

Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedures for Whole Stream Metabolism Survey Using a Non-toxic Gas and Conservative Dye Tracer

Version 1.0

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Signatures on File

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)
2/24/2016	1.0	Recertified	all	Kammin

Environmental Assessment Program

Standard Operating Procedure for Whole Stream Metabolism Survey Using a Non-toxic Gas and Conservative Dye Tracer

1.0 Purpose and Scope

- 1.1 This document is the Environmental Assessment Program Standard Operating Procedure (SOP) for conducting a whole stream metabolism (WSM) survey using a non-toxic gas and conservative dye tracer.

2.0 Applicability

- 2.1 This document was designed for use on the Intensively Monitored Watersheds (IMW) streams receiving an application of carcass analogs to determine whole stream metabolism. It may be applicable to other studies assessing whole stream metabolism in open systems.
- 2.2 This open system procedure is only practical in study reaches having the following properties (Grace and Imberger, 2006):
- 2.2.1 relatively constant flow.
 - 2.2.2 minimal (<5%) groundwater inflow.
 - 2.2.3 well mixed water column.
 - 2.2.4 no tributaries or distributaries in the study reach.
 - 2.2.5 no braiding in the mixing zone or at the upstream or downstream sampling points.

3.0 Definitions

- 3.1 Matrix spike: lab method to determine whether there are interferences in the analysis of a particular sample matrix and their effect on analyte recovery (Manchester Lab User's Manual 2008).
- 3.2 Mixing zone: a 300-500 m stream segment immediately upstream of the sampling reach where the rhodamine dye and a non-toxic gas can adequately mix and evenly distribute in the water column before flowing past the upstream sampling point.
- 3.3 Open system: main stream flowpath (Grace and Imberger, 2006).
- 3.4 Propane injection: constant flow of the non-toxic gas, propane, C₃H₈, at the desired rate for the whole duration of the sampling interval.
- 3.5 Rhodamine WT: orange-red dye used in time-of-travel studies. Does not easily degrade in water and is non-toxic at low concentrations. This is purchased as a 20% solution.
- 3.6 Sampling reach: the continuous reach of stream between the upstream and downstream sampling points, from which whole stream metabolism is calculated.

- 3.7 Slug injection: an instantaneous dump or pour of dye into the water.
- 3.8 Thalweg: the deepest continuous line of a main flowing channel.
- 3.9 Whole stream metabolism (WSM): diel measurement of changes in dissolved oxygen (DO) concentrations resulting from photosynthesis, respiration, and reaeration.

4.0 Personnel Qualifications/Responsibilities

- 4.1 Knowledge of the contents of this SOP.
- 4.2 Knowledge of the contents of the Standard Operating Procedures for: Time-of-Travel Studies in Freshwater Using a Dye Tracer; Collection and Analysis of Dissolved Oxygen (Winkler Method); and Hydrolab® DataSonde® and MiniSonde® Multiprobes.
- 4.3 Successful completion of Hydrolab® training from a Hach representative or an in-house Hydrolab® custodian and familiarity with the Hydrolab® user's manual.

5.0 Equipment, Reagents, and Supplies

Dissolved Oxygen QA:

- 5.1.1 BOD bottles and caps (4 per sampling event)
- 5.1.2 Surveyor flagging and permanent marker
- 5.1.3 Manganous sulfate monohydrate reagent (see Attachment B for MSDS) ***Caution* this chemical is a skin and eye irritant and may be harmful if inhaled or swallowed.**
- 5.1.4 Alkali-iodine-azide reagent (see Attachment C for MSDS) ***Danger* this chemical is corrosive and may cause eye or skin burns or internal damage if inhaled or swallowed.**
- 5.1.5 Nitrile gloves
- 5.1.6 Pipettes
- 5.1.7 DO Sampler (See SOP for Collection and Analysis of DO (SOP EAP023) for more information on sampler design)
- 5.1.8 DO box

Establishing Reaches:

- 5.2.1 Hip chain and spare string
- 5.2.2 Surveyor flagging and permanent marker

WSM Survey:

- 5.3.1 DataSonde® or MiniSonde® with rhodamine and DO sensors, and probe protection cages (2 per stream)
- 5.3.2 AA and/or C batteries (sonde dependent)
- 5.3.3 Hydrolab® Surveyor and communication cable
- 5.3.4 Zipties and wire cutters

- 5.3.5 Five gallon propane tanks (1 per stream) (see Attachment E for MSDS)
- 5.3.6 Hose
- 5.3.7 Regulator with gauges to read injection rate and tank pressure
- 5.3.8 Diffuser
- 5.3.9 Wrenches
- 5.3.10 Frame backpack
- 5.3.11 Rhodamine WT (see Attachment D for MSDS)
- 5.3.12 2 gallon bucket
- 5.4 Sampling:
- 5.4.1 1 L plastic sampling bottles (4 per stream)
- 5.4.2 40 mL VOA glass sample vials with 1ml 10% HCL preservative (14/stream)
- 5.4.3 Sample labels and rubber bands
- 5.4.4 Laboratory Analyses Required (LAR) form for contracting lab
- 5.4.5 Foam vial crates for transport
- 5.5 Additional Supplies:
- 5.5.1 Datasheet
- 5.5.2 Pencil
- 5.5.3 Watch
- 5.5.4 Cooler with ice
- 5.5.5 Walkie-talkies (one per crew member)

6.0 Summary of Procedure

6.1 Pre-Survey Preparation

- 6.1.1 Refer to the SOP for Hydrolab® DataSonde® and MiniSonde® Multiprobes (SOP EAP033) for guidance on sonde calibration and proper usage. Pre-calibrate the sondes for conductivity, pH, and percent DO (or LDO) saturation.
- 6.1.2 Refer to the SOP for Time-of-Travel Studies in Freshwater Using a Dye Tracer (SOP EAP037) for guidance on designing time-of-travel studies, alerting authorities to dye use, and identifying sources of real time discharge data.
- 6.1.3 Monitor flow patterns and discharge in the stream of interest using real-time gauging station data if available. Estimate the necessary length for the sampling reach and the mixing zone based on guidance in Grace and Imberger (2006).
- 6.1.4 Refer to Hubbard et al. (1982) to calculate the quantity of rhodamine necessary to achieve a peak concentration of 10 to 30 ppb at the downstream sonde.

6.2 Pre-Survey Dissolved Oxygen QA

- 6.2.1 Place all sondes in the same location in the stream. Allow them to be continuously submerged for fifteen minutes.
- 6.2.2 After fifteen minutes, collect two DO samples and fix them according the SOP for the Collection and Analysis of DO (SOP EAP023) (Fig. 1). Record the date and time of

DO collection on the datasheet as *Dissolved Oxygen QA Deployment* (see Attachment A for a sample datasheet).



Fig. 1. Collect DO samples at the same location as the sondes.

6.3 Establishing Sampling and Mixing Reaches

- 6.3.1 Identify a suitable location for the downstream sonde. It should be sufficiently deep to submerge the probes, protected from debris flowing downstream, in the main flow, and near a sturdy object to which it can be attached (Fig. 2). Note: Sonde theft has occurred. Refer to the SOP for Time-of-Travel Studies in Freshwater Using a Dye Tracer (SOP EAP 037) for guidance on discreetly positioning the sonde if monitoring is occurring in public use or high visibility areas. Tie the hip chain string to the same structure and reset the dial to 0 m.



Fig. 2. Attach sonde to sturdy in-stream material to prevent loss.

- 6.3.2 Walk upstream in the thalweg for the estimated sampling reach distance, occasionally securing the hip chain string to prevent breakage and so that it spools out following the stream's sinuosity.
- 6.3.3 At the upper end of the sampling reach, identify a suitable location for the upstream sonde. Record the distance (in meters) from the downstream sonde to the upstream sonde on the datasheet as *Distance from downstream HL to upstream HL*.
- 6.3.4 To establish the mixing zone, continue walking upstream in the thalweg for the estimated distance, measuring with the hip chain.

- 6.3.5 At the upper end of the mixing zone, identify a pool 2-3 feet deep with consistent flow throughout as a suitable location for the propane injection site. There should be no braiding at this location. Record the distance (in meters) from the downstream sonde to the propane injection site as *Distance from downstream HL to propane injection*.
- 6.3.6 Identify an area immediately upstream (within 20 m) of the propane injection site where the rhodamine slug can be injected. The ideal location should be a riffle to allow rapid mixing in the water column, and there should be no stream braiding between the location of the slug injection and the location of the propane injection. Measure the distance to this site using the hip chain and record the distance (in meters) on the datasheet as *Distance from downstream HL to tracer injection*.
- 6.4 Perform WSM Survey
- 6.4.1 Designate one sonde as the “Upstream Hydrolab®” and one as the “Downstream Hydrolab®” and record their identifiers on the datasheet as *Hydrolabs Downstream Sonde* and *Hydrolabs Upstream Sonde*.
- 6.4.2 Deploy upstream and downstream sondes at predetermined locations by securing them to in-stream or channel adjacent structures using zipties. Record the date and time of deployment of each sonde on the datasheet as *Hydrolab Downstream/Upstream Deployment*.
- 6.4.3 Place the propane diffuser in the previously identified pool, spanning the stream and perpendicular to flow (Figs. 3 and 4). If the channel is wider than the diffuser is long, position the diffuser so that it spans the thalweg. If the channel is narrower than the diffuser is long, allow the diffuser to assume a slightly wavy shape so that the entire diffuser is submerged. Weight the diffuser using stream rocks to prevent it from floating to the surface.



Fig. 3. Position the propane tank level on the stream bank.



Fig. 4. Place the diffuser in the thalweg, perpendicular to flow.

- 6.4.4 Begin the propane injection by adjusting the regulator valves until the desired constant injection rate is achieved. Record the injection rate on the datasheet as *Propane injection rate*. Record the date and time injection begins on the datasheet as

Injection date and *Propane injection time*. Allow the propane tank to off gas for twenty minutes in order to be sure injection rate is steady and tank pressure is stable according to the gauges on the regulator (Fig. 5).



Fig.5. Monitor constant injection rate and tank pressure using the gauges on the regulator.

6.4.5 Twenty minutes after propane injection begins, prepare the rhodamine slug for injection. Fill a 2 gallon bucket with stream water and add the rhodamine to it (Fig. 6). Pour the mixture into the riffle evenly, from bank to bank and perpendicular to flow (Fig. 7). Rinse the empty bucket in the riffle to ensure the entire slug is in the stream. Record the rhodamine injection time and volume of rhodamine solution added to the bucket (in mL) on the datasheet as *Tracer injection time* and *Tracer injection quantity*, respectively.



Fig. 6. Mix rhodamine and stream water in a 2 gallon bucket.



Fig. 7. Pour the rhodamine evenly into the riffle.

6.4.6 Position one person at the upstream sonde and one person at the downstream sonde with walkie-talkies for communication.

6.4.7 Attach a Hydrolab® surveyor to the downstream sonde (Fig. 8). Record the date and time rhodamine reaches peak concentration on the datasheet as *Peak Concentration Date* and *Peak Concentration Time*. Record the peak concentration (in ppb) on the datasheet as *Peak Concentration*. Calculate 1 to 2 percent of the peak concentration and record this value (in ppb) on the datasheet as *Concentration at Propane Collection*.



Fig. 8. Monitor rhodamine concentration at the downstream sonde on a Surveyor.

6.4.8 When the rhodamine plume has decreased to 1 to 2 percent of peak concentration at the downstream sonde, collect water samples at the upstream and downstream sondes simultaneously, using walkie-talkies to communicate between samplers.

6.4.9 Collect two replicates at each location in one 1 L sampling container per replicate (Fig. 9). Rinse the 1 L sampling container three times with stream water, and passively fill by partially submerging the container with the bottle mouth pointed upstream. Do not allow the water to splash into the container and do not agitate the sample.



Fig. 9. Collect two replicates in 1L sampling containers.

- 6.4.10 At the downstream location, pour the first replicate into five pre-acidified glass vials (two of which are for the matrix spike) and the second replicate into three glass vials. At the upstream location, pour both the first and the second replicate into three glass vials. Pour slowly down the side of the vial, filling to maximum capacity so that an inverse meniscus forms at the mouth of the vial. **DO NOT OVERFILL**, as the preservative will be lost. Cap the vial and invert to ensure no air bubbles are trapped in the sample.
- 6.4.11 Label the samples according to the convention of the contract lab, but include at least the **Site Name, Up or Downstream, Date and Time** of collection, and **Replicate** (e.g., WT-DOWN2 7/12/2012 1345 is the second downstream replicate collected at West Twin Creek on 7/12/2012 at 1:45pm). Group vials by station and replicate, band them together, and attach the label. Store on ice. Discard the remaining water in the 1 L sample containers after the samples have been poured into vials. Record sample collection time on the datasheet as *Propane Samples Upstream/Downstream Time*. Record the contract lab's *Lab Sample #*, the *Number of vials* in each replicate (3 or 5), and whether the replicate is used for a *Matrix Spike* (Y or N) on the datasheet.
- 6.4.12 Leave the sondes deployed for at least 24 hours.
- 6.5 Post-Survey Dissolved Oxygen QA
- 6.5.1 Remove the upstream sonde. Record the removal date and time on the datasheet as *Hydrolab Upstream Retrieval*. Place the upstream sonde in the same pool as the downstream sonde.
- 6.5.2 After fifteen minutes, collect two DO samples and fix them according to the SOP for the Collection and Analysis of DO (SOP EAP023). Record the date and time of DO collection on the datasheet as *Dissolved Oxygen QA Retrieval*.
- 6.5.3 Remove the sondes and record the date and time on the datasheet as *Hydrolab Downstream Retrieval*. Replace the batteries if deploying the sonde in another stream. Prepare and stow sondes for transport.
- 6.6 Post-Survey Sample Processing and Wrap-Up
- 6.6.1 Submit water samples to contracting lab for analysis within 14 days.
- 6.6.2 Titrate deployment and retrieval DO QA samples using the Winkler Method outlined in the SOP for Collection and Analysis of DO (SOP EAP023). Record the DO values (in mg/L) on the datasheet as *DO1* and *DO2*.
- 6.6.3 Download the Hydrolab datafile to the computer.
- 6.6.4 Post-calibrate the sondes for conductivity, pH, and percent DO (or LDO) saturation.
- 6.6.5 Maintain, clean, and stow hydrolabs according the guidance outlined in the SOP for Hydrolab® DataSonde® and MiniSonde® Multiprobes (SOP EAP033).

7.0 Records Management

- 7.1 Record all field data on datasheets as described in the procedure.
- 7.2 Fill out all required information on contract lab's LAR before submitting samples for analysis.
- 7.3 Correctly record site name, lab sample number, replicate number, station (upstream or downstream), date and time on all sample labels.
- 7.4 Save raw Hydrolab® datafiles to a network drive that is backed up nightly. Select data collected during the deployment period and export it to an Excel workbook.
- 7.5 Save propane concentration data returned from the contract lab to a network drive that is backed up nightly.
- 7.6 Manage calibration data, data entered on the field datasheet, propane concentration data, and clipped Hydrolab® data in consolidated Excel workbooks or Access databases. Save data to a network drive that is backed up nightly.

8.0 Quality Control and Quality Assurance

- 8.1 Ensure calibration and proper functioning of sondes before deploying in the field.
- 8.2 Monitor stream flow at gauging stations in the weeks leading up to sampling to ensure flows are not fluctuating and the planned reach lengths are suitable.
- 8.3 Review notes and propane concentration values from previous surveys in the same location. If propane concentrations at the downstream sonde are classified as non-detect by the contracting lab, consider increasing the propane injection rate, shortening the survey reach, or both.
- 8.4 Monitor gauges on the propane regulator during injection to ensure constant injection rate. Keep tank level in a warm area and agitate it frequently to prevent tank from freezing.
- 8.5 Do not agitate water samples and do not overfill sample vials. Fill properly to prevent air bubbles from forming in the sample vials.
- 8.6 Ensure datasheets, sample labels, and LAR forms are all filled out entirely and correctly in the field.
- 8.7 Perform normality checks during the Winkler Titration procedure as outlined in the SOP for Collection and Analysis of DO (SOP EAP023).

9.0 Safety

- 9.1 File a field work plan before commencing field activities.
- 9.2 Use caution when walking in stream channels and while wearing waders. See EAP Safety Manual Chapter 1: General Field Work – Working in Rivers or Streams. Consider wearing a PFD in deep water. The use of a PFD is mandatory where the danger of drowning exists.
- 9.3 Maintain proper physical fitness in order to safely transport the propane tank on a framed backpack. Use caution when lifting heavy objects. See Ecology Safety Program Manual – Lifting Safety.

- 9.4 Use gloves when handling DO reagents and rhodamine in the field. Observe all safety guidelines in EAP labs. Refer to the SOP for Collection and Analysis of DO (SOP EAP023) for additional safety concerns associated with performing Winkler Titrations and the SOP for Time-of-Travel Studies in Freshwater Using a Dye Tracer (SOP EAP037) for additional safety concerns associated with using rhodamine.
- 9.5 The effect of rhodamine dye on stream water can be very alarming for the general public. Learn how to mitigate negative interactions with confrontational individuals in the field should such a situation arise.

10.0 References

- 10.1 Carroll, J. 2008. Standard Operating Procedure for Time-of-Travel Studies in Freshwater Using a Dye Tracer, v. 1.0. Washington State Department of Ecology, Olympia, WA. www.ecy.wa.gov/programs/eap/quality.html
- 10.2 Grace, M. and S. Imberger. 2006. Stream Metabolism: Performing & Interpreting Measurements. Water Studies Centre Monash University, Murray Darling Basin Commission and New South Wales Department of Environment and Climate Change, New South Wales, AU.
- 10.3 Hubbard, E., F. Kilpatrick, L. Martens, and J. Wilson, Jr. 1982. Measurement of Time of Travel and Dispersion in Streams by Dye Tracing, Chapter A9, Book 3: Applications of Hydraulics, Techniques of Water-Resources Investigations of the United States Geological Survey, United States Government Printing Office, Washington, DC.
- 10.4 Manchester Environmental Laboratory. 2016. Laboratory User's Manual, 10th edition. Washington State Department of Ecology, Olympia, WA.
- 10.5 Swanson, T. 2007. Standard Operating Procedure for Hydrolab® DataSonde® and MiniSonde® Multiprobes, v. 1.1. Washington State Department of Ecology, Olympia, WA. www.ecy.wa.gov/programs/eap/quality.html
- 10.6 Ward, W. and N. Mathieu. 2011. Standard Operating Procedure for Collection and Analysis of Dissolved Oxygen (Winkler Method), v. 2.1. Washington State Department of Ecology, Olympia, WA. www.ecy.wa.gov/programs/eap/quality.html

Attachment A: Example Datasheet

**Intensively Monitored Watersheds
Whole Stream Metabolism**

Basin: West Twin Creek Date: _____
Crew: _____

Site Information

Distance from downstream HL to upstream HL (m) _____
Distance from downstream HL to tracer injection (m) _____
Distance from downstream HL to propane injection (m) _____

Dissolved Oxygen QA

Status	Date	Time	DO 1 (mg/l)	DO 2 (mg/l)
Deployment				
Retrieval				

Hydrolabs

Location	Sonde	Status	Date	Time
Downstream		Deployment		
		Retrieval		
Upstream		Deployment		
		Retrieval		

Injection

Injection date _____
Propane injection time _____
Propane injection rate _____
Tracer injection time _____
Tracer injection quantity (ml) _____

Downstream Tracer Concentration

Peak Concentration Date _____
Peak Concentration Time _____
Peak Concentration (ppb) _____
Concentration at Propane Collection (ppb) _____

Propane Samples

Location	Time	Replicate	Station ID	Lab Sample #	Number of vials	Matrix Spike?
Downstream		1	WT-DOWN1		<input type="checkbox"/>	
		2	WT-DOWN2		<input type="checkbox"/>	
Upstream		1	WT-UP1		<input type="checkbox"/>	
		2	WT-UP2		<input type="checkbox"/>	

Notes _____

Attachment B: MSDS For Manganous Sulfate



Material Safety Data Sheet

Section 1. Product and Company Identification

Product Name Manganous Sulfate Solution, 38% **Product Code** VW3329

Manufacturer EMD Chemicals Inc.

Effective Date 8/1/2005

P.O. Box 70_{480 Democrat Road} **Print Date** 10/5/2005

Gibbstown, NJ 08027 Prior to January 1, 2003 EMD Chemicals Inc. was EM Industries, Inc. or EM Science, Division of EM Industries, Inc.

For More Information Call

In Case of Emergency Call

856-423-6300 Technical Service 800-424-9300 CHEMTREC (USA) Monday-Friday: 8:00 AM - 5:00 PM 613-996-6666 CANUTEC (Canada) 24 Hours/Day: 7 Days/Week

Synonym None.

Material Uses Laboratory Reagent

Chemical Family Organic salt solution

Section 2. Composition and Information on Ingredients

Component	CAS #	% by Weight
Manganese Sulfate	10034-96-5	36.4
Water	7732-18-5	63.6

Section 3. Hazards Identification

Physical State and Appearance Liquid. **Appearance**

Emergency Overview CAUTION ! HARMFUL IF SWALLOWED. CAUSES EYE AND SKIN IRRITATION. MAY BE HARMFUL IF INHALED.

Routes of Entry Eye contact. Inhalation.

Potential Acute Health Effects

Eyes Hazardous in case of eye contact (irritant). Inflammation of the eye is characterized by redness, watering, and itching.

Skin Hazardous in case of skin contact (irritant). Skin inflammation is characterized by itching,

scaling, reddening, or, occasionally, blistering. Non-permeator by skin.

Inhalation May be hazardous in case of inhalation.

Ingestion Hazardous in case of ingestion. Do not take internally.

Potential Chronic Health Effects

Carcinogenic Effects This material is not known to cause cancer in animals or humans.

Additional information See Toxicological Information (section 11)

Medical Conditions Repeated exposure to a highly toxic material may produce general deterioration of health by an **Aggravated by** accumulation in one or many human organs.

Overexposure:

Section 4. First Aid Measures

Eye Contact Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Inhalation If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

+ Section 5. Fire Fighting Measures

Flammability of the Product Non-flammable.

Auto-ignition Temperature Not applicable.

Flash Points Not applicable.

Flammable Limits Not applicable.

Products of Combustion Not applicable.

Fire Hazards in Presence of Various Substances Not applicable.

Explosion Hazards in Presence of Various Substances Risks of explosion of the product in presence of static discharge: No. **Presence of Various Substances** Risks of explosion of the product in presence of mechanical impact: No.

Substances

Fire Fighting Media and Instructions Not applicable.

Protective Clothing (Fire) Not applicable.

Special Remarks on Fire Not available. **Hazards**

Special Remarks on Not available. **Explosion Hazards**

Section 6. Accidental Release Measures

Small Spill and Leak Dilute with water and mop up, or absorb with a stable dry material and place in an appropriate waste disposal container. If necessary: **Neutralize the residue with a dilute solution of sodium carbonate.**

Large Spill and Leak Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. **Neutralize the residue with a dilute solution of sodium carbonate.** Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Spill Kit Information No specific spill kit required for this product.

Section 7. Handling and Storage

Handling Avoid contact with eyes, skin and clothing. Do not ingest. Avoid breathing vapors or spray mists. Keep container closed. Use only with adequate ventilation. Wash thoroughly after handling.

Storage Keep container tightly closed. Keep container in a cool, well-ventilated area.

+ Section 8. Exposure Controls/Personal Protection

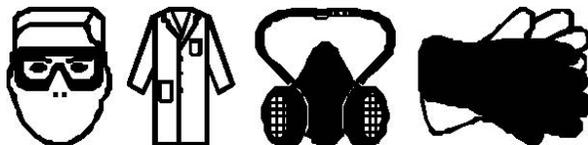
Engineering Controls Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective occupational exposure limits. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection

Eyes Splash goggles. **Body** Lab coat.

Respiratory Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate. **Hands** Gloves. **Feet** *Not applicable.*

Protective Clothing (Pictograms)



Personal Protection in Case of a Large Spill Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Product Name

Exposure Limits

Manganese Sulfate

Belgium Minister of Labour (Belgium, 1998).

VL: 0.2 mg/m³ 8 hour(s).

BAUA (Germany, 1997).

Spitzenbegrenzung: 2 mg/m³

TWA: 0.5 mg/m³ 8 hour(s). **DK-Arbejdstylnet (Denmark, 1996).**

GV: 2.5 mg/m³ 8 hour(s).

Tyterveyslaitos (Finland, 1998).

TWA: 0.5 mg/m³ 8 hour(s).

INRS (France, 1996).

VME: 1 mg/m³ 8 hour(s).

National Authority for Occupational Safety/Health (Ireland, 1999).

OEL: 5 mg/m³ 8 hour(s).

Arbeidsinspectie (Netherlands, 1999).

TGG 15 min: 3 mg/m³ 15 minute(s).

TGG 8 uur: 1 mg/m³ 8 hour(s).

N-Arbejdstylnet (Norway, 1996).

AN: 2.5 mg/m³ 8 hour(s).

AFS (Sweden, 1996).

NGV: 1 mg/m³ 8 hour(s).

EH40-OES (United Kingdom (UK), 1997).

TWA: 5 mg/m³ 8 hour(s). Water Not available.

Section 9. Physical and Chemical Properties

Odor	Odorless.
Color	Clear.
Physical State and Appearance	Liquid.
Molecular Weight	Not applicable.
Molecular Formula	MnSo4.H2O, H2O
pH	3.8 [Acidic.]
Boiling/Condensation Point	The lowest known value is 99.9°C (211.8°F) (Water).
Melting/Freezing Point	May start to solidify at -0.1°C (31.8°F) based on data for: Water.
Specific Gravity	Not available.
Vapor Pressure	Not available.
Vapor Density	Not available.
Odor Threshold	Not available.
Evaporation Rate	0.36 (Water) compared to(n-Butyl Acetate =1)
LogK_{ow}	Not available.

Solubility Soluble in water.

Section 10. Stability and Reactivity

Stability and Reactivity The product is stable.

Conditions of Instability Not available.

Incompatibility with Various Substances Highly reactive with oxidizing agents, metals. **Rem/Incompatibility** Not available.
Reactive with reducing agents. Non-reactive with acids.

Hazardous Decomposition SO_x Products

Hazardous Polymerization Will not occur.

Section 11. Toxicological Information

RTECS Number: Manganous Sulphate Monohydrate OP0893500 Water
ZC0110000 **Toxicity** LD₅₀: Not available. LC₅₀: Not available.

Chronic Effects on Humans Not available.

Acute Effects on Humans Hazardous in case of eye contact (irritant). Inflammation of the eye is characterized by redness, watering, and itching. Hazardous in case of skin contact (irritant). Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering. Non-permeator by skin. May be hazardous in case of inhalation. Hazardous in case of ingestion.

Special Remarks on Other MAY BE IRRITATING ON CONTACT WITH MUCOUS MEMBRANES. (Manganese Sulfate) **Toxic Effects on Humans**

Synergetic Products Not available. (Toxicologically)

Irritancy Draize Test: Not available.

Sensitization Not available.

Carcinogenic Effects This material is not known to cause cancer in animals or humans.

Toxicity to Reproductive System Not available.

Teratogenic Effects Not available.

Mutagenic Effects Not available.

Section 12. Ecological Information

Ecotoxicity Not available.

BOD₅ and COD Not available.

Toxicity of the Products of Biodegradation The products of degradation are less toxic than the product itself.

Section 13. Disposal Considerations

EPA Waste Number Not available.

Treatment

Material does not have an EPA Waste number and is not a listed waste, however consultation with a permitted waste disposal site (TSD) should be accomplished. Always contact permitted waste disposer (TSD) to assure compliance with all Current local, State and Federal Regulations.

Section 14. Transport Information

DOT Classification Not available

TDG Classification Not available.

IMO/IMDG Classification Not available.

ICAO/IATA Classification Not available.

Section 15. Regulatory Information

U.S. Federal Regulations TSCA 8(b) inventory: Manganese Sulfate; Water

SARA 302/304/311/312 extremely hazardous substances: No products were found.

SARA 302/304 emergency planning and notification: No products were found.

SARA 302/304/311/312 hazardous chemicals: Manganese Sulfate

SARA 311/312 MSDS distribution - chemical inventory - hazard identification: Manganese Sulfate: Immediate (Acute) Health Hazard, Delayed (Chronic) Health Hazard

SARA 313 toxic chemical notification and release reporting: No products were found.

Clean Water Act (CWA) 307: No products were found.

Clean Water Act (CWA) 311: No products were found.

Clean air act (CAA) 112 accidental release prevention: No products were found.

Clean air act (CAA) 112 regulated flammable substances: No products were found.

Clean air act (CAA) 112 regulated toxic substances: No products were found.

WHMIS (Canada)

Class D-2B: Material causing other toxic effects (TOXIC).

CEPA DSL: Water

This product has been classified in accordance with the hazard criteria of the Controlled Product Regulations and the MSDS contains all required information.

International Regulations

EINECS

Manganese Sulfate 232-089-9

EAP069 Whole Stream Metabolism Survey Using a Non-toxic Gas and Conservative Dye Tracer

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Water 231-791-2

DSCL (EEC)

R38- Irritating to skin.
R41- Risk of serious damage to eyes.

International Lists Australia (NICNAS): Manganese Sulfate; Water Japan (MITI): Water Korea (TCCL):
Water Philippines (RA6969): Manganese Sulfate; Water

China: No products were found.

State Regulations New Jersey: Manganous Sulfate Solution, 38% California prop. 65: No products were found.

Section 16. Other Information

**National Fire
Protection
Association
(U.S.A.)
Specific Hazard**



Changed Since Last

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Revision

Notice to Reader

The statements contained herein are based upon technical data that EMD Chemicals Inc. believes to be reliable, are offered for information purposes only and as a guide to the appropriate precautionary and emergency handling of the material by a properly trained person having the necessary technical skills. Users should consider these data only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use, storage and disposal of these materials and the safety and health of employees and customers and the protection of the environment. EMD CHEMICALS INC. MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE, WITH RESPECT TO THE INFORMATION HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS.



Material Safety Data Sheet

Section 1. Product and Company Identification

Product Name Alkaline-Iodide-Azide Solution

Product Code VW3301

Manufacturer EMD Chemicals Inc.

Effective Date 9/9/2004

P.O. Box 70 480 Democrat Road Gibbstown, NJ 08027 Prior to January 1, 2003 EMD Chemicals Inc.
 was EM Industries, Inc. or EM Science, Division of EM Industries, Inc.

Print Date 9/9/2004

For More Information Call

In Case of Emergency Call

856-423-6300 Technical Service 800-424-9300 CHEMTREC (USA) Monday-Friday: 8:00 AM
 - 5:00 PM 613-996-6666 CANUTEC (Canada) 24 Hours/Day: 7 Days/Week

None.

Synonym

Material Uses Analytical reagent.

Chemical Family Solution.

Section 2. Composition and Information on Ingredients

Component	CAS #	% by Weight
Water	7732-18-5	20-50
Sodium Azide	26628-22-8	0-1
Sodium Iodide	7681-82-5	15-40
Sodium Hydroxide	1310-73-2	15-40

Section 3. Hazards Identification

Physical State and Appearance Liquid.

Emergency Overview DANGER! CAUSES EYE AND SKIN BURNS. HARMFUL IF INHALED OR SWALLOWED. MAY BE HARMFUL IF ABSORBED THROUGH SKIN. CAUSES RESPIRATORY TRACT IRRITATION. CONTAINS MATERIAL WHICH CAUSES DAMAGE TO THE FOLLOWING ORGANS: KIDNEYS, LUNGS, RESPIRATORY TRACT, SKIN, CENTRAL NERVOUS SYSTEM, EYE, LENS OR CORNEA.

Routes of Entry Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Potential Acute Health Effects

Eyes Hazardous in case of eye contact (corrosive). Causes eye burns.

Skin Hazardous in case of skin contact (corrosive). Skin contact produces burns. May be hazardous in case of skin contact (permeator).

Inhalation Hazardous in case of inhalation (lung irritant).

Ingestion Hazardous in case of ingestion.

Potential Chronic Health Effects

Carcinogenic Effects This material is not known to cause cancer in animals or humans. Additional information See Toxicological Information (section 11)

Medical Conditions Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe **Aggravated by** skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract **Overexposure:** irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4. First Aid Measures

Eye Contact Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cold water may be used. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

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

Ingestion If swallowed, do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Section 5. Fire Fighting Measures

Flammability of the Product Non-flammable. **Product**

Auto-ignition Not applicable. **Temperature**

Flash Points Not applicable.

Flammable Limits Not applicable.

Products of Combustion Not available.

Fire Hazards in Presence of Various Substances Not applicable.

Explosion Hazards in Presence of Various Substances Risks of explosion of the product in presence of static discharge: No.

Risks of explosion of the product in presence of mechanical impact: No.

Fire Fighting Media and Instructions Not applicable.

Protective Clothing (Fire) Not applicable.

Special Remarks on Fire Hazards Not available.

Special Remarks on Explosion Hazards Forms explosion sensitive compounds with some metals such as lead, silver, mercury and copper. (Sodium Azide)

Accidental Release Measures

Small Spill and Leak Dilute with water and mop up, or absorb with an stable dry material and place in an appropriate waste disposal container.

Large Spill and Leak Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water

inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Spill Kit Information The following EMD Chemicals Inc. SpillSolv[®] absorbent is recommended for this product: SX1320 Caustic Treatment Kit

Section 7. Handling and Storage

Handling Do not ingest. Do not breathe vapor or mist. Keep container closed. Do not get in eyes, on skin, or on clothing.
Storage Keep container in a cool, well-ventilated area.

Section 8. Exposure Controls/Personal Protection

Engineering Controls Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective occupational exposure limits. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection
Eyes Face shield.

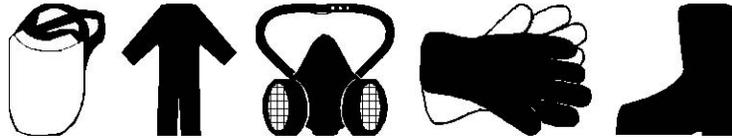
Body Full suit.

Respiratory Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.

Hands Gloves.

Feet Boots.

Protective Clothing (Pictograms)



Personal Protection in Case of a Large Spill Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self-contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Product Name **Exposure Limits**

Water Sodium Azide

Sodium Iodide Sodium Hydroxide Not available.

ACGIH (United States, 1996).

CEIL: 0.29 mg/m³

CEIL: 0.11 ppm Form: Vapor

NIOSH REL (United States, 1994). Skin

CEIL: 0.3 mg/m³ Form: As NaN₃

CEIL: 0.1 ppm Form: As HN₃

OSHA Final Rule (United States, 1989). Skin

CEIL: 0.3 mg/m³ CEIL: 0.1 ppm Not available.

ACGIH (United States).

CEIL: 2 mg/m³

OSHA (United States).

CEIL: 2 mg/m³

AUVA (Austria, 1995).

Spitzenbegrenzung: 4 mg/m³ 8 times per shift, 5 minute(s).

TWA: 2 mg/m³ 8 hour(s).

Belgium Minister of Labour (Belgium, 1998).

CEIL: 2 mg/m³

VL: 2 mg/m³ 8 hour(s).

BAUA (Germany, 1997).

Spitzenbegrenzung: 2 mg/m³

TWA: 2 mg/m³ 8 hour(s).

DK-Arbejdstylnet (Denmark, 1996).

Loftværdi: 2 mg/m³

GV: 2 mg/m³ 8 hour(s).

Tyterveyslaitos (Finland, 1998).

TWA: 2 mg/m³ 8 hour(s).

INRS (France, 1996).

VME: 2 mg/m³ 8 hour(s).

National Authority for Occupational Safety/Health (Ireland, 1999).

STEL: 2 mg/m³ 15 minute(s).

Arbeidsinspectie (Netherlands, 1999).

MAC-C: 2 mg/m³

TGG 8 uur: 2 mg/m³ 8 hour(s).

N-Arbeidstylnet (Norway, 1996).

AN: 2 mg/m³ 8 hour(s).

AFS (Sweden, 1996).

KTV: 2 mg/m³ 15 minute(s).

EH40-OES (United Kingdom (UK), 1997).

STEL: 2 mg/m³ 15 minute(s).

NIOSH REL (United States, 1994).

CEIL: 2 mg/m³

OSHA Final Rule (United States, 1989).

CEIL: 2 mg/m³

Section 9. Physical and Chemical Properties

Odor	Not available.
Color	Not available.
Physical State and Appearance	Liquid.
Molecular Weight	Not applicable.
Molecular Formula	Not applicable.
pH	Not available.
Boiling/Condensation Point	The lowest known value is 99.9°C (211.8°F) (Water).

Melting/Freezing Point	May start to solidify at -0.1°C (31.8°F) based on data for: Water.
Specific Gravity	The only known value is 2.13 (Water = 1) (Sodium Hydroxide).
Vapor Pressure	Not available.
Vapor Density	Not available.
Odor Threshold	Not available.

Evaporation Rate 0.36 (Water) compared to (n-BUTYL ACETATE=1)

LogK_{ow} Not available.

Solubility Soluble in water.

Section 10. Stability and Reactivity

Stability and Reactivity The product is stable.

Conditions of Instability Not available.

Incompatibility with Reactive with acids.

Various Substances Slightly reactive to reactive with oxidizing agents, organic materials, metals.

Rem/Incompatibility Contact with acids liberates toxic gas. (Sodium Azide)

Hazardous Decomposition nitrogen oxides (NO, NO₂...) **Products**

Hazardous Polymerization Will not occur.

Section 11. Toxicological Information

RTECS Number:	Water	ZC0110000
	Sodium Azide	VY8050000
	Sodium Iodide	WB6475000
	Sodium Hydroxide	WB4900000
Toxicity	Acute oral toxicity (LD ₅₀): 4340 mg/kg [Rat]. (SODIUM IODIDE).	

Chronic Effects on Humans Not available.

Acute Effects on Humans Hazardous in case of eye contact (corrosive). Causes eye burns. Hazardous in case of skin contact (corrosive). Skin contact produces burns. May be hazardous in case of skin contact (permeator). Hazardous in case of inhalation (lung irritant). Hazardous in case of ingestion.

Synergetic Products (Toxicologically) Not available.

Irritancy Draize Test: Not available.

Sensitization Not available.

Carcinogenic Effects This material is not known to cause cancer in animals or humans.

Toxicity to Reproductive Not available.

System

Teratogenic Effects Not available.

Mutagenic Effects Not available.

Information

Ecotoxicity Not available.
BOD5 and COD Not available.

Toxicity of the Products of The products of degradation are less toxic than the product itself. **Biodegradation**

Section 13. Disposal Considerations

EPA Waste Number D002 P105

Treatment Specified Technology - Neutralize to pH 6-9. Contact your local permitted waste disposal site (TSD) for permissible treatment sites. Always contact a permitted waste disposal (TSD) to assure compliance with all current local, state, and Federal Regulations..

Section 14. Transport Information

DOT Classification Not available.

TDG Classification Not available.

IMO/IMDG Not available. **Classification**
ICAO/IATA Not available. **Classification**

Section 15. Regulatory Information

U.S. Federal Regulations TSCA 8(b) inventory: Water; Sodium Azide; SODIUM IODIDE; Sodium Hydroxide SARA 302/304/311/312 extremely hazardous substances: Sodium Azide SARA 302/304 emergency planning and notification: Sodium Azide SARA 302/304/311/312 hazardous chemicals: Sodium Azide; SODIUM IODIDE; Sodium Hydroxide SARA 311/312 MSDS distribution - chemical inventory - hazard identification: Sodium Azide: Immediate (Acute) Health Hazard; SODIUM IODIDE: Immediate (Acute) Health Hazard, Delayed (Chronic) Health Hazard; Sodium Hydroxide: Immediate (Acute) Health Hazard
Clean Water Act (CWA) 307: No products were found.
Clean Water Act (CWA) 311: Sodium Hydroxide
Clean air act (CAA) 112 accidental release prevention: No products were found.

Clean air act (CAA) 112 regulated flammable substances: No products were found.
Clean air act (CAA) 112 regulated toxic substances: No products were found.

WHMIS (Canada) Class D-1B: Material causing immediate and serious toxic effects (TOXIC). Class D-2A: Material causing other toxic effects (VERY TOXIC). CLASS E: Corrosive liquid.

CEPA DSL: Water; Sodium Azide; SODIUM IODIDE; Sodium Hydroxide
This product has been classified in accordance with the hazard criteria of the Controlled Product Regulations and the MSDS contains all required information.

International Regulations

EINECS

Water 231-791-2 Sodium Azide 247-852-1 SODIUM IODIDE 231-679-3 Sodium Hydroxide 215-185-5

DSCL (EEC) R21- Harmful in contact with skin. R35- Causes severe burns.

International Lists Australia (NICNAS): Water; Sodium Azide; SODIUM IODIDE; Sodium Hydroxide Japan (MITI): Water; Sodium Azide; SODIUM IODIDE; Sodium Hydroxide Korea (TCCL): Water; Sodium Azide; SODIUM IODIDE; Sodium Hydroxide Philippines (RA6969): Water; Sodium Azide; SODIUM IODIDE; Sodium Hydroxide

China: No products were found.

State Regulations Pennsylvania RTK: Sodium Azide: (environmental hazard, generic environmental hazard); Sodium Hydroxide: (environmental hazard, generic environmental hazard) Massachusetts RTK: Sodium Azide; Sodium Hydroxide New Jersey: Water; Sodium Azide; Sodium Hydroxide

California prop. 65: No products were found.

Section 16. Other Information

National Fire Protection Association (U.S.A.)



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Notice to Reader

The statements contained herein are based upon technical data that EMD Chemicals Inc. believes to be reliable, are offered for information purposes only and as a guide to the appropriate precautionary and emergency handling of the material by a properly trained person having the necessary technical skills. Users should consider these data only as a supplement to other information gathered by them and must make independent determinations of suitability and completeness of information from all sources to assure proper use, storage and disposal of these materials and the safety and health of employees and customers and the protection of the environment. EMD CHEMICALS INC. MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE, WITH RESPECT TO THE INFORMATION HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS.

Attachment D: MSDS for Rhodamine WT

ORCOACID RHODAMINE WT LIQUID

SAFETY DATA SHEET

SECTION I: IDENTIFICATION



ORGANIC DYESTUFFS CORPORATION
65 VALLEY STREET
East Providence, Rhode Island 02914-0258
WWW.ORGANICDYE.COM
Telephone No. (401) 434-3300
Hours of Operation M-F 8-4:30 EST

Trade Name...: ORCOACID RHODAMINE WT LIQUID Product Code: 11388OR10
Date of Last Revision: 11/15/11 Prepared by: Candace G. Turner

SECTION II: HAZARDOUS INGREDIENTS

Material: NO KNOWN HAZARDOUS INGREDIENTS PRESENT.
AS PER CFR 29 PART 1910.1200 (OSHA HAZ COMMUNICATION STD)

CONTAINS RTK CHEMICAL : TRIMELLITIC ACID <3% CAS [528-44-9]

Warning.: OVEREXPOSURE TO THIS PRODUCT MAY CAUSE SLIGHT IRRITATION OF EYES AND SKIN.

SECTION III: COMPOSITION INFORMATION

Chemical Name: XANTHENE CAS: PROPRIETARY

100% PROPRIETARY ACID RED DYE

SECTION IV: FIRST-AID MEASURES

Eyes.....: IMMEDIATE AND CONTINUOUS IRRIGATION WITH FLOWING WATER FOR AT LEAST FIFTEEN MINUTES. CONSULT PHYSICIAN IF IRRITATION OCCURS.
Skin.....: IMMEDIATELY FLUSH SKIN WITH PLENTY OF WATER. WASH WELL WITH SOAP AND WATER. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE.
Ingestion.: IF CONSCIOUS, GIVE TWO GLASSES OF WATER TO DILUTE. ONLY INDUCE VOMITING IF ADVISED BY POISON CONTROL CENTER.
Inhalation: REMOVE TO FRESH AIR. IF EFFECTS OCCUR, CONSULT PHYSICIAN.

ACUTE/IMMEDIATE EFFECTS:	SLIGHT IRRITATION OF EYES AND SKIN
CHRONIC/DELAYED EFFECTS:	NONE KNOWN

SECTION V: FIRE FIGHTING MEASURES

Extinguishing Media.....: WATER SPRAY, DRY CHEMICALS, FOAM OR CARBON DIOXIDE.

Special Fire Fighting Procedures.: FIREFIGHTERS SHOULD WEAR FULL-FACE, SELF-CONTAINED BREATHING APPARATUS AND IMPERVIOUS PROTECTIVE CLOTHING.

Unusual Fire and Explosion Hazards: NONE EXPECTED

Flash Point and Method.....: N.A. Flammable Limits LEL: N.A. UEL: N.A.

NFPA Fire Hazards Code	Key	HMIS Codes
HEALTH	1	0-MINIMAL
FIRE	1	1-SLIGHT
REACTIVITY	0	2-MODERATE
SPECIFIC	NA	3-SERIOUS
		4-SEVERE

SECTION VI: ACCIDENTAL RELEASE MEASURES

ALWAYS WEAR PROPER PROTECTIVE CLOTHING AND RESPIRATORY PROTECTION. MIX MATERIAL WITH SWEEPING COMPOUND TO MINIMIZE DUSTING WHILE SWEEPING UP AND CONTAINING. VACUUM CONTAMINATED AREA.

KEEP AWAY FROM DRAINS, SURFACE AND GROUND WATER.

REMOVE ANY SOURCES OF POTENTIAL IGNITION.

SECTION VII: HANDLING AND STORAGE

AVOID BREATHING MIST. AVOID CONTACT WITH EYES AND SKIN. WASH THOROUGHLY AFTER HANDLING. STORE IN A DRY PLACE AWAY FROM EXCESSIVE HEAT, IN ORIGINAL OR SIMILAR WATERPROOF CONTAINERS. RESEAL CONTAINERS IMMEDIATELY AFTER USE.

MAINTAIN GOOD HOUSEKEEPING. AVOID INGESTION, EYE AND SKIN CONTACT. MINIMIZE INHALATION EXPOSURE BY USING RESPIRATOR. WASH HANDS AFTER WEIGHING DYE TO AVOID CONTACT OF THE SKIN OR EYES WITH CONTAMINATED HANDS. A SENSITIZED INDIVIDUAL SHOULD NOT BE EXPOSED TO THE PRODUCT WHICH CAUSED THE SENSITIZATION.

MINIMIZE RELEASE OF SUBSTANCE INTO THE ENVIRONMENT

SECTION VIII: EXPOSURE CONTROLS/PPE

Ventilation.....: USE LOCAL EXHAUST VENTILATION TO MINIMIZE EXPOSURE. MAINTAIN AIR CONCENTRATIONS BELOW OCCUPATIONAL EXPOSURE STANDARDS WHEN POSSIBLE

Respiratory.....: A NIOSH/MSHA APPROVED DUST RESPIRATOR SHOULD BE WORN.

Eye Protection...: WEAR SIDE-SHIELD SAFETY GLASSES OR CHEMICAL SAFETY GOGGLES.

Skin.....: WEAR APPROPRIATE PROTECTIVE CLOTHING, WEAR IMPERVIOUS GLOVES AS A STANDARD HANDLING PROCEDURE.

DELUGE SAFETY SHOWER, AND EYE WASH STATION SHOULD BE IN VICINITY OF WORK AREA

All chemicals should be handled so as to prevent eye contact and excessive or repeated skin contact. Appropriate eye and skin protection should be employed. Inhalation of dusts and vapors should be avoided.

SECTION IX: PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE:	LIQUID				
COLOR:	RED				
ODOR:	SLIGHTLY AROMATIC				
SOLUBILITY:	MISCIBLE				
pH :	N.E.				
MELTING POINT:	N.A.				
BOILING POINT:	N.A.				
FLASH POINT:	N.E.	METHOD:	N.E.	LEL:	N.E.
AUTO IGNITION TEMP:	N.A.			LUL:	N.E.
DECOMPOSITION TEMP:	N.A.				
VISCOSITY:	N.A.				

SECTION X: STABILITY AND REACTIVITY

STABLE UNDER NORMAL STORAGE CONDITIONS.

Incompatibility (Materials to Avoid): OXIDIZING AND REDUCING AGENTS.

Hazardous Decomposition Products.....: BURNING WILL PRODUCE OXIDES OF CARBON, NITROGEN AND SULFUR.

Hazardous Polymerization.....: WILL NOT OCCUR UNDER NORMAL CONDITIONS.

SECTION XI: TOXICOLOGICAL INFORMATION

LD-50: N.E.
LD-50: N.E.

ROUTE OF EXPOSURE: SKIN AND EYES
TLV: N.E.

EFFECTS IF OVEREXPOSURE:

ACUTE: SLIGHT IRRITATION OF EYES AND /OR SKIN
CHRONIC: NO KNOWN CHRONIC ILL EFFECTS.

NOT A KNOWN MUTAGEN, CARCINOGEN, OR ASPIRATION HAZARD.
NOT KNOWN TO CAUSE REPRODUCTIVE TOXICITY.

SECTION XII: ECOLOGICAL INFORMATION

NOT EVALUATED

SECTION XIII: DISPOSAL INFORMATION

Disposal Considerations...: DISPOSE OF IN ACCORDANCE WITH LOCAL, STATE AND FEDERAL ENVIRONMENTAL CONTROL REGULATIONS. EMPTIED CONTAINERS RETAIN PRODUCT RESIDUE AND SHOULD NOT BE DISTRIBUTED, MADE AVAILABLE, FURNISHED OR REUSED EXCEPT FOR STORAGE AND SHIPMENT OF ORIGINAL PRODUCT.

SECTION XIV: TRANSPORTATION INFORMATION

DOT SHIPPING NAME: NOT REGULATED
TECHNICAL SHIPPING NAME: NOT REGULATED
DOT HAZARD CLASSIFICATION
PRIMARY: NOT APPLICABLE
SECONDARY: NOT APPLICABLE
FREIGHT CLASSIFICATION: NOT REGULATED
UN NUMBER: NOT APPLICABLE
IMO HAZARD CLASS: NOT REGULATED
DOT LABELS REQUIRED: COMMUNITY RIGHT TO KNOW LABEL
EPA/DOT HAZARDOUS SUBSTANCE RQ: NOT APPLICABLE.

SECTION XV: REGULATORY INFORMATION

TSCA: ALL COMPONENTS OF THIS PRODUCT ARE IN COMPLIANCE WITH THE TOXIC SUBSTANCE CONTROL ACT.

APPROVED SUBSTANCE ON THE FOLLOWING INTERNATIONAL LISTS:
ASIA-PAC NZIoC

COMMUNITY RIGHT TO KNOW LABEL TRIMELLITIC ACID < 3%

NOT REPORTABLE UNDER SARA TITLE III SEC: 302,304, 313
NOT KNOWN TO BE A FORBIDDEN AZO DYE (GERMAN LIST)
NOT LISTED AS PROPOSITION 65 CHEMICAL
NO LABEL NECESSARY IN ACCORDANCE WITH ECC DIRECTIVES
CONFORMS TO EC DIRECTIVE 2001/58/EC

SECTION XVI: OTHER INFORMATION

FOR INDUSTRIAL USE ONLY

DISCLAIMER

Information contained herein is, to our best knowledge, true and accurate. It is offered for information only, as we cannot guarantee the results of processes not under our direct control.

N.E. NOT ESTABLISHED N.A. NOT APPLICABLE

REASON FOR UPDATE: FORMAT CHANGE

Attachment E: MSDS for Propane

Ferrellgas Material Safety Data Sheet - Propane

Ferrellgas One Liberty Plaza Liberty, MO 64068

Section 1: Emergency Information

24 Hour Emergency Number

Call 1-800-424-9300 (Chemtrec) in case of emergencies involving propane.

Warning!

- Extremely flammable compressed gas.
- Asphyxiant in high concentrations.
- Skin contact with liquid causes burns similar to frostbite.
- Ethyl mercaptan used as a warning agent may not be entirely effective in all situations.
- Read the warnings in section 9.

NFPA hazard rating

Hazard ratings are in the following table

Health hazard = 1

Fire hazard = 4

Reactivity = 0

Where:

0 = Least 3 = High

1 = Slight 4 = Extreme

2 = Moderate

General MSDS assistance

Call 816-792-1600 and ask to speak with the Safety Department for general assistance with questions about this MSDS.

Section 2: Hazardous Components/Identity Information

Product

Propane (odorized)

Chemical name

Propane

Chemical family

Liquefied Petroleum Gas (Paraffinic Hydrocarbons)

Hazardous components

Propane may contain various percentages of these hazardous components, depending on the source of supply.

Component	CAS Number	Percentage
Propane	74-98-6	85 - 100
Propylene	115-07-1	0 - 15
Butane and heavier	106-97-8	0 - 2.5
Ethane	74-84-0	0 - 5
Ethyl Mercaptan (Odorant)	75-08-1	<0.0025

Section 3: Health Information

Purpose

The health effects are consistent with requirements of the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Eye contact

Direct contact with liquid propane can result in eye burns.

Skin contact

Direct contact with liquid propane can result in skin burns (frostbite).

Inhalation

This product is classified as a simple asphyxiant. High vapor concentrations may produce a reversible central nervous system depression (anesthesia). Higher concentrations may produce asphyxiation.

Ingestion

Ingestion is not likely.

Signs and symptoms

- Eye or skin burns (frostbite) as noted previously.
- Early to moderate central nervous system depression may be evidenced by giddiness,
- headache, dizziness and nausea. In extreme cases, unconsciousness may occur.
- Asphyxiation may be noted by a sudden loss of consciousness. Death may quickly follow.

Aggravated medical conditions

Caution is recommended for personnel with pre-existing central nervous system or chronic respiratory diseases.

Acute toxicity data

Acute toxicity data is not applicable to this product.

Carcinogenicity

This product is not classified as a carcinogen.

Occupational exposure limits

Use this table to determine the allowable exposure limits for personnel.

OSHA		ACGIH	
PEL/TWA	PEL/Ceiling	TLV/TWA	TLV/STEL
Propane: 1,000 PPM Butane: 800 PPM	Not established	Butane: 800 PPM	Not established

Cardiac effects

While there is no evidence that exposure to industrially acceptable levels of hydrocarbons have produced cardiac effects in humans, animal studies have shown that inhalation of high vapor levels of the components of this product have produced cardiac sensitization. Such sensitization may cause fatal changes in heart rhythms. This latter effect was shown to be enhanced by hypoxia or the injection of adrenaline-like agents.

Effects of propylene

Laboratory animals exposed to high levels of propylene for prolonged periods of time showed evidence of effects in the liver, kidneys, and nasal cavity.

Section 4: Emergency and First Aid Procedures

Purpose

Follow these procedures in case of personal injuries resulting from use of this product.

Eye contact with liquid

Flush eyes with water. Get medical attention.

Skin contact with liquid

Flush with water. If frostbite or burn occurs, get medical attention.

Inhalation

Remove victim to fresh air and provide oxygen if breathing is difficult.

Seek immediate medical attention if victim is not breathing. Give artificial respiration.

Ingestion

Not applicable to this product.

Section 5: Physical Data

Physical properties

Refer to this table for the physical properties of this product.

Property	Value
Appearance and odor	Colorless gas, liquid under pressure. Mercaptan “rotten cabbage” odor
Boiling point	-44 degrees F.
Evaporation rate (Butyl Acetate = 1)	<1 (diffuses readily)
Flash point	-156 degrees F.
Liquid to vapor expansion ratio	1:270
Molecular weight	44.096
Solubility in water	Slight
Specific gravity (liquid)	0.500 - 0.510 (Water = 1)
Specific gravity (vapor)	1.52 (Air = 1)
Vapor pressure (maximum)	208 PSIG @ 100 degrees F.

Section 6: Fire and Explosion Hazards

Flammability limits

Flammability limits by volume in air.

- Lower 2.15 percent
- Upper 9.6 percent

Ignition temperature

Auto Ignition temperature is 940 degrees, F.

Extinguishing media

Allow product to burn if source cannot be shut off safely.

- Class B-C or A-B-C dry chemical or halon extinguishers can be used on small fires.

- Apply water from a safe distance to cool containers, surrounding equipment, and structures.

Special fire-fighting procedures and precautions

Extremely flammable. Containers may explode if not sufficiently cooled with water spray. Evacuate surrounding area of unprotected personnel and isolate. Do not enter confined fire space without full bunker gear (helmet with face shield, bunker coats, gloves, and rubber boots) and a positive pressure NIOSH approved self-contained breathing apparatus.

Section 7: Reactivity

Stability and hazardous polymerization

This product is stable. Hazardous polymerization will not occur.

Conditions and materials to avoid

Avoid heat, sparks, flame and contact with strong oxidizing agents. Avoid buildups of static electricity.

Prevent vapor accumulation.

Hazardous decomposition products

Carbon monoxide and unidentified organic products may be formed during combustion.

Section 8: Employee Protection

Respiratory protection

Use a NIOSH approved respirator as required when airborne exposure limits are exceeded. In accord with 29 CFR 1910.134, use either an atmosphere supplying respirator or an air purifying respirator for organic vapors.

Protective clothing

Avoid liquid contact with eyes or skin.

- Wear safety glasses or goggles as appropriate.
- Wear protective clothing as appropriate.

Additional protective measures

Use explosion-proof ventilation as required to control vapor concentrations.

Section 9: Precautions For Safe Handling and Use

Release, spill or leak procedures

Warning! Extremely flammable.

- Eliminate sources of ignition.
- Isolate hazard area and deny entry to unnecessary or unprotected personnel.

- Stay upwind and keep out of low areas.
- Notify local fire department.
- Disperse vapor clouds with water spray.
- Shut off source of leak only if it can be done safely.

Training

Train all personnel involved in handling propane in proper handling and operating procedures.

- Document all training.

Handling and storing

Handle and store propane in accordance with NFPA 58 and local fire codes.

- Keep containers away from heat sources or temperatures exceeding 130 degrees F.
- Do not drop or roll any container.
- Store and transport containers with relief valves in vapor space.
- Keep all container valves closed when not in use.
- Keep protective caps (if applicable) on containers when not in use.

DOT cylinders

Take these precautions when using DOT cylinders.

- Periodically inspect and requalify DOT cylinders in accordance with DOT and NFPA 58 codes and Compressed Gas Association Pamphlets C-6 and C-6a.
- Store and use cylinders with valves off and the relief valves in the container vapor space.
- Shut all valves and follow recommended procedures before exchanging cylinders.

Special precautions

Containers, even those that have been emptied, can contain explosive vapors.

- Do not cut, drill, grind, weld or perform similar operations on or near containers.

Propane odorization

Warning! Any smell of odorant, even a faint one, may indicate a dangerous situation.

Ethyl mercaptan is the preferred warning agent for propane. Although ethyl mercaptan has excellent warning properties, “It is recognized that no odorant will be completely effective as a warning agent in every circumstance” (NFPA 58 A-1-4.1, 1992 edition).

Instances in which odorants may lose their effectiveness include, but are not limited to:

- Odor may fade due to chemical oxidation in improperly prepared new tanks and cylinders or from rust, air, and water in used containers that have been allowed to stand open to the atmosphere.

- Odor may be absorbed and adsorbed by the walls of containers and distribution systems.
- Odor in the gas escaping from underground leaks may be absorbed by certain types of soils.
- Effectiveness of the odorant may be reduced by cold temperatures.
- Other odors, such as from cooking or from a musty basement, may mask or cover up the mercaptan odor in propane.
- Exposure to the mercaptan odor of propane for extended periods of time may affect a person's ability to detect the odorant.
- Physical disabilities or the use of alcohol, tobacco, or drugs may decrease a person's ability to detect the odorant.

Section 10: Transportation Requirements

DOT shipping name

Liquefied Petroleum Gas

DOT classification

Division 2.1 (Flammable Gas)

Other transportation requirements

UN 1075, Hazardous Materials Guide Number 115.

North American Industrial Classification System (NAICS) Number 454312

Section 11: Other Regulatory Controls

EPA/TSCA

The components of this product are listed on the EPA/TSCA inventory of chemical substances.

EPA Hazard Classification

This product is classified by 40 CFR 372 (SARA Section 313) as:

Acute Hazard	Chronic Hazard	Fire Hazard	Pressure Hazard	Reactive Hazard
XXX		XXX	XXX	

Ozone depleting substances

This product does not contain, nor was it directly manufactured with, any class I or class II ozone depleting substances.

RCRA Information

This product is not subject to 40CFR 268.30 ban on the disposal of hazardous wastes. If this product becomes a waste material, it would be an ignitable hazardous waste, having a waste code number D0001. Refer to latest EPA or state regulations regarding proper disposal. Under EPA-RCRA, containers are considered hazardous unless depressurized to a pressure approaching atmospheric. Depressurize containers at a controlled rate to a flare.

State regulatory information

The ingredients in this product are specifically listed by individual states; other product specific health and safety data in other sections of the MSDS may also be applicable for state requirements.

- Contact the appropriate agency in your state for details on your regulatory requirements.

California Proposition 65 warning

Chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm are created by the combustion of propane.

Section 12: Supplemental Information

Disclaimer of liability

The information in this MSDS was obtained from sources which we believe are reliable.

However, the information is provided without any warranty, express or implied, regarding its correctness.

The conditions or methods of handling, storage, use and disposal of this product are beyond our control and may be beyond our knowledge. **For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage, or expense arising out of or in any way connected with the handling, storage, use, or disposal of this product.**

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