray to cool unopened containers. Chemical foam. Cool closed containers exposed to fire with water spray.
Unsuitable Extinguishing Media	No information available
Flash Point	6 °C / 42.8 °F
Method -	No information available
Autoignition Temperature	440 °C / 824 °F

Explosion Limits

Upper	12.80%
Lower	9.70%
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Flammable. Vapors may travel to source of ignition and flash back. Containers may explode when heated. Vapors may form explosive mixtures with air.

Hazardous Combustion Products
Hydrogen chloride gas Carbon monoxide (CO) Carbon dioxide (CO_2)
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	3	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment. Remove all sources of ignition. Take precautionary measures against static discharges. Avoid contact with skin, eyes and clothing.
Environmental Precautions	See Section 12 for additional ecological information. Do not flush into surface water or sanitary sewer system.
Methods for Containment and Clean Up	Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Keep in suitable, closed containers for disposal. Remove all sources of ignition. Use spark-proof tools and explosion-proof equipment.

7. Handling and storage

Handling	Ensure adequate ventilation. Wear personal protective equipment. Use explosion-proof equipment. Use only non-sparking tools. Avoid contact with skin, eyes and clothing. Avoid breathing dust/fume/gas/mist/vapors/spray. Avoid ingestion and inhalation. Keep away from open flames, hot surfaces and sources of ignition. Take precautionary measures against static discharges. To avoid ignition of vapors by static electricity discharge, all metal parts of the equipment must be grounded.

Storage	Keep in a dry, cool and well-ventilated place. Keep container tightly closed. Keep away from heat and sources of ignition. Flammables area. Keep container tightly closed in a dry and well-ventilated place.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
cis-1,2-Dichloroethylene	TWA: 200 ppm			

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

Engineering Measures	Ensure adequate ventilation, especially in confined areas. Use explosion-proof electrical/ventilating/lighting/equipment. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	No protective equipment is needed under normal use conditions.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	aromatic
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-80 °C / -112 °F
Boiling Point/Range	60 °C / 140 °F @ 760 mmHg
Flash Point	6 °C / 42.8 °F
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	12.80%
Lower	9.70%
Vapor Pressure	201 mmHg @ 25 °C
Vapor Density	3.34 (Air = 1.0)
Specific Gravity	1.280
Solubility	No information available
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	440 °C / 824 °F
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	C2 H2 Cl2
Molecular Weight	96.94

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Keep away from open flames, hot surfaces and sources of ignition. Exposure to air. Exposure to light. Incompatible products. Exposure to moist air or water.
Incompatible Materials	Bases
Hazardous Decomposition Products	Hydrogen chloride gas, Carbon monoxide (CO), Carbon dioxide (CO_2)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information
Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Irritating to eyes, respiratory system and skin
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
cis-1,2-Dichloroethylene	156-59-2	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Do not flush into surface water or sanitary sewer system. Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea

cis-1,2-Dichloroethylene	Not listed	Not listed	EC50 = 721 mg/L 5 min EC50 = 905 mg/L 30 min	Not listed

Persistence and Degradability	Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its volatility.

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT

UN-No	UN1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

TDG

UN-No	UN1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

IATA

UN-No	1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

IMDG/IMO

UN-No	1150
Proper Shipping Name	1,2-DICHLOROETHYLENE
Hazard Class	3
Packing Group	II

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
cis-1,2-Dichloroethylene	X	-	X	205-859-7	-		-	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b)	Not applicable

SARA 313	Not applicable
SARA 311/312 Hazard Categories	See section 2 for more information
CWA (Clean Water Act)	Not applicable
Clean Air Act	Not applicable

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
cis-1,2-Dichloroethylene	X	-	X	-	-

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date	22-Sep-2009
Revision Date	23-Jan-2018
Print Date	23-Jan-2018
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Revision Date 17-Jan-2018 **Revision Number** 3

1. Identification

Product Name	**1,1,2-Trichloro-1,2,2-trifluoroethane**
Cat No. :	**T178-1; T178-4**
Synonyms	Fluorocarbon 113; Freon 113; 1,1,2-Trichlorotrifluoroethane
Recommended Use	Laboratory chemicals.
Uses advised against	Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Based on available data, the classification criteria are not met

Label Elements
None required

Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	99

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes.

Inhalation	Move to fresh air.
Ingestion	Do not induce vomiting.
Most important symptoms and effects	No information available.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	770 °C
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products
No information available
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
1	0	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment.
Environmental Precautions	See Section 12 for additional ecological information.
Methods for Containment and Clean Up	No information available.

7. Handling and storage

Handling	Ensure adequate ventilation.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place.

8. Exposure controls / personal protection

Exposure Guidelines	This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies.

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
1,1,2-Trichloro-1,2,2-trifluoroethane	TWA: 1000 ppm STEL: 1250 ppm	(Vacated) TWA: 1000 ppm (Vacated) TWA: 7600 mg/m^3 (Vacated) STEL: 1250 ppm (Vacated) STEL: 9500 mg/m^3 TWA: 1000 ppm TWA: 7600 mg/m^3	IDLH: 2000 ppm TWA: 1000 ppm TWA: 7600 mg/m^3 STEL: 1250 ppm STEL: 9500 mg/m^3	TWA: 1000 ppm TWA: 1600 mg/m^3 STEL: 1250 ppm STEL: 9500 mg/m^3

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures	Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Clear
Odor	aromatic
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-36 °C
Boiling Point/Range	48 °C
Flash Point	No information available
Evaporation Rate	> 1.0 (Ether = 1.0)
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	363 hPa @ 20 °C
Vapor Density	6.5 (Air = 1.0)
Specific Gravity	1.47 @ 21°C
Solubility	Insoluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	770 °C
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	$C_2Cl_3F_3$
Molecular Weight	187.38

10. Stability and reactivity

Reactive Hazard	None known, based on information available

Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products.
Incompatible Materials	Strong acids, Powdered metals
Hazardous Decomposition Products	No information available
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
1,1,2-Trichloro-1,2,2-trifluoroethane	LD50 = 43 g/kg (Rat)	Not listed	LC50 = 38000 ppm (Rat) 4 h LC50 = 38500 mg/kg (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	No information available
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	None known
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	No information available
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains. Chlorotrifluoromethane (CFC-13) is a Class I ozone-depleting chlorofluorocarbon. It is stable in the atmosphere. The half-life for degradation by reaction with photochemically-produced hydroxyl radicals is about 62 years. Following gradual diffusion into the stratosphere above the ozone layer, it slowly degrades (est. half-life of 180-450 years) due to direct photolysis and contributes to the catalytic removal of atmosphere ozone.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
1,1,2-Trichloro-1,2,2-trifluoroethane	Not listed	LC50: 7 - 14 mg/L, 96h static (Brachydanio rerio) LC50: = 1250 mg/L, 96h (Pimephales promelas) LC50: = 6240 mg/L, 96h (Oryzias latipes)	Not listed	EC50: = 71 mg/L, 48h (Daphnia magna)

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available.

Mobility No information available.

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT	Not regulated
TDG	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
1,1,2-Trichloro-1,2,2-trifluoroethane	X	X	-	200-936-1	-		X	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313 Not applicable

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	99	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act) Not applicable

Clean Air Act Not applicable

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
1,1,2-Trichloro-1,2,2-trifluoroethane	-	X	-

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA Not applicable

Component	Hazardous Substances RQs	CERCLA EHS RQs
1,1,2-Trichloro-1,2,2-trifluoroethane	5000 lb	-

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations Not applicable

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
1,1,2-Trichloro-1,2,2-trifluoroethane	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Revision Date 17-Jan-2018
Print Date 17-Jan-2018
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

ThermoFisher
SCIENTIFIC

SAFETY DATA SHEET

Creation Date 10-Dec-2009 **Revision Date** 23-Jan-2018 **Revision Number** 5

1. Identification

Product Name	**Tetrachloroethylene**
Cat No. :	**AC445690000; ACR445690010; AC445690025; AC445691000**
CAS-No	127-18-4
Synonyms	Perchloroethylene
Recommended Use	Laboratory chemicals.
Uses advised against	Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Skin Sensitization	Category 1
Carcinogenicity	Category 1B
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, Blood.	

Label Elements

Signal Word
Danger

Hazard Statements
Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
May cause cancer
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN: Wash with plenty of soap and water
Take off contaminated clothing and wash before reuse
If skin irritation or rash occurs: Get medical advice/attention
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Toxic to aquatic life with long lasting effects
WARNING. Cancer - https://www.p65warnings.ca.gov/.

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Tetrachloroethylene	127-18-4	>95

4. First-aid measures

General Advice	If symptoms persist, call a physician.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. If skin irritation persists, call a physician.
Inhalation	Move to fresh air. If not breathing, give artificial respiration. Get medical attention if symptoms occur.
Ingestion	Clean mouth with water and drink afterwards plenty of water.

Most important symptoms and effects	None reasonably foreseeable. May cause allergic skin reaction. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated.

Hazardous Combustion Products

Chlorine Hydrogen chloride gas Phosgene

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	0	0	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment. Ensure adequate ventilation.
Environmental Precautions	Do not flush into surface water or sanitary sewer system.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Ensure adequate ventilation. Avoid ingestion and inhalation.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from sunlight.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Tetrachloroethylene	TWA: 25 ppm STEL: 100 ppm	(Vacated) TWA: 25 ppm (Vacated) TWA: 170 mg/m^3 Ceiling: 200 ppm TWA: 100 ppm	IDLH: 150 ppm	TWA: 100 ppm TWA: 670 mg/m^3 TWA: 200 ppm TWA: 1250 mg/m^3 STEL: 200 ppm STEL: 1340 mg/m^3

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin and body protection Long sleeved clothing.

Respiratory Protection Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

Hygiene Measures Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Characteristic, sweet
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-22 °C / -7.6 °F
Boiling Point/Range	120 - 122 °C / 248 - 251.6 °F @ 760 mmHg
Flash Point	No information available
Evaporation Rate	6.0 (Ether = 1.0)
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	18 mbar @ 20 °C
Vapor Density	No information available
Density	1.619
Specific Gravity	1.625
Solubility	0.15 g/L water (20°C)
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	> 150°C
Viscosity	0.89 mPa s at 20 °C
Molecular Formula	C2 Cl4
Molecular Weight	165.83

10. Stability and reactivity

Reactive Hazard None known, based on information available

Stability Stable under normal conditions.

Conditions to Avoid Incompatible products. Excess heat. Exposure to moist air or water.

Incompatible Materials Strong acids, Strong oxidizing agents, Strong bases, Metals, Zinc, Amines, Aluminium

Hazardous Decomposition Products Chlorine, Hydrogen chloride gas, Phosgene

Hazardous Polymerization Hazardous polymerization does not occur.

Hazardous Reactions None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Tetrachloroethylene	LD50 = 2629 mg/kg (Rat)	LD50 > 10000 mg/kg (Rat)	LC50 = 27.8 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes and skin

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Tetrachloroethylene	127-18-4	Group 2A	Reasonably Anticipated	A3	X	A3

IARC: (International Agency for Research on Cancer)	*IARC: (International Agency for Research on Cancer)* *Group 1 - Carcinogenic to Humans* *Group 2A - Probably Carcinogenic to Humans* *Group 2B - Possibly Carcinogenic to Humans*
NTP: (National Toxicity Program)	*NTP: (National Toxicity Program)* *Known - Known Carcinogen* *Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen*
ACGIH: (American Conference of Governmental Industrial Hygienists)	*A1 - Known Human Carcinogen* *A2 - Suspected Human Carcinogen* *A3 - Animal Carcinogen* *ACGIH: (American Conference of Governmental Industrial Hygienists)*
Mexico - Occupational Exposure Limits - Carcinogens	*Mexico - Occupational Exposure Limits - Carcinogens* *A1 - Confirmed Human Carcinogen* *A2 - Suspected Human Carcinogen* *A3 - Confirmed Animal Carcinogen* *A4 - Not Classifiable as a Human Carcinogen* *A5 - Not Suspected as a Human Carcinogen*

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Central nervous system (CNS)

STOT - repeated exposure Kidney Liver Blood

Aspiration hazard No information available

Symptoms / effects,both acute and delayed Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing

Endocrine Disruptor Information

Component	EU - Endocrine Disrupters Candidate List	EU - Endocrine Disruptors - Evaluated Substances	Japan - Endocrine Disruptor Information
Tetrachloroethylene	Group II Chemical	Not applicable	Not applicable

Other Adverse Effects Tumorigenic effects have been reported in experimental animals.

12. Ecological information

Ecotoxicity

Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Tetrachloroethylene	EC50: > 500 mg/L, 96h (Pseudokirchneriella subcapitata)	LC50: 4.73 - 5.27 mg/L, 96h flow-through (Oncorhynchus mykiss) LC50: 11.0 - 15.0 mg/L, 96h static (Lepomis macrochirus) LC50: 8.6 - 13.5 mg/L, 96h static (Pimephales promelas) LC50: 12.4 - 14.4 mg/L, 96h flow-through (Pimephales promelas)	EC50 = 100 mg/L 24 h EC50 = 112 mg/L 24 h EC50 = 120.0 mg/L 30 min	EC50: 6.1 - 9.0 mg/L, 48h Static (Daphnia magna)

Persistence and Degradability Insoluble in water Persistence is unlikely based on information available.

Bioaccumulation/ Accumulation No information available.

Mobility . Is not likely mobile in the environment due its low water solubility. Will likely be mobile in the environment due to its volatility.

Component	log Pow
Tetrachloroethylene	2.53 - 2.88

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Tetrachloroethylene - 127-18-4	U210	-

14. Transport information

DOT

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

TDG

UN-No	UN1897

Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IATA

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IMDG/IMO

UN-No	UN1897
Proper Shipping Name	TETRACHLOROETHYLENE
Hazard Class	6.1
Subsidiary Hazard Class	P
Packing Group	III

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Tetrachloroethylene	X	X	-	204-825-9	-		X	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Tetrachloroethylene	127-18-4	>95	0.1

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Tetrachloroethylene	-	-	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Tetrachloroethylene	X		-

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA	This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Tetrachloroethylene	100 lb 1 lb	-

California Proposition 65	This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Tetrachloroethylene	127-18-4	Carcinogen	14 µg/day	Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Tetrachloroethylene	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	Y
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade	No information available

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	10-Dec-2009
Revision Date	23-Jan-2018
Print Date	23-Jan-2018
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Creation Date 03-Feb-2010 **Revision Date** 14-Jul-2016 **Revision Number** 2

1. Identification

Product Name	**Trichloroethylene**
Cat No. :	**T340-4; T341-4; T341-20; T341-500; T403-4**
Synonyms	Trichloroethene (Stabilized/Technical/Electronic/Certified ACS)
Recommended Use	Laboratory chemicals.
Uses advised against	

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/irritation	Category 2
Serious Eye Damage/Eye Irritation	Category 2
Skin Sensitization	Category 1
Germ Cell Mutagenicity	Category 2
Carcinogenicity	Category 1A
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Central nervous system (CNS).	
Specific target organ toxicity - (repeated exposure)	Category 2
Target Organs - Kidney, Liver, Heart, spleen, Blood.	

Label Elements

Signal Word
Danger

Hazard Statements
Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
Suspected of causing genetic defects
May cause cancer
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN: Wash with plenty of soap and water
Take off contaminated clothing and wash before reuse
If skin irritation or rash occurs: Get medical advice/attention
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Harmful to aquatic life with long lasting effects
WARNING! This product contains a chemical known in the State of California to cause cancer, birth defects or other reproductive harm.

3. Composition / information on ingredients

Component	CAS-No	Weight %
Trichloroethylene	79-01-6	100

4. First-aid measures

General Advice	Show this safety data sheet to the doctor in attendance. Immediate medical attention is required.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If not breathing, give artificial respiration. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a

	pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.
Ingestion	Do not induce vomiting. Call a physician or Poison Control Center immediately.
Most important symptoms/effects	None reasonably foreseeable. May cause allergic skin reaction. Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	410 °C / 770 °F
Explosion Limits	
Upper	10.5 vol %
Lower	8 vol %
Oxidizing Properties	Not oxidising
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Thermal decomposition can lead to release of irritating gases and vapors. Containers may explode when heated. Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products

Hydrogen chloride gas Chlorine Phosgene Carbon monoxide (CO) Carbon dioxide (CO_2)

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
2	1	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas.
Environmental Precautions	Should not be released into the environment. Do not flush into surface water or sanitary sewer system.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Use only under a chemical fume hood. Do not breathe vapors or spray mist. Do not ingest.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Protect from light. Do not store in aluminum containers.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Trichloroethylene	TWA: 10 ppm STEL: 25 ppm	(Vacated) TWA: 50 ppm (Vacated) TWA: 270 mg/m^3 Ceiling: 200 ppm (Vacated) STEL: 200 ppm (Vacated) STEL: 1080 mg/m^3 TWA: 100 ppm	IDLH: 1000 ppm	TWA: 100 ppm TWA: 535 mg/m^3 STEL: 200 ppm STEL: 1080 mg/m^3

Legend

ACGIH - American Conference of Governmental Industrial Hygienists
OSHA - Occupational Safety and Health Administration
NIOSH IDLH: The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health

Engineering Measures	Use only under a chemical fume hood. Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Long sleeved clothing.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Characteristic
Odor Threshold	No information available
pH	No information available
Melting Point/Range	-85 °C / -121 °F
Boiling Point/Range	87 °C / 188.6 °F
Flash Point	No information available
Evaporation Rate	0.69 (Carbon Tetrachloride = 1.0)
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	10.5 vol %
Lower	8 vol %
Vapor Pressure	77.3 mbar @ 20 °C
Vapor Density	4.5 (Air = 1.0)
Specific Gravity	1.460
Solubility	Slightly soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	410 °C / 770 °F
Decomposition Temperature	> 120°C
Viscosity	0.55 mPa.s (25°C)

Molecular Formula	C2 H Cl3
Molecular Weight	131.39

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Light sensitive.
Conditions to Avoid	Incompatible products. Excess heat. Exposure to light. Exposure to moist air or water.
Incompatible Materials	Strong oxidizing agents, Strong bases, Amines, Alkali metals, Metals,
Hazardous Decomposition Products	Hydrogen chloride gas, Chlorine, Phosgene, Carbon monoxide (CO), Carbon dioxide (CO_2)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Trichloroethylene	LD50 = 4290 mg/kg (Rat) LD50 = 4920 mg/kg (Rat)	LD50 > 20 g/kg (Rabbit) LD50 = 29000 mg/kg (Rabbit)	LC50 = 26 mg/L (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Irritating to eyes and skin
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Trichloroethylene	79-01-6	Group 1	Reasonably Anticipated	A2	X	Not listed

IARC: (International Agency for Research on Cancer)	*IARC: (International Agency for Research on Cancer)* *Group 1 - Carcinogenic to Humans* *Group 2A - Probably Carcinogenic to Humans* *Group 2B - Possibly Carcinogenic to Humans*
NTP: (National Toxicity Program)	*NTP: (National Toxicity Program)* *Known - Known Carcinogen* *Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen*
ACGIH: (American Conference of Governmental Industrial Hygienists)	*A1 - Known Human Carcinogen* *A2 - Suspected Human Carcinogen* *A3 - Animal Carcinogen* *ACGIH: (American Conference of Governmental Industrial Hygienists)*

Mutagenic Effects	Mutagenic effects have occurred in humans.
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.

STOT - single exposure	Central nervous system (CNS)
STOT - repeated exposure	Kidney Liver Heart spleen Blood
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Inhalation of high vapor concentrations may cause symptoms like headache, dizziness, tiredness, nausea and vomiting: Symptoms of allergic reaction may include rash, itching, swelling, trouble breathing, tingling of the hands and feet, dizziness, lightheadedness, chest pain, muscle pain or flushing
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Do not empty into drains. The product contains following substances which are hazardous for the environment. Contains a substance which is:. Harmful to aquatic organisms. Toxic to aquatic organisms.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Trichloroethylene	EC50: = 175 mg/L, 96h (Pseudokirchneriella subcapitata) EC50: = 450 mg/L, 96h (Desmodesmus subspicatus)	LC50: 39 - 54 mg/L, 96h static (Lepomis macrochirus) LC50: 31.4 - 71.8 mg/L, 96h flow-through (Pimephales promelas)	EC50 = 0.81 mg/L 24 h EC50 = 115 mg/L 10 min EC50 = 190 mg/L 15 min EC50 = 235 mg/L 24 h EC50 = 410 mg/L 24 h EC50 = 975 mg/L 5 min	EC50: = 2.2 mg/L, 48h (Daphnia magna)

Persistence and Degradability	Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	Will likely be mobile in the environment due to its volatility.

Component	log Pow
Trichloroethylene	2.4

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

Component	RCRA - U Series Wastes	RCRA - P Series Wastes
Trichloroethylene - 79-01-6	U228	-

14. Transport information

DOT

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

TDG

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

IATA

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE

Hazard Class	6.1
Packing Group	III

IMDG/IMO

UN-No	UN1710
Proper Shipping Name	TRICHLOROETHYLENE
Hazard Class	6.1
Packing Group	III

15. Regulatory information

All of the components in the product are on the following Inventory lists: X = listed

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
Trichloroethylene	X	X	-	201-167-4	-		X	X	X	X	X

Legend:
X - Listed
E - Indicates a substance that is the subject of a Section 5(e) Consent order under TSCA.
F - Indicates a substance that is the subject of a Section 5(f) Rule under TSCA.
N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
R - Indicates a substance that is the subject of a Section 6 risk management rule under TSCA.
S - Indicates a substance that is identified in a proposed or final Significant New Use Rule
T - Indicates a substance that is the subject of a Section 4 test rule under TSCA.
XU - Indicates a substance exempt from reporting under the Inventory Update Rule, i.e. Partial Updating of the TSCA Inventory Data Base Production and Site Reports (40 CFR 710(B).
Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b) Not applicable

Component	TSCA 12(b)
Trichloroethylene	Section 5

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Trichloroethylene	79-01-6	100	0.1

SARA 311/312 Hazard Categories

Acute Health Hazard	Yes
Chronic Health Hazard	Yes
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Trichloroethylene	X	100 lb	X	X

Clean Air Act

Component	HAPS Data	Class 1 Ozone Depletors	Class 2 Ozone Depletors
Trichloroethylene	X		-

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA

This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Trichloroethylene	100 lb 1 lb	-

California Proposition 65 This product contains the following proposition 65 chemicals

Component	CAS-No	California Prop. 65	Prop 65 NSRL	Category
Trichloroethylene	79-01-6	Carcinogen Developmental Male Reproductive	14 µg/day 50 µg/day	Developmental Carcinogen

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Trichloroethylene	X	X	X	X	X

U.S. Department of Transportation

Reportable Quantity (RQ):	Y
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security

This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	03-Feb-2010
Revision Date	14-Jul-2016
Print Date	14-Jul-2016
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

SAFETY DATA SHEET

Revision Date 19-Jan-2018 **Revision Number** 3

1. Identification

Product Name	**Poly(vinyl chloride), high molecular weight**
Cat No. :	**AC183320000; AC183320010; AC183325000**
Synonyms	Chlorethene homopolymer; Ethylene, chloro-, polymer; PVC
Recommended Use	Laboratory chemicals.
Uses advised against	Not for food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Acros Organics
One Reagent Lane
Fair Lawn, NJ 07410

Emergency Telephone Number
For information **US** call: 001-800-ACROS-01 / **Europe** call: +32 14 57 52 11
Emergency Number **US:**001-201-796-7100 / **Europe:** +32 14 57 52 99
CHEMTREC Tel. No.**US:**001-800-424-9300 / **Europe:**001-703-527-3887

2. Hazard(s) identification

Classification
Classification under 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Based on available data, the classification criteria are not met

Label Elements
None required

Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
PVC (Chloroethylene, polymer)	9002-86-2	100

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.

Skin Contact	Wash off immediately with plenty of water for at least 15 minutes.
Inhalation	Move to fresh air.
Ingestion	Do not induce vomiting.
Most important symptoms and effects	No information available.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Unsuitable Extinguishing Media	No information available
Flash Point	
Method -	No information available
Autoignition Temperature	435 °C
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Keep product and empty container away from heat and sources of ignition.

Hazardous Combustion Products
None known
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
1	1	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment.
Environmental Precautions	See Section 12 for additional ecological information.
Methods for Containment and Clean Up	No information available.

7. Handling and storage

Handling	Ensure adequate ventilation.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
PVC (Chloroethylene, polymer)	TWA: 1 mg/m^3			

Legend

ACGIH - American Conference of Governmental Industrial Hygienists

Engineering Measures	Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Powder Solid
Appearance	Off-white
Odor	Odorless
Odor Threshold	No information available
pH	
Melting Point/Range	No data available
Boiling Point/Range	
Flash Point	
Evaporation Rate	No information available
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	No information available
Specific Gravity	1.4000
Solubility	No information available
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	435 °C
Decomposition Temperature	No information available
Viscosity	No information available

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products.
Incompatible Materials	Strong oxidizing agents
Hazardous Decomposition Products	None under normal use conditions
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Component Information	
Toxicologically Synergistic Products	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	No information available
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
PVC (Chloroethylene, polymer)	9002-86-2	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	None known
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	No information available
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Do not empty into drains.

Persistence and Degradability	No information available
Bioaccumulation/ Accumulation	No information available.
Mobility	No information available.

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT	Not regulated
TDG	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated

15. Regulatory information

International Inventories

Component	TSCA	DSL	NDSL	EINECS	ELINCS	NLP	PICCS	ENCS	AICS	IECSC	KECL
PVC (Chloroethylene, polymer)	X	X	-	-	420-490-3		X	X	X	X	X

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N - Indicates a polymeric substance containing no free-radical initiator in its inventory name but is considered to cover the designated polymer made with any free-radical initiator regardless of the amount used.
P - Indicates a commenced PMN substance
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Y1 - Indicates an exempt polymer that has a number-average molecular weight of 1,000 or greater.
Y2 - Indicates an exempt polymer that is a polyester and is made only from reactants included in a specified list of low concern reactants that comprises one of the eligibility criteria for the exemption rule.

U.S. Federal Regulations

TSCA 12(b)	Not applicable
SARA 313	Not applicable
SARA 311/312 Hazard Categories	See section 2 for more information
CWA (Clean Water Act)	Not applicable
Clean Air Act	Not applicable

OSHA Occupational Safety and Health Administration
Not applicable

CERCLA	Not applicable
California Proposition 65	This product does not contain any Proposition 65 chemicals
U.S. State Right-to-Know Regulations	Not applicable

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
PVC (Chloroethylene, polymer)	-	X	-	-	-

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security
This product does not contain any DHS chemicals.

Other International Regulations

Mexico - Grade	No information available

16. Other information

Prepared By
Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Revision Date	19-Jan-2018
Print Date	19-Jan-2018
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

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End of SDS

Hydrogen bonds are only one-tenth to one-thirteenth as strong as covalent bonds but they have pronounced effects on the properties of substances in which they occur, especially as regards melting point, boiling point, and crystalline structure. They are found in compounds containing such strongly electronegative atoms as nitrogen, oxygen, and fluorine. They play an important part in the bonding of cellulosic compounds, e.g., in the paper industry, and occur also in many complex structures of biochemical importance, e.g., adenine-uracil linkage in DNA.

hydrogen bromide. CAS: 10035-10-6. HBr.
Properties: Colorless gas, d 2.71 (air = 1.00), fp −86C, bp −66.4C, specific volume 4.8 cu ft/lb (70F, 1 atm), soluble in water and alcohol, nonflammable.
Derivation: (1) By passing hydrogen with bromine vapor over warm platinum sponge which acts as a catalyst. (2) As a by-product in the bromination of organic compounds.
Grade: Up to 99.8% min purity.
Hazard: Toxic by inhalation, strong irritant to eyes and skin. TLV: ceiling 3 ppm in air.
Use: Organic synthesis, makes bromides by direct reaction with alcohols, pharmaceutical intermediate; alkylation and oxidation catalyst, reducing agent.
See also hydrobromic acid.

hydrogen chloride. CAS: 7647-01-0. HCl.
Properties: Colorless, fuming, with a suffocating odor, D 1.268 (air = 1.00), fp −114C, bp −85C, specific volume 10.9 cu ft/lb (21.1C, 1 atm), very soluble in water, soluble in alcohol and ether. Non-flammable.
Derivation: (1) By-product of organic chlorination reactions (approximately 90%), (2) reaction of sodium chloride and sulfuric acid, (3) burning hydrogen in an atmosphere of chlorine in absence of air.
Hazard: Toxic by inhalation, strong irritant to eyes and skin. TLV: ceiling 5 ppm in air.
Use: Production of vinyl chloride from acetylene and alkyl chlorides from olefins, hydrochlorination (see rubber hydrochloride), polymerization, isomerization, alkylation, and nitration reactions.
See also hydrochloric acid.

hydrogen cyanide. See hydrocyanic acid.

hydrogen dioxide. See hydrogen peroxide.

hydrogen electrode. See electrode, hydrogen.

hydrogen fluoride. CAS: 7664-39-3. HF.
Properties: Colorless, fuming gas or liquid; very soluble in water; the liquid and gas consist of associated molecules; the vapor density corresponds to hydrogen fluoride only at high temperatures; fp −83C, bp 19.5C, d (liquid) 0.988 (14C), sp vol 17 cu ft/lb (21.1C, 1 atm). Nonflammable.
Derivation: Distillation from the reaction product of calcium fluoride and sulfuric acid, also from fluosilicic acid.
Grade: To 99.9% min purity.
Hazard: Toxic by ingestion and inhalation, strong irritant to eyes, skin, and mucous membranes. TLV: ceiling 3 ppm in air.
Use: Catalyst in alkylation, isomerization, condensation, dehydration, and polymerization reactions; fluorinating agent in organic and inorganic reactions; production of fluorine and aluminum fluoride; additive in liquid rocket propellants; refining of uranium.
See also hydrofluoric acid.

hydrogen hexafluorosilicate. See fluosilicic acid.

hydrogen iodide. CAS: 10034-85-2. HI.
Properties: Colorless gas, bp −35C, fp −51C, fumes in moist air, d 5.2 (25C), freely soluble in water. Non-flammable.
Hazard: Strong irritant. Poison.
Use: Making hydriodic acid.

hydrogen ion concentration. See pH.

hydrogenolysis. (destructive hydrogenation).
A type of hydrogenation reaction in which molecular cleavage of an organic compound occurs with addition of hydrogen to each portion. An important application is hydrocracking (hydrogenative splitting) of large organic molecules, with formation of fragments that react with hydrogen by use of catalysts and high temperatures. Hydrogenolysis of coal to gaseous and liquid fuels was used in Germany in the 1940s; a similar method (oil/gas process) is under development in the U.S. The German process used pulverized coal made into a paste with heavy oil and a metallic catalyst. The mixture plus the necessary hydrogen was subjected to 300–700 atm at approximately 500C. The coal was converted into heavy oil, distillable oil, gasoline, and hydrocarbon gases. Large quantities of hydrogen are necessary.
See also gasification, hydrogenation.

hydrogen overvoltage. The difference between actual cathode potential for hydrogen evolution and the equilibrium (theoretical) potential of hydrogen in the same electrolyte.

hydrogen peroxide. CAS: 7722-84-1. H_2O_2 (molecular formula); H–O–O–H (structural formula).
Properties: (pure anhydrous) density of solid,

optical activity; most effective between pH 6 and 8.
Derivation: (1) Alkaline hydrolysis of the waste liquor from beet sugar refining, (2) a similar hydrolysis of wheat or corn gluten, (3) organic synthesis based on acrylonitrile.
Grade: Technical, 99%, ND, FCC.
Use: Flavor enhancer for foods in concentration of about 0.3%.
See also flavor, glutamic acid.

sodium glycolate. (sodium hydroxyacetate). $NaOOCCH_2OH$.
Properties: White powder.
Use: Buffer in electrodeless plating and textile finishing.

sodium gold chloride. (sodium aurichloride; sodium chloraurate; sodium chloroaurate; gold sodium chloride; gold salts). $NaAuCl_4{\cdot}2H_2O$.
Properties: Yellow crystals, soluble in water and alcohol.
Derivation: By neutralizing chloroauric acid with sodium carbonate.
Use: Photography, staining fine glass, decorating porcelain, medicine.

sodium gold cyanide. (sodium cyanoaurite; sodium aurocyanide; gold sodium cyanide). $NaAu(CN)_2$.
Properties: Yellow powder, soluble in water, contains 46% gold (min).
Hazard: Toxic. TLV (as CN): 5 mg/m^3 of air.
Use: For gold-plating electronic components.

sodium guanylate. (GMP; disodium guanylate). CAS: 5550-12-9. $Na_2C_{10}H_{12}N_5O_8P{\cdot}2H_2O$.
A 5′-nucleotide.
Properties: Crystals, soluble in cold water, very soluble in hot water.
Derivation: From a seaweed or from dried fish.
Use: Flavor potentiator in foods.
See also guanylic acid.

sodium heparin. See heparin.

sodium heptametaphosphate. See sodium metaphosphate.

sodium hexachloroosmate. (osmium-sodium chloride; sodium-osmium chloride). Na_2OsCl_6.
Properties: Orange, rhombic prisms, contains 40.3% osmium, unstable, soluble in alcohol, water.
Grade: Technical.
Use: Catalyst (oxidation).

sodium hexachloroplatinate. See sodium chloroplatinate.

sodium hexylene glycol monoborate. $C_6H_{12}O_3BNa$.
Properties: Amorphous, white solid; bulk d 0.25; mp 426C; soluble in nonpolar solvents.
Purity: Min 98%.
Use: Corrosion inhibitor in organic systems, additive to lubricating oils, flame-retardant, siloxane resin additive.

sodium hexachloroplatinate. See sodium chloroplatinate.

sodium hexafluorosilicate. See sodium fluorosilicate.

sodium hexametaphosphate. See "Calgon."

sodium hydrate. See sodium hydroxide.

sodium hydride. CAS: 7646-69-7. NaH.
Properties: Practically odorless powder, d 0.92, mp 800C (decomposes), must be kept cool and dry, particle size range 5–50 μm, starts to decompose with evolution of hydrogen at about 255C.
Preparation: Reaction of sodium metal with hydrogen. A microcrystalline dispersion of gray powder in oil containing 50 or 25% by weight.
Hazard: Dangerous fire risk, reacts violently with water, evolving hydrogen. Irritant.
Use: Condensing or alkylating agent, especially for amines, descaling metals.

sodium hydrogen sulfide. See sodium hydrosulfide.

sodium hydrogen sulfite. See sodium bisulfite.

sodium hydrosulfide. (sodium sulfhydrate; sodium bisulfide; sodium hydrogen sulfide). CAS: 16721-80-5. $NaSH{\cdot}2H_2O$.
Properties: Colorless needles to lemon-colored flakes; soluble in water, alcohol, and ether; 70–72% NaSH; mp 55C; water of crystallization 26–28%.
Derivation: From calcium sulfide by treating it in the cold with sodium bisulfate.
Grade: Technical, flake, 70–72%, soluble 40–44%.
Hazard: Contact with acids causes evolution of toxic gases.
Use: Paper pulping, dyestuffs processing, rayon and cellophane desulfurizing, unhairing hides, bleaching reagent.

sodium hydrosulfite. See sodium dithionite.

sodium hydroxide. (caustic soda; sodium hydrate; lye; white caustic). CAS: 1310-73-2. The most important commercial caustic. Eighth highest-volume chemical produced in U.S. (1991).

Properties: White, deliquescent solid; chiefly in form of beads or pellets, also 50% and 73% aqueous solutions. Absorbs water and carbon dioxide from the air, d 2.13, mp 318C, bp 1390C, soluble in water, alcohol, and glycerol.

Derivation: Electrolysis of sodium chloride (brines) (electrolytic cell), reaction of calcium hydroxide and sodium carbonate.

Grade: Commercial, ground, flake, beads, FCC, granulated (60% and 75% Na_2O), rayon (low in iron, copper, and manganese), purified by alcohol (sticks, lumps, and drops), reagent, highest purity, CP, USP.

Hazard: Corrosive to tissue in presence of moisture, strong irritant to tissue (eyes, skin, mucous membranes), by ingestion. TLV: ceiling of 2 mg/m^3 of air.

Use: Chemical manufacture, rayon and cellophane, neutralizing agent in petroleum refining; pulp and paper, aluminum, detergents, soap, textile processing, vegetable oil refining, reclaiming rubber, regenerating ion exchange resins, organic fusions, peeling of fruits and vegetables in food industry, lab reagent, etching and electroplating, food additive.

sodium hypochlorite. CAS: 7681-52-9. $NaOCl \cdot 5H_2O$.

Properties: Unstable in air unless mixed with sodium hydroxide. Strong oxidizing agent, usually stored and used in solution, disagreeable, sweetish odor and pale greenish color, soluble in cold water, decomposed by hot water, mp 18C.

Derivation: Addition of chlorine to cold dilute solution of sodium hydroxide.

Grade: Technical.

Hazard: Fire risk in contact with organic materials. Toxic by ingestion, strong irritant to tissue.

Use: Bleaching paper pulp, textiles, etc., intermediate, organic chemicals, water purification, medicine, fungicides, swimming-pool disinfectant laundering, reagent, germicide.

sodium hypophosphite. CAS: 7681-53-0. $NaH_2PO_2 \cdot H_2O$.

Properties: Colorless, pearly, crystalline plates or white granular powder; saline taste; deliquescent. Soluble in water, partially soluble in alcohol.

Derivation: By neutralizing hypophosphoric acid with sodium carbonate.

Grade: Technical, CP.

Hazard: Explosion risk when mixed with strong oxidizing agents, decomposes to phosphine on heating, store in cool, dry place, away from oxidizing materials.

Use: Pharmaceuticals, reducing agent in electrodeless nickel plating of plastics and metals, lab reagent, substitute for sodium nitrite in smoked meats.

sodium hyposulfate. See sodium dithionate.

sodium inosinate. CAS: 4691-65-0. $C_{10}H_{11}Na_2N_4O_8P$. A 5′-nucleotide derived from seaweed or dried fish. Sodium guanylate is a by-product.

Use: Flavor potentiator in foods.

See also inosinic acid.

sodium iodate. CAS: 7681-55-2. $NaIO_3$.

Properties: White crystals, d 4.28, soluble in water and acetone, insoluble in alcohol.

Derivation: Interaction of sodium chlorate and iodine in presence of nitric acid.

Grade: CP, reagent, technical.

Hazard: Oxidizing agent, fire risk near organic materials.

Use: Antiseptic, disinfectant, feed additive reagent.

sodium iodide. CAS: 7681-82-5. (1) NaI (2) $NaI \cdot 2H_2O$.

Properties: White, cubical crystals or powder, or colorless, odorless crystals; slowly becomes brown in air, deliquescent, saline, somewhat bitter taste; soluble in water, alcohol, and glycerol; d (1) 3.665, (2) 2.448 (21C), mp (1) 653C, bp (1) 1304C.

Grade: Technical, CP, USP, single crystals.

Use: Photography, solvent for iodine, organic chemicals, reagent, feed additive, cloud seeding, scintillation (thallium-activated form), expectorant.

sodium iodide (I-131). (sodium radio-iodide). A radioactive form of sodium iodide containing iodine-131, which can be used as a tracer.

Grade: USP (as capsules or solution).

See iodine-131.

sodium iodipamide. N,N′-adipolybis(3-amino-2,4,6-triiodobenzoic acid) disodium salt. $C_{20}H_{12}I_6N_2NaO_6$.

Properties: Radiopaque, water-soluble, available as a 20% solution for injection as a clear, colorless to pale-yellow, slightly viscous liquid.

Derivation: By dissolving the free acid in dilute sodium hydroxide and buffering to pH 6.5–7.7.

Grade: USP.

Use: X-ray contrast medium.

sodium iodomethanesulfonate. See sodium methiodal.

sodium iothalamate. (sodium-5-acetamido-2,4,6-triiodo-N-methylisophthalamate). CAS: 1225-20-3. $C_6I_3(CONHCH_3)_2COONa$.

Grade: USP (for injection).

Use: Medicine (radiopaque medium).

sulfur dichloride. SCl_2.
Properties: Reddish-brown, fuming liquid with pungent chlorine odor. D 1.638 (15.5C), fp −78C, bp decomposes above 59C on rapid heating, boils near 60C, decomposes in water and alcohol, soluble in benzene, refr index 1.567 (20C).
Derivation: Chlorine is passed into sulfur monochloride to saturation at 6–10C followed by carbon dioxide to drive off the excess chlorine.
Grade: Technical.
Hazard: Toxic by inhalation and ingestion, strong irritant to tissue.
Use: Chlorine carrier or chlorinating agent, rubber vulcanizing, vulcanized oils, purifying sugar juices, sulfur solvent, chloridizing agent in metallurgy, manufacture of organic chemicals and insecticides.

sulfur dioxide. CAS: 7446-09-5. SO_2.
Properties: Colorless gas or liquid with sharp, pungent odor; soluble in water, alcohol, and ether; forms sulfurous acid (H_2SO_3). D 1.4337, liquid at 0C, fp −76.1C, bp −10C, vap press 3.2 atmosphere at 20C, refr index (liquid) 1.410 (24C), an outstanding oxidizing and reducing agent. Non-combustible.
Derivation: (1) By roasting pyrites in special furnaces. The gas is readily liquefied by cooling with ice and salt or at a pressure of three atmospheres. (2) By purifying and compressing sulfur dioxide gas from smelting operations. (3) By burning sulfur.
Grade: Commercial, USP, technical, refrigeration, anhydrous 99.98% min.
Hazard: Toxic by inhalation, strong irritant to eyes and mucous membranes, especially under pressure. Dangerous air contaminant and constituent of smog. Not permitted in meats and other sources of vitamin B_1. TLV: 2 ppm in air, U.S. atmospheric standard 0.140 ppm.
Use: Chemicals (H_2SO_4, salt cake, sulfites, hydrosulfites of potassium and sodium, thiosulfates, alum from shale, recovery of volatile substances), sulfite paper pulp, ore and metal refining, soybean protein, intermediates, solvent extraction of lubricating oils, bleaching agent for oils and starch, sulfonation of oils, disinfecting and fumigating, food additive (inhibition of browning, of enzyme-catalyzed reactions, bacterial growth), reducing agent, antioxidant.

sulfur dye. See sulfide dye.

sulfuretted hydrogen. See hydrogen sulfide.

sulfur hexafluoride. CAS: 2551-62-4. SF_6.
Properties: Colorless gas, fp −64C (sublimes), d (gas) 6.5 g/L, d (liquid) 1.67, specific volume 2.5 cu ft/lb (21.1C), slightly soluble in water, soluble in alcohol and ether, odorless. Non-combustible.
Hazard: TLV: 1000 ppm in air.
Use: Dielectric (gaseous insulator for electrica equipment and radar wave guides).

sulfuric acid. (hydrogen sulfate; battery acid electrolyte acid). CAS: 7664-93-9. H_2SO_4. By far the most widely used industrial chemical its production was 79.23 billion pounds in 1985 Highest-volume chemical produced in U.S (1991).
Properties: Strongly corrosive, dense, oily liquid: colorless to dark brown depending on purity; miscible with water. Very reactive, dissolves most metals; concentrated acid oxidizes, dehydrates, or sulfonates most organic compounds, often causes charring; d of pure material 1.84; mp 10.4C; bp varies over range 315–338C due to loss of sulfur trioxide during heating to 300C or higher.
Note: Use great caution in mixing with water because of heat evolution that causes explosive spattering. Always add the acid to water, *never* the reverse.
Derivation: From sulfur, pyrite (FeS_2), hydrogen sulfide, or sulfur-containing smelter gases by the contact process (vanadium pentoxide catalyst). The first step is combustion of elemental sulfur or roasting of iron pyrites to yield sulfur dioxide. Then follows the critical reaction—catalytic oxidation of sulfur dioxide to sulfur trioxide

$$(SO_2 + \tfrac{1}{2}O_2 \xrightarrow[425°C]{V_2O_5} SO_3)$$

in a four-stage converter at 425–450C with evolution of heat. After cooling to 160C, the sulfur trioxide is absorbed in a circulating stream of 98–99% sulfuric acid, where it unites with the small excess of water in the acid to form more sulfuric acid.

$$(SO_3 + H_2O \xrightarrow{260°C} H_2SO_4)$$

Sulfuric acid can also be made by the "Cat-Ox" process and from gypsum (calcium sulfate).
Grade: Commercial 60 degrees Bé: (d 1.71, 77.7% sulfuric acid); 66 degrees Bé (d 1.84, 93.2% sulfuric acid); 98% (d 1.84); 99% (d 1.84). 100% (d: 1.84), depending on supplier; reagent ACS, CP.
Hazard: Strong irritant to tissue. TLV: 1 mg/m^3 of air.
See note above.
Use: Fertilizers, chemicals, dyes and pigments, etchant, alkylation catalyst, electroplating baths, iron and steel, rayon and film, industrial explosives, lab reagent, nonferrous metallurgy.
See also sulfuric acid, fuming.

iponitrile, cyanide salts, dyes, chelates, rodenticides, pesticides.

"Hydro-Darco" [*American Norit*]. TM for activated carbon based adsorbent.
Use: For purification of water, fine chemicals, waste water, air, and pharmaceuticals. Used for recovery of valuable products as in gold and organic solvents.

hydrodealkylation. (HDA). A type of hydrogenation used in petroleum refining in which heat and pressure in the presence of hydrogen are used to remove methyl or larger alkyl groups from hydrocarbon molecules, or to change the position of such groups. The process is used to upgrade products of low value, such as heavy reformate fractions, naphthenic crudes, or recycle stocks from catalytic cracking. Also toluene and pyrolysis gasoline are converted to benzene and methyl naphthalenes to naphthalene by this process.
See also transalkylation.

hydrodistillation. (steam distillation). Removal of essential oils from plant components (flowers, leaves, bark, etc.) by the use of high-temperature steam. The process is used chiefly in the perfume and fragrance industry.

hydrofining. A petroleum refining process in which a limited amount of hydrogenation converts the sulfur and nitrogen in a petroleum fraction to forms in which they can be easily removed. Hydrofining is generally a separate treatment prior to more extensive hydrogenation. The usual catalysts are oxides of cobalt and molybdenum. Desulfurization, ultrafining, and catfining have a similar meaning.

hydroflumethiazide. (trifluoromethylhydrothiazide). CAS: 135-09-1. $C_8H_8F_3N_3O_4S_2$.
Properties: White, crystalline, odorless solid. Mp 260–275C, insoluble in water and acid, soluble in dilute alkali but unstable in alkaline solutions.
Grade: NF.
Use: Medicine (antihypertensive).

hydrofluoric acid. CAS: 7664-39-3. Hydrogen fluoride in aqueous solution.
Properties: Colorless, fuming, mobile liquid; bp (38% solution) 112C. Will attack glass and any silicon-containing material.
Derivation: Dissolving hydrogen fluoride in water to various concentrations.
Grade: CP, technical, 38%, 47%, 53%, 70%.
Hazard: Toxic by ingestion and inhalation, highly corrosive to skin and mucous membranes. TLV: ceiling 3 ppm.
Use: Aluminum production, fluorocarbons, pickling stainless steel, etching glass, acidizing oil wells, fluorides, gasoline production (alkylation), processing uranium.
See also hydrogen fluoride.

hydrofluorosilicic acid. Legal label name (Rail) for fluosilicic acid.

hydrofluosilicic acid. See fluosilicic acid.

"Hydrofol" [*Sherex*]. (behenic acid).
CAS: 112-85-6. TM for synthetic waxes.
Use: For lubricants, esters, chemical synthesis, and specialties.

"Hydrofol" [*Ashland*]. (stearic acid).
CAS: 57-11-4. TM for an additive.
Use: In esters, greases, candles, crayons, cosmetics, metallic salts, mono- and diglyceride, shaving creams, textile auxiliaries, white stearates, waxes, and rubber compounding.

hydroforming. The use of hydrogen in the presence of heat, pressure, and catalysts (usually platinum) to convert olefinic hydrocarbons to branched-chain paraffins (isomerization) to yield high-octane gasoline. Catforming and similar terms are often used in the same sense.

hydrofuramide. (furfuramide). CAS: 494-47-3. $OC_4H_3CH(NCHC_4H_3O)_2$.
Properties: Light brown to white powder, mp 117C, boils about 250C with decomposition, insoluble in cold water, soluble in alcohol and ether.
Derivation: Treatment of furfural with ammonia.
Use: Rubber accelerator, hardening agent for resins, rodenticides, fungicides.

hydrogasification. Production of gaseous or liquid fuels by direct addition of hydrogen to coal.
See also gasification.

hydrogen. CAS: 1333-74-0. H_2. Nonmetallic element of atomic number 1, group IA of periodic table, atomic weight 1.0079, valence of 1. Molecular formula is H_2. Isotopes: deuterium (^2D), tritium (^3T). Hydrogen discovered by Cavendish in 1766, named by Lavoisier in 1783.
Properties: A diatomic gas, density 0.08999 g/L, d 0.0694 (air = 1.0), specific volume 193 cu ft/lb (21.1C), fp −259C, bp −252C, autoign temperature 1075F (580C). Very slightly soluble in water, alcohol, and ether; Noncorrosive; can exist in crystalline state at from 4–1 K; classed as an asphyxiant gas; rate of permeation through solids is approximately four times that of air.
Occurrence: Chiefly in combined form (water, hydrocarbons, and other organic compounds),

ple is the nitration of cellulose to nitrocellulose. It is widely used in aromatic reactions to form such compounds as nitrobenzene, trinitrotoluene, nitroglycerin, and other explosives. Aromatic nitrations are usually effected with mixed acid, a mixture of nitric and sulfuric acids, at 0–120C. Aliphatic nitration is less common than aromatic, but propane can be nitrated under pressure to yield nitroparaffins.

nitrene. Electron-deficient, uncharged monovalent nitrogen species with either singlet or triplet electronic configurations; analog of carbene.

nitric acid. (aqua fortis; engraver's acid; azotic acid). CAS: 7697-37-2. HNO_3. 13th highest-volume chemical produced in U.S. (1991).
Properties: Transparent, colorless or yellowish, fuming, suffocating, hygroscopic, corrosive liquid. Will attack almost all metals. The yellow color is due to release of nitrogen dioxide on exposure to light; strong oxidizing agent, miscible with water, decomposes in alcohol, bp (decomposes) 78C, fp −42C, d 1.504 (25/4C), vap press 62 mm Hg (25C), refr index 1.3970 (24C), viscosity 0.761 cP (25C).
Derivation: (1) Oxidation of ammonia by air or oxygen with platinum catalyst. (*Note*: A pelleted catalyst not containing platinum or other noble metals is available.) Air oxidation yields 60% acid; concentration is achieved by (1) distillation with sulfuric acid, (2) extractive distillation with magnesium nitrate, or (3) by neutralizing the weak acid with soda ash, evaporating to dryness, and treating with sulfuric acid. Method (3) yields synthetic niter cake ($NaHSO_4$) as a by-product. (2) High-pressure oxidation of nitrogen tetroxide (yields 98% acid). (3) Reaction of nitrogen and oxygen in nuclear reactors; two tons of nitric acid are said to be produced from one gram of enriched uranium. Not in commercial use.
Strength of solutions: 36, 38, 40, 42 degrees Bé; 58–63.5%; 95%.
Hazard: Dangerous fire risk in contact with organic materials. Highly toxic by inhalation, corrosive to skin and mucous membranes, strong oxidizing agent. TLV: 2 ppm in air.
Use: Manufacture of ammonium nitrate for fertilizer and explosives, organic synthesis (dyes, drugs, explosives, cellulose nitrate, nitrate salts), metallurgy, photo-engraving, etching steel, ore flotation, urethanes, rubber chemicals, reprocessing spent nuclear fuel.

nitric acid, fuming. (1) White fuming nitric acid (WFNA) contains more than 97.5% nitric acid, less than 2% water, and less than 0.5% NO_x. It is a colorless or pale yellow liquid which fumes strongly. It is decomposed by light or elevated temperatures, becoming red in color from nitrogen dioxide.
(2) Red fuming nitric acid (RFNA) contains more than 85% nitric acid, approximately 6–15% NO_x (as nitrogen dioxide), and less than 5% water.
Derivation: From dilute nitric acid, nitrogen dioxide, and oxygen.
Hazard: Toxic by inhalation, corrosive to skin and mucous membranes. Strong oxidizing agent, may explode in contact with strong reducing agents. Dangerous fire risk.
Use: Preparation of nitro-compounds, rocket fuels, laboratory reagent.

nitric oxide. CAS: 10102-43-9. NO.
Properties: Colorless gas (readily reacts with oxygen at room temperature to form nitrogen dioxide, NO_2, a reddish-brown gas), bp −152C, fp −164C, d at bp 1.27, slightly soluble in water. Non-combustible.
Derivation: Oxidation of ammonia above 500C, decomposition of nitrous acid (aqueous solution). Also from atmospheric oxygen and nitrogen in the electric-arc process for fixation of nitrogen.
Grade: Pure (99%).
Hazard: Supports combustion. Toxic by inhalation, strong irritant to skin and mucous membranes. TLV: 25 ppm in air.
Use: Intermediate in production of nitric acid from ammonia, preparation of nitrosyl carbonyls, bleaching rayon.
See also nitrogen dioxide.

nitride. A compound of metal and nitrogen, as in aluminum nitride.

nitriding. A process of case hardening in which a ferrous alloy, usually of special composition, is heated in an atmosphere of ammonia or in contact with nitrogenous material to produce surface hardening by absorption of the nitrogen without quenching. The alloys used for nitriding are known as nitroalloys. Several types are
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tion, mp 214
Derivation: By
Use: Manufacture
p-nitro-o-aminophenol.
$C_6H_3OHNH_2NO_2$.

90-4.
liquid, partially
ature, mp approxi-
uble in ether, decom-
ol. Combustible.
tion.

methylacetopyranone. See dehydroacetic acid.

methylacetylene. (allylene; propyne).
CAS: 74-99-7. $CH_2C{\equiv}CH$.
Properties: Colorless, liquefied gas. Bp −23.1C, fp −101.5C, sp vol 9.7 cu ft/lb (70F).
Hazard: Flammable, dangerous fire risk. Toxic by inhalation. TLV: 1000 ppm in air.
Use: Specialty fuel, chemical intermediate.

methylacetylene-propadiene, stabilized. (MAPP).
Properties: Colorless, liquefied gas. D (liquid): 0.576 (15/15C), boiling range −39 to −20C, flame temperature (in oxygen) 2925C. A mixture containing 60–66.5% methylacetylene and propadiene, balance propane and butane.
Hazard: Flammable, dangerous fire risk. Toxic by inhalation. TLV: 1000 ppm in air.
Use: Industrial fuel gas for cutting, welding, brazing, heat treating, metallizing.
See also "Mapp."

methyl acetylricinoleate.
$C_{17}H_{32}(OCOCH_3)COOCH_3$.
Properties: Pale yellow, low viscosity, oily liquid. Mild odor, d 0.938 (25/25C), solidifies at −26C, soluble in most organic liquids, insoluble in water. Combustible.
Derivation: Castor oil, methanol and acetic anhydride.
Use: Plasticizer, lubricant, protective coatings, synthetic rubbers, vinyl compounds.

methyl acetylsalicylate. CAS: 580-02-9.
$CH_3COOC_6H_4COOCH_3$.
Properties: White crystals, mp 52C, 134–136C (9 mm Hg).
Derivation: By heating methyl salicylate with a slight excess of acetic anhydride, adding alcohol, then water, and separating the resulting precipitate.
Use: Perfumery (fixative).

methyl acid phosphate. See methylphosphoric acid.

β-methylacrolein. See crotonaldehyde.

methyl acrylate. CAS: 96-33-3.
$CH_2{:}CHCOOCH_3$.
Properties: Colorless, volatile liquid. Bp 80.5C, fp −76.5C, vap press 65 mm Hg (20C), d 0.9574 (20/20C), bulk d 8.0 lb/gal, slightly soluble in water, readily polymerized, flash p 25F (−3.8C) (TOC).
Derivation: (1) Ethylene cyanohydrin, methanol, and dilute sulfuric acid; (2) Oxo reaction of acetylene, carbon monoxide, and methanol in the presence of nickel or cobalt catalyst; (3) from β-propiolactone.
Grade: Technical (inhibited).
Hazard: Flammable, dangerous fire and explosion risk. Toxic by inhalation, ingestion, and skin absorption; irritant to skin and eyes. TLV: 10 ppm in air.
Use: Acrylic polymers, amphoteric surfactants, vitamin B_1, chemical intermediate.
See also acrylate.

β-methylacrylic acid. See crotonic acid.

methylal. (dimethoxymethane; formal).
CAS: 109-87-5. $CH_3OCH_2OCH_3$.
Properties: Colorless, volatile liquid; chloroform-like odor; pungent taste; fp −105C; d 0.86 (20/4C); bp 42.3C; soluble in water at 20C to extent of 32 wt%; miscible in alcohol, ether, and hydrocarbons; flash p (OC) approximately 0F (−17.7C); autoign temp 459F (237C).
Hazard: Flammable, dangerous fire and explosion risk. Toxic by ingestion and inhalation. TLV: 1000 ppm in air.
Use: Solvent, organic synthesis, perfumes, adhesives, and protective coatings; special fuel.

2-methylalanine. See aminoisobutyric acid.

methyl alcohol. (methanol; wood alcohol).
CAS: 67-56-1. CH_3OH. 22nd highest-volume chemical produced in U.S. (1991).
Properties: Clear, colorless, mobile, highly polar liquid; miscible with water, alcohols, and ether. D 0.7924, fp −97.8C, bp 64.5C, bulk d 6.59 lb/gal (20C), refr index 1.329 (20C), surface tension 22.6 dynes/dm (20C), viscosity 0.00593 poise (20C), vap press 92 mm Hg (20C), flash p 54F (12.2C) (OC), autoign temp 867F (464C).
Derivation: (1) By high-pressure catalytic synthesis from carbon monoxide and hydrogen; (2) partial oxidation of natural gas hydrocarbons; (3) several processes for making methanol by gasification of wood, peat, and lignite have been developed but have not yet proved out commercially; (4) from methane with molybdenum catalyst (experimental).
Method of purification: Rectification.
Grade: Technical, CP (99.85%), electronic (used to cleanse and dry components), fuel.
Hazard: Flammable, dangerous fire risk. Explosive limits in air 6–36.5% by volume. Toxic by ingestion (causes blindness). TLV: 200 ppm in air.
Use: Manufacture of formaldehyde, acetic acid, and dimethyl terephthalate; chemical synthesis (methyl amines, methyl chloride, methyl methacrylate); antifreeze; solvent for nitrocellulose, ethylcellulose, polyvinyl butyral, shellac, rosin, manila resin, dyes; denaturant for ethanol; dehydrator for natural gas; fuel for utility plants (methyl fuel); feedstock for manufacture of synthetic proteins by continuous fermentation;

Derivation: (1) Addition of sodium cyanide and formaldehyde to a basic solution of ethylenediamine (forms the tetrasodium salt), (2) heating tetrahydroxyethylethylenediamine with sodium hydroxide or potassium hydroxide with cadmium oxide catalyst.
Use: Detergents, liquid soaps, shampoos, agricultural chemical sprays; metal cleaning and plating, metal chelating agent, treatment of chlorosis, decontamination of radioactive surfaces; metal deactivator in vegetable oils, oil emulsions, pharmaceutical products, etc.; anticoagulant of blood, eluting agent in ion exchange; to remove insoluble deposits of calcium and magnesium soaps; in textiles to improve dyeing, scouring, and detergent operations; antioxidant; clarification of liquids; analytical chemistry, spectrophotometric titration; aid in reducing blood cholesterol; in medicine to treat lead poisoning and calcinosis; food additive (preservative).
Note: A number of salts of EDTA are available with uses identical or similar to the acid. The USP salts are called edetates (calcium disodium, disodium edetates), others are usually abbreviated to EDTA (tetrasodium, trisodium EDTA). Other salts, known chiefly under trademark names, are the sodium ferric, dihydrogen ferrous and a range of disodium salts with magnesium, divalent cobalt, manganese, copper, zinc, and nickel.

ethylenediaminetetraacetonitrile. (EDTAN). $[-CH_2NCH_2CN_2]_2$.
Properties: White, crystalline solid. Melting range 126–132C, bulk d 48.4 lb/cu ft, slightly soluble in water, soluble in acetone.
Hazard: Toxic by ingestion and inhalation.
Use: Chelating agent and intermediate.

ethylene dibromide. (EDB; 1,2-dibromoethane; ethylene bromide). CAS: 106-93-4. $BrCH_2CH_2Br$.
Properties: Colorless, non-flammable liquid. Sweetish odor, emulsifiable, miscible with most solvents and thinners, slightly soluble in water, d 2.17–2.18 (20C), bulk d 18.1 lb/gal, bp 131C, vap press 17.4 mm Hg (30C), fp 9C, refr index 1.5337 (25C), flash p none.
Derivation: Action of bromine on ethylene.
Hazard: TLV: suspected human carcinogen. Toxic by inhalation, ingestion, and skin absorption, strong irritant to eyes and skin.
Use: Scavenger for lead in gasoline, grain fumigant, general solvent, waterproofing preparations, organic synthesis, fumigant for tree crops.
Note: May poison platinum catalysts.

ethylene dichloride. (sym-dichloroethane; 1,2-dichloroethane; ethylene chloride; Dutch oil). CAS:107-06-2. $ClCH_2CH_2Cl$. 15th highest-volume chemical produced in U.S. (1991).
Properties: Colorless, oily liquid. Chloroform-like odor, sweet taste. Stable to water, alkalies, acids, or active chemicals; resistant to oxidation, will not corrode metals, miscible with most common solvents, slightly soluble in water, bp 83.5C, fp −35.5C, d 1.2554 (20/4C), 10.4 lb/gal, refr index 1.444, flash p 56C (13.3C).
Derivation: Action of chlorine on ethylene with subsequent distillation with metallic catalyst, also by reaction of acetylene and hydrochloric acid.
Grade: Technical, spectrophotometric.
Hazard: Toxic by ingestion, inhalation, and skin absorption; strong irritant to eyes and skin, a carcinogen. Flammable, dangerous fire risk, explosive limits in air 6–16%. TLV: 10 ppm in air.
Use: Production of vinyl chloride, trichloroethylene, vinylidene chloride, and trichloroethane; lead scavenger in antiknock gasoline; paint, varnish, and finish removers; metal degreasing; soaps and scouring compounds, wetting and penetrating agents; organic synthesis, ore flotation; solvent, fumigant.

ethylene dicyanide. See ethylene cyanide.

ethylenedinitrilotetraacetic acid. See ethylenediaminetetraacetic acid.

ethylenedinitrilotetra-2-propanol. See N,N,N′,N′-tetrakis(2-hydroxypropyl)ethylenediamine.

ethylenediphenyldiamine. See N,N-diphenylethylenediamine.

1,1′-ethylene-2,2′-dipyridinium dibromide. See diquat.

ethylene glycol. (ethylene alcohol; glycol; 1,2-ethanediol). CAS: 107-21-1. CH_2OHCH_2OH. The simplest glycol; 30th highest-volume chemical produced in U.S. (1991).
Properties: Clear, colorless, syrupy liquid. Sweet taste, hygroscopic, lowers fp of water, relatively non-volatile, odorless. Soluble in water, alcohol, and acetone. D 1.1155 (20C), bp 197.2C, fp −13.5C, bulk d 9.31 lb/gal (15/15C), refr index 1.430 (25C), flash p 240.8F (116C), autoign temperature 775F (412C). Combustible.
Derivation: (1) Air oxidation of ethylene followed by hydration of the ethylene oxide formed, (2) acetoxylation, (3) from carbon monoxide and hydrogen (synthesis gas) from coal gasification, (4) Oxirane process.
Grade: Technical.
Hazard: TLV: (vapor) ceiling 50 ppm. Toxic by ingestion and inhalation. Lethal dose reported to be 100 cc.

acetate fiber, saponified. Regenerated cellulose fibers obtained by complete saponification of highly oriented cellulose acetate fibers. Available in continuous filament form having a high degree of crystallinity and great strength.
Properties: Tensile strength (psi) 136,000–155,000; elongation 6%; d 1.5–1.6; moisture regain 9.6–10.7%; decomposes about 149C. Similar to cotton in chemical resistance, dyeing, and resistance to insects and mildew. Combustible.
Use: Cargo parachutes; typewriter ribbons; belts; webbing; tapes; carpet backing.

acetate film. A durable, highly transparent film with non-deforming characteristics, produced from cellulose acetate resin. It is grease-, oil-, dust-, and air-proof and hygienic. Combustible.
Available forms: Rolls and cut-to-size sheets.
Use: Laminates; support for photographic film; document preservation; pressure-sensitive tape; magnetic sound recording tape; window cartons and envelopes packaging.

acetate of lime. Commercial term for calcium acetate made from pyroligneous acid and milk of lime. There are brown and gray acetates of lime.
See also calcium acetate.

acetate process. See cellulose acetate.

acetate rayon. The yarn made from refined wood cellulose by the acetate process.
See acetate fiber

acetate rayon process. In this process cellulose is combined with acetic anhydride to make cellulose acetate, which is dissolved in acetone and forced through spinnerette holes into a precipitating bath. See acetate fiber.

acethydrazidepyridinium chloride. See Girard's reagent.

acetic acid. (ethanoic acid; vinegar acid; methanecarboxylic acid). CAS: 64-19-7. (CH_3COOH). Glacial acetic acid is the pure compound (99.8% min), as distinguished from the usual water solutions known as acetic acid. 34th highest-volume chemical produced in U.S. (1991).
Properties: Clear, colorless liquid; pungent odor. Mp 16.63C; bp 118C (765 mmHg), 80C (202 mmHg); d 1.0492 (20/4C); wt/gal (20C) 8.64 lb; viscosity (20C) 1.22 cps; flash p (OC) 110F (43C); refr index 1.3715 (20C). Miscible with water, alcohol, glycerol, and ether; insoluble in carbon disulfide; autoign temperature 800F (426C). Combustible.
Derivation: (a) Liquid- and vapor-phase oxidation of petroleum gases (with catalyst); (b) oxidation of acetaldehyde; (c) reaction of methanol and carbon monoxide (with catalyst; this is the most cost-efficient method and has been in general use for some years); (d) fermentative oxidation of ethanol.
Grade: USP (glacial, 99.4 wt %, and dilute, 36–37 wt %); CP; technical (80; 99.5%); commercial (6, 28, 30, 36, 56, 60, 70, 80, and 99.5%); NF (diluted; 6.0 g/100 mL).
Hazard: Moderate fire risk. Pure acetic acid is moderately toxic by ingestion and inhalation, but dilute material is approved by FDA for food use. Strong irritant to skin and tissue. TLV: 10 ppm in air.
Use: Manufacturing of acetic anhydride, cellulose acetate, and vinyl acetate monomer; acetic esters; chloroacetic acid; production of plastics, pharmaceuticals, dyes, insecticides, photographic chemicals, etc., food additive (acidulant); latex coagulant; oil-well acidizer; textile printing.
See also vinegar.

acetic acid amine. See acetamide.

acetic acid, glacial. See acetic acid.

acetic aldehyde. See acetaldehyde.

acetic anhydride. (acetyl oxide; acetic oxide). CAS: 108-24-7. $(CH_3CO)_2O$.
Properties: Colorless, mobile, strongly refractive liquid; strong odor; d 1.0830 (20/20C); bp 139.9C; fp −73.1C; flash p 121F (49.4C) (CC). Autoign temperature 732F (385C); wt/gal (20C) 9.01 lb. Miscible with alcohol, ether, and acetic acid; soluble in cold water; decomposes in hot water to form acetic acid. Combustible.
Derivation: (1) Oxidation of acetaldehyde with air or oxygen with catalyst; (2) by catalyzed thermal decomposition of acetic acid to ketone; (3) reaction of ethyl acetate and carbon monoxide; (4) from carbon monoxide and methanol.
Grade: C.P., technical (75, 85, 90–95%).
Hazard: Strong irritant and corrosive; may cause burns and eye damage. TLV: Ceiling 5 ppm in air. Moderate fire risk.
Use: Cellulose acetate fibers and plastics; vinyl acetate; dehydrating and acetylating agent in production of pharmaceuticals, dyes, perfumes, explosives; etc.; aspirin. Esterifying agent for food starch (5% max).

acetic ester. See ethyl acetate.

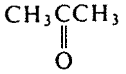
acetic ether. See ethyl acetate.

acetic oxide. See acetic anhydride.

acetin. (monoacetin; glyceryl monoacetate). CAS: 102-76-1. $C_3H_5(OH)_2OOCCH_3$.

Hazard: Toxic by ingestion.
Use: Medicine (antiseptic, solution 1:1000).

acetone. (dimethylketone; 2-propanone). CAS: 67-64-1. CH_3COCH_3. 44th highest-volume chemical produced in U.S. (1991).



$$CH_3\underset{\underset{O}{\|}}{C}CH_3$$

Properties: Colorless, volatile liquid; sweetish odor. Mp −94.3C; bp 56.2C; refr index (20C) 1.3591; d 0.792 (20/20C); wt/gal 6.64 lb (15C); flash p (OC) 15F (−9.4C). Autoign temperature 1000F (537C). Miscible with water, alcohol, ether, chloroform, and most oils.
Derivation: (1) Oxidation of cumene; (2) dehydrogenation or oxidation of isopropyl alcohol with metallic catalyst; (3) vapor phase oxidation of butane; (4) by-product of synthetic glyerol production.
Grade: Technical; CP; NF; electronic; spectrophotometric.
Hazard: Flammable; dangerous fire risk. Explosive limits in air 2.6–12.8%. TLV: 750 ppm in air. Narcotic in high concentrations. Moderately toxic by ingestion and inhalation.
Use: Chemicals (methyl isobutyl ketone; methyl isobutyl carbinol; methyl methacrylate; bisphenol-A); paint, varnish and lacquer solvent; cellulose acetate, especially as spinning solvent; to clean and dry parts of precision equipment; solvent for potassium iodide and permanganate; delusterant for cellulose acetate fibers; specification testing of vulcanized rubber products.

acetone bromoform. See tribromo-tert-butyl alcohol.

acetonecarboxylic acid. See acetoacetic acid.

acetone chloroform. See chlorobutanol.

acetone cyanohydrin. (α-hydroxyisobutyronitrile; 2-methyllactonitrile). CAS: 75-86-5. $(CH_3)_2COHCN$.
Properties: Colorless liquid; bp 82C (23 mm Hg); mp −20C; d 0.932 (19C); refr index 1.3996 (20C); flash p 165F (73.9C); soluble in alcohol and ether. Combustible; autoign temperature 1270F (685C).
Derivation: Condensing acetone with hydrocyanic acid.
Grade: Technical (97–98% pure).
Hazard: Toxic. Readily decomposes to hydrocyanic acid and acetone.
Use: Insecticides; intermediate for organic synthesis, especially methyl methacrylate.

acetonedicarboxyllic acid.
See β-ketoglutaric acid.

acetone number. The degree of polymerization of a bodied vegetable oil, measured by the amount of matter which is insoluble in acetone.

acetone oxime. See acetoxime.

acetone semicarbazone. $(CH_3)_2CNNHCONH_2$. A chemical intermediate.
Properties: White powder; mp 188C.

acetone sodium bisulfate. See sodium acetone bisulfate.

acetonitrile. (methyl cyanide). CAS: 75-05-8. CH_3CN.
Properties: Colorless, limpid liquid; aromatic odor; d 0.783; mp −41C; bp 82C; flash p 42F (5.56C). Soluble in water and alcohol; high dielectric constant; high polarity; strongly reactive.
Derivation: By-product of propylene-ammonia process for acrylonitrile.
Grade: Technical; nanograde; spectrophotometric.
Hazard: Flammable, dangerous fire risk. TLV: 40 ppm in air, toxic action by skin absorption and inhalation.
Use: Solvent in hydrocarbon extraction processes, especially for butadiene; specialty solvent; intermediate; catalyst; separation of fatty acids from vegetable oils; manufacturing of synthetic pharmaceuticals.

acetonylacetone. (1,2-diacetylethane; hexanedione-2,5; 2,5-diketohexane). CAS: 110-13-4. $CH_3COCH_2CH_2COCH_3$.
Properties: Colorless liquid, soluble in water, d 0.9734 (20/20C), bp 192.2C, vap press 0.43 mm Hg at 20C, fp −5.4C, flash p 185F (85C), bulk d 8.2 lb/gal (20C), autoign temperature 920F (493C). Combustible.
Derivation: By-product in the production of acetaldehyde from acetylene.
Grade: Technical.
Hazard: Irritant to eyes and skin.
Use: Solvent for cellulose acetate, roll-coating inks, lacquers, stains; intermediate for pharmaceuticals and photographic chemicals; electroplating.

acetonyl alcohol.
See hydroxy-2-propanone.

3-(α-acetonylbenzyl)-4-hydroxycoumarin.
See "Warfarin."

3-(α-acetonylfurfuryl)-4-hydroxycoumarin.
(sodium salt also used). A rodenticide.
Hazard: Highly toxic by ingestion and inhalation.

N-isopropylacrylamide. (NIPAM). Crystalline solid; homopolymers and copolymers prepared with this material show inverse solubility in water.
Use: Binders in textiles, paper, adhesives, detergents, cosmetics.
See also acrylic resin.

isopropyl alcohol. (IPA; dimethylcarbinol; sec propyl alcohol; isopropanol; 2-propanol).
CAS: 67-63-0. $(CH_3)_2CH_2O$. 48th highest-volume chemical produced in U.S. (1991).
Properties: Colorless liquid, pleasant odor, bp 82.4C, d 0.7863 (20/20C), refr index 1.3756 (20C), sp ht 0.65 cal/g, fp −86C, critical temperature 235C, critical pressure 53 atm, vap press 33 mm Hg at 20C, flash p 53F (11.7C (TOC), heat of combustion 14,346 Btu/lb, heat of vaporization 288 Btu/lb, viscosity 2.1 cP (25C), autoign temperature 850F (453C). Soluble in water, alcohol, and ether.
Derivation: By treatment of propylene with sulfuric acid and hydrolyzing.
Method of purification: Rectification.
Grade: 91%, 95%, 99%, NF (99%), nanograde.
Hazard: Flammable, dangerous fire risk, explosive limits in air 2–12%. Toxic by ingestion and inhalation. TLV: 400 ppm in air.
Use: Manufacture of acetone and its derivatives, manufacture of glycerol and isopropyl acetate, solvent for essential and other oils, alkaloids, gums, resins, etc.; latent solvent for cellulose derivatives, coatings solvent, deicing agent for liquid fuels, lacquers, extraction processes, dehydrating agent, preservative, lotions, denaturant.

isopropylamine. (2-aminopropane).
CAS: 75-31-0. $(CH_3)_2CHNH_2$.
Properties: Colorless, volatile liquid. Amine odor, strong alkaline reaction, bp 32.4C, fp −101C, d 0.6881 (20/20C), bulk d 5.7 lb/gal (20C), refr index 1.3770 (15C), flash p (OC) −35F (−37.2C), autoign temperature 756F (402C). Miscible with water, alcohol, and ether.
Derivation: From acetone and ammonia under pressure.
Hazard: Highly flammable, dangerous fire risk. Strong irritant to tissue. TLV: 5 ppm in air.
Use: Solvent, intermediate in synthesis of rubber accelerators, pharmaceuticals, dyes, insecticides, bactericides, textile specialties, and surface-active agents, dehairing agent, solubilizer for 2,4-D acid.

p-isopropylaminodiphenylamine. See N-isopropyl-N′phenyl-p-phenylenediamine.

isopropylaminoethanol. (IPAE).
CAS: 109-56-8. A commercial mixture of approximately 60% isopropylethanolamine, $(CH_3)_2CHNHCH_2CH_2OH$, and 40% isopropyldiethanolamine, $(CH_3)_2CHN(CH_2CH_2OH)_2$.
Properties: Amber to straw-colored liquid, distillation range 110–165C, fp approximately −50C, d 0.91–0.94 (20/20C), flash p 145–155F (62.7–68.3C) (OC). Combustible.
Use: Synthesis of emulsifiers.

N-isopropylaniline. CAS: 768-52-5.
$C_6H_5NHCH(CH_3)_2$.
Properties: Yellowish liquid, bp 206C, pour point below −67C, refr index 1.5365 (20C), flash p 190F (87.7C) (COC). Combustible.
Hazard: Toxic by inhalation and skin absorption. TLV: 2 ppm in air.
Use: Dyeing acrylic fibers, chemical intermediate.

p-isopropylaniline. See cumidine.

isopropyl antimonite. $[(CH_3)_2CHO]_3Sb$.
Properties: Colorless liquid, bp 82C at 7 mm Hg pressure.
Derivation: Reaction of antimony trichloride with isopropanol.
Use: Cross-linking agent, flameproofing agent.

isopropylarsine. See "Epigrade" [*Advanced*].

p-isopropylbenzaldehyde. See cuminic aldehyde.

isopropylbenzene. See cumene.

p-isopropylbenzyl alcohol. See cuminic alcohol.

isopropylbiphenyl. See "Tanacol CG" [*Sybron*].

isopropyl bromide. CAS: 75-26-3.
$CH_3CHBrCH_3$.
Properties: Colorless liquid, d 1.304 (25/25C), bp 58.5–60.5C, fp −90C, refr index 1.422 (25C), flash p none, slightly soluble in water, soluble in ethanol and ether. Non-flammable.
Use: Synthesis of pharmaceuticals, dyes, other organics.

isopropyl butyrate. CAS: 638-11-9.
$(CH_3)_2CHOOCC_3H_7$.
Properties: Colorless liquid, d 0.8652 (13C), bp 128C.
Use: Solvent for cellulose ethers, flavoring.

isopropylcarbinol. See isobutyl alcohol.

isopropyl chloride. CAS: 75-29-6.
$CH_3CHClCH_3$.
Properties: Colorless liquid, d 0.858 (25/25C), bp 34.8C, fp −117.6C, refr index 1.374 (25C), flash p −26F (−32.3C), autoign temperature 1100F (593C), slightly soluble in water, soluble in ethanol and ether.

Hazard: Flammable, moderate fire risk.

Use: Solvent for cellulose acetate, dyeing textiles.

propyl butyrate. CAS: 105-66-8. $C_3H_7OOCC_3H_7$.

Properties: Colorless liquid, d 0.8789 (15C), bp 142.7C, fp −95.2C, slightly soluble in water, soluble in alcohol and ether. Combustible.

Hazard: Irritant to mucous membranes, narcotic in high concentration.

Use: Solvent mixture for cellulose ethers.

propyl chloride. (1-chloropropane). CAS: 540-54-5. $CH_3CH_2CH_2Cl$.

Properties: Liquid, fp −122.8C, bp 46.6C, refr index 1.3886 (20C), soluble in alcohol and ether, slightly soluble in water, flash p 0F (−17.7C).

Hazard: Highly flammable, dangerous fire risk, explosive limits in air 2.5–11%. Irritant and narcotic.

See also isopropyl chloride.

propyl chlorosulfonate. CAS: 109-61-5. $CH_3CH_2CH_2OSO_2Cl$.

Properties: Liquid, bp 70–72C (20 mm Hg).

Derivation: Interaction of n-propyl alcohol and sulfuryl chloride.

Hazard: Toxic by inhalation and ingestion, strong irritant to eyes.

Use: Organic synthesis, military poison gas (lachrymator).

n-propyl cyanide. See n-butyronitrile.

propyl-3,5-diiodo-4-oxo-1(4H)pyridineacetate. See propyliodone.

propylene. (propene). CAS: 115-07-1. $CH_3CH{:}CH_2$. 10th highest-volume chemical produced in U.S. (1991).

Properties: Colorless gas, soluble in alcohol and ether, slightly soluble in water, bp −47.7C, fp −185.2C, d (liquid) 0.5139 (20/4C), vap d at 0C (air = 1) 1.46, flash p −162F (−108C), autoign temp 927F (497C).

Derivation: Catalytic and thermal cracking of ethylene with zeolite catalyst, from naphtha.

Grade: 95%, 99%, and research.

Hazard: Highly flammable, dangerous fire risk, explosive limits in air 2–11%. An asphyxiant gas.

Use: Manufacture of isopropyl alcohol, polypropylene, synthetic glycerol, acrylonitrile, propylene oxide, heptene, cumene, polymer gasoline, acrylic acid, vinyl resins, oxo chemicals.

propylene carbonate.

$C_4H_6O_3$ or $\overbracket{OCOCH_2CH(CH_3)O}$.

Properties: Odorless, colorless liquid; fp −49.2C (easily super-cooled); bp 241.7C; d 1.2057 (20/4C); bulk d 10 lb/gal (20C); refr index 1.4209 (20C); flash p 270F (132C). Miscible with acetone, benzene, chloroform, ether, ethyl acetate; moderately soluble in water and carbon tetrachloride. Combustible.

Use: Solvent extraction, plasticizer, organic synthesis, natural gas purification, synthetic fiber spinning solvent.

propylene chloride. See propylene dichloride.

propylene chlorohydrin. (chloro-isopropyl alcohol; 1-chloro-2-propanol). CAS: 78-89-7. $CH_2ClCH_2OCH_3$.

Properties: Colorless liquid, mild odor, nonresidual, bp 127.5C, vap press 4.9 mm Hg (20C), flash p (CC) 125F (51.6C), bulk d 9.3 lb/gal (20C), d 1.1128 at 20/20C, soluble in water and alcohol.

Grade: Technical.

Hazard: Moderate fire risk. Toxic by ingestion and skin absorption.

Use: Organic synthesis (introducing hydroxypropyl group), manufacture of propylene oxide.

propylenediamine. Legal label name for 1,2-diaminopropane.

propylene dichloride. (1,2-dichloropropane; propylene chloride). CAS: 78-87-5. $CH_3CHClCH_2Cl$.

Properties: Colorless, stable liquid; chloroform-like odor. Bp 96.3C, d 1.1583 at 20/20C, bulk d 9.6 lb/gal (20C), refr index 1.4068 (20C), flash p 61F (16.1C), soluble in water 0.26% by wt (20C), fp −80C, miscible with most common solvents, autoign temp 1035F (557C).

Derivation: Action of chlorine on propylene.

Grade: Refined.

Hazard: Flammable, dangerous fire risk, explosive limits in air 3.4–14.5%. Toxic by ingestion and inhalation. TLV: 75 ppm in air.

Use: Intermediate for perchloroethylene and carbon tetrachloride; lead scavenger for antiknock fluids; solvents for fats, oils, waxes, gums, and resins; solvent mixture for cellulose esters and ethers; scouring compounds; spotting agents; metal degreasing agents; soil fumigant for nematodes.

1,2-propylene glycol. (1,2-dihydroxypropane; 1,2-propanediol; methylene glycol; methyl glycol). CAS: 57-55-6. $CH_3CHOHCH_2OH$.

Properties: Colorless, viscous, stable, hygroscopic liquid; practically odorless and tasteless; miscible with water, alcohols, and many organic solvents. Bp 187.3C, fp −60C, d 1.0381 at 20/20C, bulk d 8.64 lb/gal (20C), refr index 1.4293 (27C), surface tension 40.1 dynes/cm (25C), viscosity 0.581 poise (20C), vap press 0.07 mm Hg (20C), specific heat 0.590 cal/g

(20C), latent heat of evaporation 168.6 cal/g at bp, flash p (OC) 210F (99C), autoign temp 780F (415C), heat of combustion 431.0 kg cal/mole. Combustible.
Derivation: By hydration of propylene oxide.
Method of purification: By distillation.
Grade: Refined, technical, USP, FCC, feed.
Use: Organic synthesis, especially polypropylene glycol and polyester resins, cellophane, antifreeze solution. Solvent for fats, oils, waxes, resins, flavoring extracts, perfumes, colors, soft-drink syrups, antioxidants. Hygroscopic agent, coolant in refrigeration systems, plasticizers, hydraulic fluids, bactericide, textile conditioners. In foods as solvent, wetting agent, humectant. Emulsifier, feed additive, anticaking agent, preservative (retards molds and fungi), cleansing creams, sun tan lotions, pharmaceuticals, brake fluids, deicing fluids for airport runways, tobacco.
See also polypropylene glycol.

1,3-propylene glycol. See trimethylene glycol.

propylene glycol alginate. (hydroxypropyl alginate). ($C_9H_{14}O_7$).
Properties: Vary with degree of esterification. White powder, practically tasteless and odorless, soluble in water and dilute organic acids.
Grade: FCC.
Use: Stabilizer, thickener, emulsifier, food additive.

propylene glycol dinitrate. (PGDN).
CAS: 6423-43-4. $C_3H_6N_2O_6$.
Properties: Colorless liquid with unpleasant odor, mw 166.09, d 1.232 g/ml at 25C, fp −27.7C, bp decomposes above 121C, slightly soluble in water.
Hazard: Toxic by inhalation and skin contact. TLV: 0.05 ppm in air.
Use: Torpedo propellant in Otto Fuel II.

propylene glycol distearate. See propylene glycol monostearate.

propylene glycol monomethyl ether. (polypropylene glycol methyl ether). CAS: 107-98-2.
$CH_3OCH_2CH_2OCH_3$.
Properties: Colorless liquid, fp −95C (sets to glass), bp 120.1C, d 0.9234 (20/20C) bulk d 7.65 lb/gal (25C), refr index 1.402 (25C), flash p 97F (36.1C). Soluble in water, methanol, ether.
Hazard: Flammable, moderate fire risk. TLV: 100 ppm
Use: Solvent for celluloses, acrylics, dyes, inks, stains; solvent-sealing of cellophane.

propylene glycol monoricinoleate.
$C_{17}H_{32}(OH)COOCH_2CH_2OCH_3$.
Properties: Pale yellow, moderately viscous, oily liquid; mild odor. D 0.960 (25/25C), saponification value 160, hydroxyl value 285, solidifies at −26C, soluble in most organic solvents, insoluble in water. Combustible.
Derivation: Castor oil and propylene glycol.
Grade: Technical.
Use: Plasticizer, dye solvents, lubricant, cosmetics, urethane polymers, and hydraulic fluids.

propylene glycol monostearate. The FCC grade is a mixture of propylene glycol mono- and diesters of stearic and palmitic acids. White beads or flakes, bland odor and taste, insoluble in water, soluble in alcohol, ethyl acetate, chloroform and other chlorinated hydrocarbons. Combustible.
Use: Emulsifier, stabilizer.

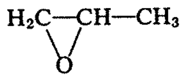
propylene glycol phenyl ether.
$C_6H_5OCH_2CHOHCH_3$.
Properties: Colorless liquid, d 1.060–1.070 (25/25C), boiling range 5.95%, 237–242C, flash p 275F (135C). Combustible.
Use: High-boiling solvent, bactericidal agent, fixative for soaps and perfumes, intermediate for plasticizers.

propyleneimine. (2-methylaziridine; propylenimine). CAS: 75-55-8.

$CH_2HCNHCH_2$.

Properties: Water-white liquid, bp 66–67C, d 0.8039–0.8070 (25/25C), 1.4094–1.4109 (25C), soluble in water and most organic solvents.
Hazard: Flammable, dangerous fire risk. Toxic by ingestion, inhalation, and skin absorption. A suspected carcinogen. TLV: 2 ppm in air.
Use: Organic intermediate whose derivatives are used in the paper, textile, rubber and pharmaceutical industries.

propylene oxide. CAS: 75-56-9.



35st highest-volume chemical produced in U.S. (1991).
Properties: Colorless liquid, ethereal odor, d 0.8304 at 20/20C, bp 33.9C, vap press 445 mm Hg (20C), flash p −35F (−37.2C), bulk d 6.9 lb/gal (20C), fp −104.4C, partially soluble in water, soluble in alcohol and ether.
Derivation: (1) Chlorohydration of propylene followed by saponification with lime, (2) peroxidation of propylene, (3) epoxidation of propylene by a hydroperoxide complex with molybdenum catalyst.
Hazard: Highly flammable, dangerous fire risk,

bp 230.3C, fp −90C, soluble in water, wt/gal 7.8 lb, flash p 250F (121C). Combustible.
Use: Solvent, hydraulic-fluid components, antistall additive for automotive fuels, plasticizer, intermediate.

butoxyethyl laurate. See ethylene glycol monobutyl ether laurate.

butoxyethyl oleate. See ethylene glycol monobutyl ether oleate.

butoxyethyl stearate. See ethylene glycol monobutyl ether stearate.

p-butoxyphenol. $HOC_6H_4OC_4H_9$.
Properties: White to faint yellow, crystalline powder; mp 61–65C. Soluble in alcohol, acetone, ether, benzene, aqueous alkali; insoluble in water. Combustible.
Grade: 93% pure.
Use: Synthesis.

butoxy polypropylene glycol. (generic name for polypropylene glycol monobutyl ether).
$CH_3CH_2O(CH_2OCHCH_3)_nCH_2OC_4H_9$. Colorless liquid.
Use: An insect repellent.

n-butoxypropanol. CAS: 63716-40-5.
Properties: Colorless liquid, d 0.8801 (20/20C), bp 170.2C, fp −80C (sets to glass), soluble in water, flash p 154F (67.7C). Combustible.
Use: Solvent for water-based enamels.

b-butoxy-β′-thiocyanodiethyl ether. [2-(2-butoxyethoxy)ethyl thiocyanate].
$CH_3(CH_2)_3OCH_2OCH_2CH_2SCN$.
Hazard: Toxic by ingestion and skin absorption. Skin irritant.
Use: Insecticide.

butoxytriglycol. (triethylene glycol monobutyl ether).
CAS: 143-22-6. $C_4H_9O(C_2H_4O)_3H$.
Properties: Liquid, d 1.0021 (20/20C), bp (decomposes), fp −47.6C, miscible in water, flash p 290F (143C). Combustible.
Use: Plasticizer, intermediate.

butter. (1) A colloidal system (emulsion) in which the continuous phase is composed of liquid fat from fat globules disintegrated by mechanical agitation and the dispersed phase is composed of finely divided water droplets and undamaged fat globules. (2) Outmoded term for hygroscopic metallic chlorides of viscous consistency, e.g., butter of zinc, etc.

buttercup yellow. See zinc yellow.

butterfat. The oily portion of the milk of mammals.
Properties: Composition is largely glycerides of oleic, stearic, and palmitic acids, with smaller amounts of the glycerides of butyric, caproic, caprylic, and capric acids, d range 0.910–0.914. Cow's milk contains approximately 4% butterfat.
See also milk.

butter yellow. See dimethylaminoazobenzene.

"Butvar" [*Monsanto*]. TM for polyvinyl butyral resins with various hydroxy content whose solutions provide a range of viscosities.
Use: For film clarity, flexibility, abrasion, and water resistance; for use in primers, structural hot-metal adhesives, inks, and waterproof coatings.

butyl. (1) The group C_4H_9; (2) butyl rubber.

n-butyl acetate. CAS: 123-86-4.
$CH_3COOCH_2CH_2CH_2CH_2$.
Properties: Colorless liquid, fruity odor. Soluble in alcohol, ether, and hydrocarbons; slightly soluble in water. Vapor is heavier than air, d 0.8826 at 20/20C, bp 126.3C, vap press 8.7 mm Hg (20C), fp −75C, refr index 1.2951 (20C), wt/gal 7.35 lb (20C), flash p 98F (36.6C) (TOC). Autoign temperature 790F (421C).
Derivation: Esterification and then distillation after contact of butyl alcohol with acetic acid in the presence of a catalyst such as sulfuric acid.
Hazard: Skin irritant, toxic. Flammable, moderate fire risk. TLV: 150 ppm in air.

sec-butyl acetate. CAS: 105-46-4.
$CH_3COOCH(CH_3)(C_2H_5)$.
Properties: Colorless liquid, bp 112.2C, d 0.8905 at 0/4C, 0.870 at 20/4C, refr index 1.389 (20C), wt/gal 7.21 lb, flash p 88F (31C) (OC). Miscible with alcohol and ether, insoluble in water.
Derivation: Esterification of sec-butyl alcohol.
Hazard: Flammable, dangerous fire risk. TLV: 200 ppm in air.
Use: Solvent for nitrocellulose lacquers, thinners, nail enamels, leather finishes.

tert-butyl acetate. CAS: 540-88-5.
$CH_3COOC(CH_3)_2$.
Properties: Colorless liquid, bp 96C, d 0.896 (20C). Insoluble in water, soluble in alcohol and ether.
Hazard: Flammable, moderate fire risk. TLV: 200 ppm in air.
Use: Solvent, gasoline additive.

butyl acetate dilution ratio. Measure of approximate tolerance of nitrocellulose solutions for pe-

Grade: Commercial 85–88%, 95–98%, 99%, NF (99%), FCC.
Hazard: Toxic by inhalation and skin absorption; irritant to eyes and skin. Flammable; dangerous fire and explosion risk, flammable limits in air 2.2–9%. TLV: 400 ppm in air.
Use: General solvent in coatings and plastics, organic synthesis, smokeless powders, pharmaceuticals, synthetic fruit essences.

ethyl-o-acetate. $CH_3C(OC_2H_5)_3$.
Properties: Colorless liquid, bp 144–148C, refr index 1.395 (25C), insoluble in water, soluble in alcohol and ether, flash p 131F (55C). Combustible.
Hazard: Moderate fire risk.
Use: Intermediate.

ethyl acetate, anhydrous. ethyl acetate, grade 99%.

ethyl acetic acid. See butyric acid.

ethyl acetoacetate. (diacetic ester; acetoacetic ester). $CH_3COCH_2COOC_2H_5$ (keto form), $CH_3C(OH){:}CHCOOC_2H_5$ (enol form). This compound is a tautomer at room temperature consisting of about 93% keto form and 7% enol form.
Properties: Colorless liquid, fruity odor, soluble in water and common organic solvents, d 1.0250 (20/4C), fp (enol) -80C; (keto) -39C, bp 180–181C, bulk d 8.5 lb/gal, vap press 0.8 mm Hg (20C), flash p 185F (85C) (COC), coefficient of expansion 0.00101/C. Combustible.
Derivation: Action of metallic sodium on ethyl acetate with subsequent distillation.
Grade: Technical, 98%.
Hazard: Toxic by ingestion and inhalation; irritant to skin and eyes.
Use: Organic synthesis; antipyrine, lacquers, dopes, plastics; manufacture of dyes, pharmaceuticals antimalarials, vitamin B; flavoring.

ethyl acetone. See methyl propyl ketone.

ethyl-n-acetyl-α-cyanoglycine. See ethyl acetamidocyanoacetate.

ethylacetylene. (1-butyne). CAS: 107-00-6. $C_2H_5C=CH$.
Properties: Available as liquefied gas, bp 8.3C, d 0.669 (0/0C), fp −130C, flash p < 20F (−6.6C) (TOC), specific volume 7.2 cu ft/lb (21.2C), insoluble in water.
Hazard: Flammable, dangerous fire risk.
Use: Specialty fuel, chemical intermediate.

ethyl acrylate. CAS: 140-88-5. $CH_2{:}CHCOOC_2H_5$.
Properties: Colorless liquid, bp 99.4C, fp −72.0C, d 0.9230 (20/20C), refr index 1.4037 (25C), bulk d 7.6 lb/gal (20C), soluble in alcohol and ether, readily polymerized, flash p 60F (15.5C) (OC).
Derivation: (1) Ethylene cyanohydrin, ethyl alcohol, and dilute sulfuric acid; (2) Oxo reaction of acetylene, carbon monoxide, and ethyl alcohol in the presence of nickel or cobalt catalyst.
Grade: Technical (inhibited, usually with hydroquinone or its monomethyl ether), pure uninhibited.
Hazard: Toxic by ingestion, inhalation, skin absorption; irritant to skin and eyes. Flammable, dangerous fire and explosion hazard. TLV: 5 ppm in air; suspected human carcinogen.
Use: Monomer for acrylic resins.
See also acrylate; acrylic resin.

ethyl alcohol. (alcohol; grain alcohol; ethanol; EtOH). CAS: 64-17-5. C_2H_5OH.
Properties: (pure 100% absolute alcohol, dehydrated): Colorless, limpid, volatile liquid. Bp 78.3C, fp −117.3C, ethereal vinous odor, pungent taste. Miscible with water, methanol, ether, chloroform, and acetone. (95% alcohol): Refr index 1.3651 (15C), surface tension 22.3 dynes/cm (20C), viscosity 0.0141 poise (20C), vap press 43 mm Hg (20C), specific heat 0.618 cal/g K (23C), flash p 55F (12.7C), d 0.816 (15.56C), bp 78C, fp −114C, autoign temperature 793F (422C).
Derivation: (1) From ethylene by direct catalytic hydration or with ethyl sulfate as intermediate; (2) fermentation of biomass, especially agricultural wastes; (3) enzymatic hydrolysis of cellulose (see also cellulase).
Grade: USP (95% by volume), absolute, pure, completely denatured, specially denatured, industrial, various proofs (one-half the proof number is the percentage of alcohol by volume).
Hazard: Is classified as a depressant drug. Though it is rapidly oxidized in the body and is therefore noncumulative, ingestion of even moderate amounts causes lowering of inhibitions, often succeeded by dizziness, headache, or nausea. Larger intake causes loss of motor nerve control, shallow respiration, and in extreme cases unconsciousness and even death. Degree of intoxication is determined by concentration of alcohol in the brain. Of primary importance is the fact that intake of even moderate amounts together with barbiturates or similar drugs is extremely dangerous and may even be fatal. Flammable, dangerous fire risk; flammable limits in air 3.3–19%. TLV: 1000 ppm in air.
Use: Solvent for resins, fats, fatty acids, oils, hydrocarbons; extraction medium; manufacture of acetaldehyde, acetic acid, ethylene, butadiene, 2-ethyl hexanol, dyes, pharmaceuticals, elastomers, detergents, cleaning preparations, surface coatings, cosmetics, explosives; anti-

potassium-2,4-hexadienoate. See potassium sorbate.

potassium hexafluorophosphate. KPF_6.
Properties: Solid, mp 575C, bp decomposes, soluble in water.
Grade: 98–100%.
Hazard: Toxic by ingestion.
Use: Maintenance of fluoride atmospheres, preparation of bactericides and fungicides, lab reagent.

potassium hexanitrocobaltate III. See cobalt potassium nitrite.

potassium hexyl xanthane. $C_6H_{13}OCSSK$.
Use: Flotation agent.

potassium hydrate. See potassium hydroxide.

potassium hydride. KH. Marketed as a semidispersion of gray powder in oil.
Properties: The solid decomposes on heating or in contact with moisture.
Hazard: Dangerous fire and explosion risk, evolves toxic and flammable gases on heating and on exposure to moisture.
Use: Organic condensations and alkylations.
See also hydride.

potassium hydrogen fluoride. See potassium bifluoride.

potassium hydrogen phosphate. See potassium phosphate dibasic.

potassium hydrogen phthalate. (potassium biphthalate). $HOOCC_6H_4COOK$.
Properties: Colorless crystals, soluble in water, d 1.636.
Derivation: Potassium hydroxide and phthalic anhydride.
Grade: CP, analytical.
Use: Alkalimetric standard, buffering agent.

potassium hydrosulfide. (potassium sulfhydrate; potassium bisulfide). KHS.
Properties: White to yellow crystals, hydrogen sulfide odor. Forms the polysulfide when exposed to air. Hygroscopic, soluble in alcohol and water, d 1.69, mp 455C.
Grade: Technical.
Use: Separation of heavy metals.

potassium hydroxide. (caustic potash; potassium hydrate; lye). CAS: 1310-58-3. KOH.
Properties: White, deliquescent pieces, lumps, sticks, pellets, or flakes having a crystalline fracture. Keep well stoppered, absorbs water and carbon dioxide from the air; soluble in water, alcohol, glycerol; slightly soluble in ether; d 2.044; mp 405C (varies with water content).
Derivation: Electrolysis of concentrated potassium chloride solution.
Method of purification: Sulfur compounds are removed by the addition of potassium nitrate to the fused caustic. The purest form is obtained by solution in alcohol, filtration, and evaporation.
Grade: Commercial, ground, flake, fused (88–92%), purified by alcohol (sticks, lumps, and drops), reagent, highest purity, USP, liquid (45%), FCC.
Hazard: Toxic by ingestion and inhalation, strong caustic, handle with gloves or tongs, corrosive to tissue. TLV: ceiling of 2 mg/m³ of air.
Use: Soap manufacture, bleaching, manufacture of potassium carbonate and tetrapotassium pyrophosphate, electrolyte in alkaline storage batteries and some fuel cells, absorbent for carbon dioxide and hydrogen sulfide, dyestuffs, liquid fertilizers, food additive, herbicides, electroplating, mercerizing, paint removers, reagent.

potassium hypophosphite. (potassium hypophosphite, monobasic). CAS: 77-82-87-8. KH_2PO_2.
Properties: White, opaque crystals or powder with pungent saline taste; very deliquescent. Soluble in water and alcohol, decomposed by heat.
Derivation: Interaction of calcium hypophosphite and potassium carbonate.
Hazard: Moderate fire risk, may explode if ground with chlorates, nitrates, or other strong oxidizing agents.

potassium hyposulfate. See potassium dithionate.

potassium hyposulfite. See potassium thiosulfate.

potassium iodate. CAS: 7758-05-6. KIO_3.
Properties: White, crystalline powder; odorless. Soluble in water, sulfuric acid (dilute); insoluble in alcohol. D 3.9, mp 560C (partial decomposition).
Grade: Technical, CP, FCC.
Use: Analysis (testing for zinc and arsenic), iodometry, reagent, feed additive, in foods as maturing agent and dough conditioner, medicine (topical antiseptic).

potassium iodide. CAS: 7681-11-0. KI.
Properties: White crystals, granules, or powder; strong, bitter, saline taste; soluble in water, alcohol, acetone, and glycerol; d 3.123; mp 686C; bp 1330C.
Grade: Reagent, USP, single crystals, FCC.
Use: Reagent in analytical chemistry, photographic emulsions (precipitating Ag), feed additive, spectroscopy, infrared transmission, scin-

ATTACHMENT D
HEAT STRESS

HEAT STRESS

1. Heart rate (HR) should be monitored by the radial pulse for 30 seconds as soon as possible in the resting period.

   If at the beginning of the rest period a worker's radial pulse is measure and his heart rate exceeds 100 beats per minute, the worker's next work period should be reduced by 33%. Therefore, if the original work period was one hour, the following work cycle should be reduced to 40 minutes.

2. Heat Stroke is a true medical emergency. First aid should be directed toward immediate measures to cool the body quickly, as well as seeing that the victim receives medical attention as soon as possible.

   Prior to medical treatment, remove as much clothing as possible and proceed to cool the victim's body, taking care not to over chill the victim once his temperature falls below 102^0F. One of the following cooling measures should be taken: (a) sponge the bare skin with cool water; (b) apply cold packs continuously; (c) wrap the victim in a sheet soaked with water; or (d) immerse the victim in a tub of cold water, while closely monitoring the victim's level of consciousness.

3. Prior to site activity, the Site Safety Officer may make arrangements for heat stress monitoring (i.e., monitoring heart rate, body temperature and body water loss) during actual site work if conditions warrant these measures. In addition, the Site Safety Officer would want to ensure that the team members have been acclimatized to the particular environmental conditions and that personnel are aware of the signs and symptoms of heat sickness and have been adequately trained in first aid procedures. As Site Safety Officer, one could also make sure there is sufficient personnel on-site, so as to rotate work assignments, schedule work during hours of reduced temperatures and ensure personnel do not consume alcoholic or caffeinated beverages but rather drink moderate levels of an electrolyte solution and eat well prior to commencing site work.

4. The worker could be experiencing a condition of heat rash. Allow workers to rest and relieve the itching associated with heat rash rather than return to work too soon. Itching

workers may not follow stringent decontamination procedures or scratch where it itches on-site and risk cross contamination.

Keeping the skin clean and dry will reduce the incidence of heat rash. This can be accomplished by wearing cotton garments (or other materials that absorb perspiration) underneath protective clothing. Upon removal of the protective clothing, the worker should wash and dry his skin thoroughly.

5. The sense of thirst is not an adequate regulator of water replacement during heat exposure. Therefore, as a general rule, the amount of water administered should replace the amount of water lost, and it should be administered at regular intervals throughout the day. For every 1/2 pound of water loss, 8 ounces of water should be ingested. Water should be replaced by drinking 2-4 ounce servings during every rest period. A recommended alternative to water is an electrolyte drink spilt 50/50 with water.

6. Although there is no specific test given during a baseline physical that would identify a person's intolerance to heat, there are physical factors and personal habits which may indicate possible intolerance to heat, such as, whether or not an individual smokes, one's dietary habit, body weight, as well as predisposed physical conditions such as high blood pressure, heavier conditions, diabetes or one's medication, that may influence an individual's ability to tolerate excessive heat.

7. Heat cramps are caused by profuse perspiration with inadequate fluid intake and salt replacement. Heat cramps most often afflict people in good physical condition who overwork in conditions of high temperature and humidity. Heat cramps usually come on suddenly during vigorous activity. Untreated, heat cramps may progress directly to heat exhaustion or heat stroke. First aid treatment: remove victim to a cool place and give sips of salted water (1 teaspoon of salt to 1 quart of water) - 4 ounces every 15 minutes over a period of one hour. A commercial preparation, e.g., Gatorade, may be used if split 50/50 with water.

   The salted water or solution should mitigate the cramps. Manual pressure should not be applied to the cramped muscles.

TABLE C-1

REQUIRED FREQUENCY OF HEAT STRESS MONITORING FOR WORKERS IN IMPERMEABLE CLOTHING

Adjusted (2) Temperature (^{0}F)	**Work Time Allowed Before Monitoring Break (min.)**
90 or above	15
87.5-90	30
82.5-87.5	60
77.5-82.5	90
72.5-77.5	120

(1) Adapted from Eastern Research Group and National Institute for Occupational Safety and Health, Occupational Safety and Health Guidance Manual for Super Activities. September 26, 1984, pp. 8-75.

(2) Calculate the adjusted air temperature (Ta adj) by using this equation:

$$\text{Ta adj } {}^0\text{F} = \text{Ta } {}^0\text{F} + (13 \text{ x } \% \text{ sunshine})$$

Measure air temperature (Ta) with a standard thermometer, with the bulb shielded from radiant heat. Then estimate percent sunshine (100 percent sunshine = no cloud cover an a sharp, distinct shadow; 0 percent sunshine = no shadows).

TABLE C-2

HEAT STRESS SIGNS AND SYMPTOMS

Heat Stress Indicator	When to Measure	If Exceeds	Action
heart rate (pulse)	beginning of rest period	110 beats per minute	shorten next work period by 33%
oral temperature	beginning of rest period	99 ^{0}F (after thermometer is under tongue for 3 minutes)	shorten next work period by 33%
		100.6 ^{0}F or greater	prohibit work in impermeable clothing and shorten next work period by 33%
body weight	1. before workday begins (a.m.) 2. after workday ends (p.m.)	Decreases more than 5%	increase fluid intake

ATTACHMENT E
COLD STRESS

COLD STRESS (Hypothermia)

Cold stress is a function of cold, wetness and wind. A worker’s susceptibility to cold stress can vary according to his/her physical fitness, degree of acclimatization to cold weather, age and diet.

Prevention

Institute the following steps to prevent or overexposure of workers to cold:

1. Maintain body core temperature at 96.8^0 F or above by encouraging workers to drink warm liquids during breaks (preferably not coffee) and wear several layers of clothing. Wool is recommended since it can keep the body warm even when the wood is wet.
2. Avoid frostbite by adequately covering hands, feet and other extremities. Clothing such as insulated gloves or mittens, earmuffs and hat liners should be worn. To prevent contact frostbite (from touching metal and cold surfaces below 20^0 F) workers should wear anti-contact gloves. Tool handles and control bars should be covered with insulating material.
3. Adjust work schedules if necessary, providing adequate rest periods. When feasible, rotate personnel and perform work during the warmer hours of the day.
4. Provide a heated enclosure for workers close to their work area. Workers should remove their outer layer(s) of clothing while in the shelter to allow for sweat evaporation.
5. In the event that wind barriers are constructed around an intrusive operation (such as drilling), the enclosure must be properly vented to prevent the build-up of toxic or explosive gases or vapors. Care must be taken to keep any heat source away from flammable substances.
6. Using a wind chill chart such as the one in Table D-1, obtain the equivalent chill temperature (ECT) based on actual wind speed and temperature. Refer to the ECT when setting up work warm-up schedules, planning appropriate clothing, etc. Workers should use warming shelters at regular intervals at or below an ECT or 20^0 F For exposure skin, continuous exposure should not be permitted at or below an ECT of -35^0 F.
7. Workers who become immersed in water or whose clothing becomes wet (from perspiration, rain, etc) must immediately be provided a change of dry clothing whenever the air temperature is 25.6^0 F or below.

8. Maintain an optimal level of worker fitness by encouraging regular exercise, proper diet, etc. If possible, acclimatize workers to site conditions for several days before work begins.

Monitoring

Personnel should be aware of the symptoms of cold stress. If the following symptoms of systemic hypothermia are noticed in any worker, he/she should immediately go the warm shelter:

Heavy, uncontrollable shivering;
Excessive fatigue or drowsiness;
Loss of coordination;
Difficulty in speaking; and,
Frostbite (see below).

Frostbite is the generic term for local injury resulting from cold. The stages of frostbite and their symptoms are as follows:

1. Frostbite or incipient frostbite: sudden blanching or whitening of the skin.
2. Superficial frostbite: waxy or white skin, which is firm to the touch (tissue underneath is still resilient).
3. Deep frostbite: tissues are cold, pale and solid.

TABLE D-1

WINDCHILL CHART

Wind Speed (mph)	Actual thermometer Reading (^{0}F)									
	50	40	30	20	10	0	-10	-20	-30	-40
	Equivalent Temperature (^{0}F)									
Calm	50	40	30	20	10	0	-10	-20	-30	-40
5	48	37	27	16	6	-5	-15	-26	-36	-47
10	40	28	16	4	-9	-21	-33	-46	-58	-70
15	36	22	9	-5	-18	-36	-45	-58	-72	-85
20	32	18	4	-10	-25	-39	-53	-67	-82	-96
25	30	16	0	-15	-29	-44	-59	-74	-88	-104
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116
>40	Little Danger				Increasing Danger			Great Danger		
(Little added effect)	(For properly clothed person)				(Danger from freezing of exposed flesh)					