X. APPENDIX II

ANALYTICAL METHOD FOR MALATHION

The method presented in the NIOSH Manual of Analytical Methods [204] for analysis of parathion in air is recommended for malathion.

Principle of the Method

Malathion from the air is trapped in ethylene glycol contained in a midget impinger. The ethylene glycol solution is diluted with water and extracted with hexane. The resulting hexane solution containing the malathion is concentrated and subjected to gas chromatographic analysis using a phosphorus flame photometric detector.

Range and Sensitivity

The linear range of the flame photometric detector is 0.5-25 ng for malathion and for a 50-liter air sample carried through the following procedure to solution in 1 ml of hexane, 2 μl of which are injected into the gas chromatograph, ie, 5-250 μg/cu m. These limits can be lowered or raised by changing (1) the volume of air sampled, (2) the volume of the final hexane solution, or (3) the size of the aliquot injected into the gas chromatograph.

Interferences

Phosphorus compounds having retention times close to that of malathion will interfere with the analysis. Retention ratios, relative to ethyl parathion, have been tabulated for malathion on columns identical to column 4 as specified (see Apparatus Section), but operated at slightly different temperatures, by Thompson. [200] These indicate possible interference by malaoxon and methyl parathion. Resolution of such interference can be accomplished by varying the column compositions and temperatures used. The equipment used must be scrupulously cleaned to remove any traces of phosphate detergents.

Advantages and Disadvantages of the Method

(a) Advantages: The method is very sensitive, and the detector exhibits high specificity for phosphorus compounds. The analysis is performed directly on malathion. Separation and quantitation are accomplished in a reasonable amount of time.

(b) Disadvantages: The cost of the equipment and supplies may tax the budget of some laboratories. The sensitivity of the equipment depends on careful adjustment of the operating conditions. Contamination can occur easily through equipment or reagents. If interfering compounds are anticipated, a lengthy cleanup procedure is required.

Apparatus

(a) Forceps.

(b) Glass stirring rods.

(c) Separatory funnels, 250-ml.

(d) Beakers, 100-ml.

(e) Funnels, 65- or 75-mm (diameter at top).

(f) Glass wool.

(g) Hot-water bath.

(h) Kuderna-Danish evaporator-concentrator, consisting of a 125-ml Erlenmeyer-type flask, 3-ball Snyder column, and a 10-ml receiver graduated in milliliters.

(i) Glass beads, 3-mm.

(j) Volumetric flasks for standards.

(k) Graduated cylinders, 25- or 50-ml.

(l) Syringes, 5- or 10-μl and 100-μl.

(m) Gas chromatograph, with attendant equipment, including a phosphorus flame photometric detector.

(n) Gas-chromatography column constructed from 6-ft x 4-mm inside diameter borosilicate glass packed with one of the following:

(1) 10% DC-200 (12,500 cst) on 80-100 mesh Gas Chrom Q.

(2) 7.5% QF-1 (10,000 cst)/5% DC-200 (12,500 cst) on 80-100 mesh Gas Chrom Q.

(3) 2% diethylene glycol succinate (DEGS) (C6 stabilized) on 80-100 mesh Gas Chrom Q.

(4) 4% SE-30/6% OV-210 on 80-100 mesh Chromosorb W, HP.

Columns 1 and 2 are heat-conditioned for 2-4 days at 240-250 C under nitrogen flowing at 60 ml/minute, then primed by repeated injections of standard malathion solution under the conditions of analysis given below. Column 3 is conditioned by heating for 12 hours at 225-230 C under nitrogen

flowing at 60 ml/minute. A column of 10% Carbowax 20M on 80-100 mesh silanized support (2-in x 4-mm inside diameter glass tubing) is then inserted before Column 4, and the assembly is heated at 230-235 C for 17 hours under nitrogen flowing at 20 ml/minute. The 10% Carbowax 20 M column is subsequently removed.

Reagents

(a) Ethylene glycol, chromatoquality.

(b) Hexane, pesticide quality.

(c) Distilled water, interference-free.

(d) Saturated aqueous sodium chloride, interference-free.

(e) Anhydrous sodium sulfate.

(f) Malathion of known purity.

Analysis of Samples

(a) Transfer the sample in 17-20 ml of ethylene glycol to a 125-ml separatory funnel. Wash the sample container with a measured amount of water and add the washings to the separatory funnel. Dilute the ethylene glycol with a total of 70 ml of water.

(b) Extract the aqueous solution three times with 12 ml of hexane, and discard the aqueous layer. Should an emulsion be formed, saturated aqueous chloride can be used to disperse it.

(c) Dry the hexane solution by passing it through 2.6 g of anhydrous sodium sulfate contained in a funnel with a glass-wool retaining plug at the top of the stem. Collect the eluate in a 125-ml Kuderna-Danish

flask which has been fitted with a 10-ml receiving tube containing one 3-mm glass bead. Rinse the separatory funnel with three consecutive 2-ml portions of hexane, washing down the walls of the funnel. Allow each rinse to elute before adding the next. Finally, rinse the funnel and the sodium sulfate with two more 2-ml portions of hexane.

(d) Place the Kuderna-Danish assembly in a boiling water bath and concentrate the extract to a volume of approximately 5.0 ml. Remove the assembly from the bath, and after it has cooled, disconnect the receiving tube from the flask, rinsing the joint with a little hexane. Place the tube under a nitrogen stream at room temperature and further concentrate the extract to approximately 0.5 ml. Rinse down the wall of the tube with hexane delivered from a 100-μl syringe, diluting the extract to exactly 1.0 ml, and stir.

(e) Inject a suitable aliquot of the hexane solution into the gas chromatograph and obtain a chromatogram. The chromatographic conditions are:

Column temperature	220 C for columns 1 and 2 210 C for column 3 200 C for column 4
Injection port temperature	225 C
Detector temperature	200 C
Transfer line and switching valve temperature	235 C
Carrier gas (nitrogen) flow	60 ml/minute

The solvent-flush sample injection technique is recommended. Duplicate injections should be made. The hexane, which precedes the malathion, should be vented so the detector flame will not be extinguished.

The conditions of the run should be such that no malathion is lost during the venting process.

(f) The average of the areas under the malathion peaks is converted to the amount (ng) of malathion seen by the detector by comparing it to a standard curve for malathion.

Calibration and Standards

(a) Prepare at least three standard solutions in the concentration range of 100-12,500 ng/ml from a stock solution of malathion in hexane.

(b) Make duplicate injections of aliquots of each standard solution into the gas chromatograph and determine the peak areas.

(c) Plot the amount (ng) of malathion seen by the detector against the peak area. A straight line passing through the origin should result. If this result is not obtained, either the linear range of the detector has been exceeded or a system malfunction has occurred.

(d) Injections of standards should be interspersed among sample injections so that a watch can be maintained on detector sensitivity.

Calculations

(a) Determine the total amount in ng of malathion present in the sample:

$$\text{Total ng} = \text{ng(o)} \times \frac{\text{Soln vol}}{\text{Inj vol}}$$

where:

ng(o) = nanograms of malathion determined from calibration curve based on peak area responses

Soln vol = volume in μl of the final hexane solution (usually 1,000 μl)

Inj vol = volume in μl of the aliquot of the final hexane solution injected into the gas chromatograph

(b) Convert the volume of air sampled to standard conditions of 25 C and 760 mmHg:

$$Vs = V \times \frac{P}{760} \times \frac{298}{(T + 273)}$$

where:

Vs = volume of air in liters at 25 C and 760 mmHg

V = volume of air in liters as measured

P = barometric pressure in mmHg where sample is collected

T = temperature (degrees C) of air sampled

(c) The concentration of malathion can be expressed in ng/l or μg/cu m:

$$\mu g/cu\ m = ng/liter$$

$$\mu g/cu\ m = \frac{\text{total ng}}{Vs}$$

XI. APPENDIX III

NOTES ON THE DIAGNOSIS AND MEDICAL MANAGEMENT OF ORGANOPHOSPHORUS INTOXICATION

The following paragraphs have been adapted from an article entitled "Prevention and Management of Organophosphate Poisoning" which appeared in the Journal of the American Medical Association and which was approved by the AMA Committee on Occupational Toxicology of the Council on Occupational Health. [205]

Diagnosis

A diagnosis of organophosphate intoxication is based primarily on a definite history of exposure to an organophosphate 6 hours or less before onset of illness and clinical evidence of diffuse parasympathetic stimulation. Laboratory verification is based on depression of plasma and red blood cell ChE activities to a level substantially (50% or more) below preexposure values if these are available. If preexposure values are not available, one can use laboratory normal ranges, observing, of course, the usual caution in interpreting such figures. There are many different methods for estimation of ChE content of blood, and associated with each method is a different set of normal values and a different set of reporting units. The laboratory report of a ChE determination should state the units involved along with the appropriate normal range. Based on the Michel method, [61] the normal range of red blood cell ChE activity (delta pH/hr) is 0.39 to 1.02 for men and 0.34 to 1.10 for women. The normal range of

the enzyme activity (delta pH/hr) of plasma is 0.44 to 1.63 for men and 0.24 to 1.54 for women.

In actual practice, the ChE test is often of more value as a confirmatory, rather than a diagnostic, procedure. For moderate-to-severe intoxication, the clinician should act on his clinical impression and on the history of exposure rather than wait for laboratory confirmation.

Initial signs and symptoms of intoxication are headache, nausea, vomiting, sweating, blurred vision, weakness, diarrhea, abdominal pain, and pallor. In moderate-to-severe cases of intoxication, signs and symptoms may also include dyspnea, salivation, lacrimation, muscle fasciculation, convulsions, cyanosis, shock, and cardiac arrhythmias, coma, and death. In the case of mild poisoning where the differential diagnosis may be puzzling, the results of the ChE test may be necessary to establish a definite diagnosis.

ChE is an enzyme which hydrolyzes ACh. Two types are clinically significant: the first, true or acetylChE, is found principally in nervous tissue and in the red blood cell; the other, plasma or BuChE, is found in nervous tissue and in the circulating plasma. Whereas the action of both is inhibited by organophosphate compounds, only depression of the amount of enzyme in the red blood cells is a specific response to these toxins. The level of the enzyme in the plasma may vary with a number of diseases or toxic states. A relatively wide variation exists in the normal levels of both enzymes from one individual to another as well as in the same individual at different times. Once enzyme activity is inhibited, the regeneration times differ between the two types. Red blood cell ChE regenerates at approximately 1%/day, whereas the enzyme in the plasma

regenerates at a more rapid rate, approximating 25% in the first 7-10 days.

Circulating red blood cell and plasma ChE may be conveniently thought of as a buffer system which serves to protect the individual against the nervous system effects of organophosphate toxins by binding the pesticide in the circulating blood, thereby preventing it from reaching the nervous system. Although this is an oversimplified explanation, it is a clinically useful one. In practice, an individual who has been chronically exposed to organophosphate pesticides should be withdrawn from further exposure when his ChE activity values drop to 25-50% of normal and should not be allowed to return until these values rise to at least 75% of normal. The individual who has been acutely poisoned and has shown marked ChE activity depression should not be allowed to return to work with organophosphate pesticides until his ChE levels have returned to approximately 75% of normal.

Treatment

Treatment of organic phosphate poisoning ranges from simple removal from exposure in very mild cases to the provision of very rigorous supportive and antidotal measures in severe cases. In the moderate-to-severe case, because of pulmonary involvement, there may be a need for artificial respiration using a positive pressure method. Careful attention must be paid to removal of secretions and to maintenance of a patent airway. Anticonvulsants, such as thiopental sodium, may be necessary. The critical point is that respiration must be maintained since death usually results from weakness of the muscles of respiration and accumulation of excessive secretions in the respiratory tract. As soon as cyanosis has

been overcome, 2-4 mg of atropine iv should be administered promptly. This dose is approximately 10 times the amount which is administered for other conditions in which atropine is considered therapeutic. This dose should be repeated at 5- to 10-minute intervals until signs of atropinization appear (dry, flushed skin, tachycardia as high as 140 beats/minute, and pupillary dilatation). A mild degree of atropinization should be maintained for at least 48 hours. Atropine is contraindicated in a cyanotic patient because of the possibility of inducing ventricular fibrillation.

Although atropine remains the drug of choice, particularly if the treatment has to be continued for more than a day or two, pralidoxime chloride (Protopam chloride) is a commercially available antidote which complements atropine and hastens the reactivation of ChE enzymes. For adults, in the moderate-to-severe cases, it should be used along with atropine, injected iv as an initial dose of 1 g at a rate not in excess of 500 mg/minute. After an hour, a second dose of 1 g is indicated if muscle weakness has not been relieved. After an overwhelming inhalation or skin exposure to or after ingestion of the toxic agent, the doses may be doubled. For children, the dose may be 25-50 mg/kg of body weight. Treatment with pralidoxime chloride will be most effective if given within 24 hours after poisoning. (Its usefulness after 36-48 hours is questionable.) Together, the two antidotes, atropine and pralidoxime chloride, are more effective than either one alone. Morphine, aminophylline, and the phenothiazines are specifically contraindicated.

It is of great importance to decontaminate the patient. The stomach should be lavaged and a saline cathartic administered if the toxin has been

ingested. Contaminated clothing should be removed at once and the skin should be washed with generous amounts of soap or detergent and a flood of water, which is best accomplished under a shower or by submersion in a pond or other body of water if the exposure occurred in the field. Careful attention should be paid to cleansing of the skin and hair. The patient should be attended and monitored continuously for not less than 24 hours, since serious and sometimes fatal relapses have occurred because of continuing absorption of the toxin or dissipation of the effects of the antidote.

Atropine is antagonistic to the muscarinic effects, which include anorexia, nausea, vomiting, abdominal cramps, sweating, salivation, constricted pupils, pulmonary edema, and cyanosis. Atropine has no effect on the nicotinic manifestations, which include muscle fasciculation and weakness. Pralidoxime chloride acts to regenerate ChE and to reverse muscle weakness. Muscle weakness, specifically weakness of the muscles of respiration, is responsible for respiratory impairment and death in the fatal case. A fully atropinized patient may die of respiratory insufficiency.

XII. APPENDIX IV

METHOD OF SAMPLING AND ANALYSIS FOR BIOCHEMICAL DETERMINATION OF CHOLINESTERASE ACTIVITY

The method of Wolfsie and Winter, [155] a micromodification of the Michel method, [61] is recommended for the measurement of ChE activity.

Sample Handling and Preparation

Blood is collected from a clean, dry fingertip in a heparinized glass capillary tube. The blood is allowed to flow into the capillary tube until the tube is approximately 3/4 full, leaving 1-1.25 inches free at one end to permit flame-sealing of the tip of the tube without overheating the blood sample. The finger should be pricked deeply and care taken to collect only free-flowing blood to prevent clotting before the blood contacts the heparin lining the wall of the capillary tube.

One end of the capillary tube is plunged into solid (room temperature) paraffin and the other (free) end sealed in the flame of a Bunsen burner. The capillary tube is labeled with an adhesive tape tag bearing a serial number or name and date. The sample should then be centrifuged at 3,000-3,500 rpm for 50-60 minutes or its equivalent. When so treated, the sample may be shipped to a laboratory for immediate analysis. The sample should be stored in the cold, insofar as is feasible under field conditions.

Reagents

All reagents should be at least ACS reagent grade.

(a) Buffer solution I (for erythrocytes)

For 1 liter of buffer, dissolve 4.1236 g of sodium barbital (0.02 M), 0.5446 g of potasium orthophosphate, di-H (0.004 M), and 44.730 g of potassium chloride (0.60 M) in 900 ml of distilled water. Add 28.0 ml of 0.1 N hydrochloric acid while shaking the solution, and bring the flask to volume with distilled water. The pH of buffer I should be 8.10 at 25 C.

(b) Buffer Solution II (for plasma)

For 1 liter of buffer, dissolve 1.2371 g of sodium barbital (0.006 M), 0.1361 g of potassium orthophosphate, di-H (0.001 M), and 17.535 g of sodium chloride (0.30 M) in about 900 ml of distilled water. Add 11.6 ml of 0.1 N hydrochloric acid before bringing to volume. The pH of buffer II should be 8.00 at 25 C.

The pH of a buffer solution may decrease over a period of several weeks. The pH should be checked before use. If it has dropped more than 0.03 pH units, the solution should be discarded and a fresh one made.

(c) ACh substrate (for erythrocytes)

This is 0.11 M ACh chloride. Dissolve 2.000 g in 100 ml of distilled water.

(d) ACh substrate (for plasma)

This is 0.165 M ACh chloride. Dissolve 3.000 g in 100 ml of distilled water.

A few drops of toluene may be added to the ACh solutions as a preservative. The solutions must be refrigerated when not in use and discarded at the end of 2 weeks.

(e) Saponin solution

This is 0.01% saponin. Dissolve 100 mg in 1,000 ml of distilled water.

Apparatus

(a) Centrifuge capable of maintaining 3,500 rpm and holding capillary sample tubes.

(b) A pH meter, calibrated to 0.01 pH units.

(c) 0.02-ml Sahli-type hemoglobin pipet.

(d) Constant-temperature bath, 25 C ± 0.1.

(e) 100- and 1,000-ml volumetric flasks.

Analysis

For analysis, the capillary tube is cut cleanly with a sharp ampule file. From the packed-cell section of the capillary, draw 0.02 ml directly into a Sahli-type hemoglobin pipet. The ends of the capillary must be cut evenly to provide satisfactory juxtaposition with the tip of the pipet. Discharge the contents of the pipet directly into 1.0 ml of 0.01% saponin in a microbeaker, and rinse the pipet well (three times) in the solution. Glass vials, 1 inch (2.5 cm) deep by 3/4 inch (19 mm) in diameter, are convenient for electrometric testing. They will fit in the carrier of a standard pH meter and, when used with a clean rubber stopper, will eliminate transferring the sample from a test tube for each pH measurement. Plasma is taken from the appropriate section of the capillary in the same manner as the packed erythrocytes and discharged into 1.0 ml of distilled

water, the Sahli-type pipet being rinsed in the solution (three times) as with the erythrocytes.

Erythrocyte Assay

(a) One milliliter of hemolyzed erythrocyte solution is added to 1 ml of buffer solution I and placed in a 25 C water bath.

(b) After a 10-minute equilibration period, the initial pH (pH(i)) is determined to the nearest 0.01 pH unit with the pH meter.

(c) A volume of 0.2 ml of 0.11 M ACh solution is added with rapid mixing and the time is recorded.

(d) The reaction proceeds for 1-1.5 hours and then the final pH (pH(f)) is noted.

The beaker containing the solution should be shaken when the glass electrode is introduced to expedite the establishment of equilibrium.

Note: Buffer solution I is designed to yield a pH of 8.00 after the addition of hemolyzed human erythrocytes.

Plasma Assay

(a) One milliliter of diluted plasma is mixed with 1 ml of buffer solution II.

(b) The solution is allowed to equilibrate in a 25 C water bath for 10 minutes.

(c) At the end of 10 minutes, the pH (pH(i)) is noted to the nearest 0.01 pH unit.

(d) A volume of 0.2 ml of 0.165 M ACh solution is added with rapid mixing.

(e) The reaction mixture is incubated for 1-1.5 hours and the final pH (pH(f)) is noted.

Calculations

The final units derived from this assay are delta pH/hour:

$$\text{Delta pH/hour} = \frac{c(pH(i)) - pH(f)}{t(2) - t(1)} - cb$$

where:

pH(i) = initial pH

pH(f) = final pH

t(2) - t(1) = time elapsed in hours between pH(i) and pH(f) readings

b = nonenzymatic hydrolysis corresponding to pH 2

c = correction for variations in delta pH/hour with pH corresponding to pH 2

The b and c correction factors are given in Table XII-1. Average baseline values of erythrocyte and plasma ChE activities in men and women determined by this method are given in Table XII-2.

TABLE XII-1

CORRECTION FACTORS FOR USE IN EQUATION 1

	Erythrocyte ChE Corrections		Plasma ChE Corrections	
pH 2	b	c	b	c
7.9	0.03	0.94	0.09	0.98
7.8	0.02	0.95	0.07	1.00
7.7	0.01	0.96	0.06	1.01
7.6	0.00	0.97	0.05	1.02
7.5	0.00	0.98	0.04	1.02
7.4	0.00	0.99	0.03	1.01
7.3	0.00	1.00	0.02	1.01
7.2	0.00	1.00	0.02	1.00
7.1	0.00	1.00	0.02	1.00
7.0	0.00	1.00	0.01	1.00
6.8	0.00	0.99	0.01	1.00
6.6	0.00	0.97	0.01	1.01
6.4	0.00	0.97	0.01	1.02
6.2	0.00	0.97	0.01	1.04
6.0	0.00	0.99	0.01	1.09

Adapted from Michel [61]

TABLE XII-2

NORMAL VALUES FOR CIRCULATING CHOLINESTERASES IN HEALTHY NONEXPOSED PERSONS*

Subjects	Erythrocyte ChE Activity (delta pH/hr)			Plasma ChE Activity (delta pH/hr)			Reference
	Range	Mean	SD	Range	Mean	SD	
400 men	0.58 -0.95	0.766	0.081	0.52 -1.39	0.953	0.187	112**
400 women	0.56 -0.94	0.750	0.082	0.38 -1.25	0.817	0.187	112**
255 men	0.554-1.252	0.861	0.091	0.408-1.652	0.912	0.112	89***
120 men and women	-	-	-	0.58 -1.37	0.94	0.16	113
20 men	-	-	-	-	0.95	0.24	114
20 women	-	-	-	-	0.78	0.12	114

*All analyses by method of Michel [61]
**Ranges, means, and standard deviations estimated from data extrapolated to age 40; highest 1% and lowest 1% values eliminated from ranges
***Analytical method modified for smaller blood samples

XIII. APPENDIX V

MATERIAL SAFETY DATA SHEET

The following items of information which are applicable to a specific product or material shall be provided in the appropriate block of the Material Safety Data Sheet (MSDS).

The product designation is inserted in the block in the upper left corner of the first page to facilitate filing and retrieval. Print in upper case letters as large as possible. It should be printed to read upright with the sheet turned sideways. The product designation is that name or code designation which appears on the label, or by which the product is sold or known by employees. The relative numerical hazard ratings and key statements are those determined by the rules in Chapter V, Part B, of the NIOSH publication An Identification System for Occupationally Hazardous Materials. The company identification may be printed in the upper right corner if desired.

(a) Section I. Product Identification

The manufacturer's name, address, and regular and emergency telephone numbers (including area code) are inserted in the appropriate blocks of Section I. The company listed should be a source of detailed backup information on the hazards of the material(s) covered by the MSDS. The listing of suppliers or wholesale distributors is discouraged. The trade name should be the product designation or common name associated with the material. The synonyms are those commonly used for the product, especially formal chemical nomenclature. Every known chemical designation or

competitor's trade name need not be listed.

(b) Section II. Hazardous Ingredients

The "materials" listed in Section II shall be those substances which are part of the hazardous product covered by the MSDS and individually meet any of the criteria defining a hazardous material. Thus, one component of a multicomponent product might be listed because of its toxicity, another component because of its flammability, while a third component could be included both for its toxicity and its reactivity. Note that an MSDS for a single component product must have the name of the material repeated in this section to avoid giving the impression that there are no hazardous ingredients.

Chemical substances should be listed according to their complete name derived from a recognized system of nomenclature. Where possible, avoid using common names and general class names such as "aromatic amine," "safety solvent," or "aliphatic hydrocarbon" when the specific name is known.

The "%" may be the approximate percentage by weight or volume (indicate basis) which each hazardous ingredient of the mixture bears to the whole mixture. This may be indicated as a range or maximum amount, ie, "10-40% vol" or "10% max wt" to avoid disclosure of trade secrets.

Toxic hazard data shall be stated in terms of concentration, mode of exposure or test, and animal used, ie, "100 ppm LC50-oral-rat," "25 mg/cu m LD50-skin-rabbit," "75 ppm LC man," or "permissible exposure from 29 CFR 1910.93," or, if not available, from other sources of publications, such as the American Conference of Governmental Industrial Hygienists or the American National Standards Institute Inc. Flammable or reactive data

could be flash point, shock sensitivity, or other brief data indicating nature of the hazard.

(c) Section III. Physical Data

The data in Section III should be for the total mixture and should include the boiling point and melting point in degrees Fahrenheit (Celsius in parentheses); vapor pressure, in conventional millimeters of mercury (mmHg); vapor density of gas or vapor (air = 1); solubility in water, in parts/hundred parts of water by weight; specific gravity (water = 1); percent volatiles (indicated if by weight or volume) at 70 degrees Fahrenheit (21.1 degrees Celsius); evaporation rate for liquids or sublimable solids, relative to butyl acetate; and appearance and odor. These data are useful for the control of toxic substances. Boiling point, vapor density, percent volatiles, vapor pressure, and evaporation are useful for designing proper ventilation equipment. This information is also useful for design and deployment of adequate fire and spill containment equipment. The appearance and odor may facilitate identification of substances stored in improperly marked containers, or when spilled.

(d) Section IV. Fire and Explosion Data

Section IV should contain complete fire and explosion data for the product, including flash point and autoignition temperature in degrees Fahrenheit (Celsius in parentheses); flammable limits, in percent by volume in air; suitable extinguishing media or materials; special firefighting procedures; and unusual fire and explosion hazard information. If the product presents no fire hazard, insert "NO FIRE HAZARD" on the line labeled "Extinguishing Media."

(e) Section V. Health Hazard Information

The "Health Hazard Data" should be a combined estimate of the hazard of the total product. This can be expressed as a TWA concentration, as a permissible exposure, or by some other indication of an acceptable standard. Other data are acceptable, such as lowest LD50, if multiple components are involved.

Under "Routes of Exposure," comments in each category should reflect the potential hazard from absorption by the route in question. Comments should indicate the severity of the effect and the basis for the statement, if possible. The basis might be animal studies, analogy with similar products, or human experiences. Comments such as "Yes" or "Possible" are not helpful. Typical comments might be:

> Skin Contact--single short contact, no adverse effects likely; prolonged or repeated contact, mild irritation and possibly some blistering.
>
> Eye Contact--some pain and mild transient irritation; no corneal scarring.

"Emergency and First Aid Procedures" should be written in lay language and should primarily represent first-aid treatment that could be provided by paramedical personnel or individuals trained in first aid.

Information in the "Notes to Physician" section should include any special medical information which would be of assistance to an attending physician including required or recommended preplacement and periodic medical examinations, diagnostic procedures, and medical management of overexposed workers.

(f) Section VI. Reactivity Data

The comments in Section VI relate to safe storage and handling of hazardous, unstable substances. It is particularly important to highlight instability or incompatibility to common substances or circumstances such as water, direct sunlight, steel or copper piping, acids, alkalies, etc. "Hazardous Decomposition Products" shall include those products released under fire conditions. It must also include dangerous products produced by aging, such as peroxides in the case of some ethers. Where applicable, shelf life should also be indicated.

(g) Section VII. Spill or Leak Procedures

Detailed procedures for cleanup and disposal should be listed with emphasis on precautions to be taken to protect workers assigned to cleanup detail. Specific neutralizing chemicals or procedures should be described in detail. Disposal methods should be explicit including proper labeling of containers holding residues and ultimate disposal methods such as "sanitary landfill" or "incineration." Warnings such as "comply with local, state, and federal antipollution ordinances" are proper but not sufficient. Specific procedures shall be identified.

(h) Section VIII. Special Protection Information

Section VIII requires specific information. Statements such as "Yes," "No," or "If necessary" are not informative. Ventilation requirements should be specific as to type and preferred methods. Respirators shall be specified as to type and NIOSH or US Bureau of Mines approval class, ie, "Supplied air," "Organic vapor canister," "Suitable for dusts not more toxic than lead," etc. Protective equipment must be specified as to type and materials of construction.

(i) Section IX. Special Precautions

"Precautionary Statements" shall consist of the label statements selected for use on the container or placard. Additional information on any aspect of safety or health not covered in other sections should be inserted in Section IX. The lower block can contain references to published guides or in-house procedures for handling and storage. Department of Transportation markings and classifications and other freight, handling, or storage requirements and environmental controls can be noted.

(j) Signature and Filing

Finally, the name and address of the responsible person who completed the MSDS and the date of completion are entered. This will facilitate correction of errors and identify a source of additional information.

The MSDS shall be filed in a location readily accessible to workers potentially exposed to the hazardous material. The MSDS can be used as a training aid and basis for discussion during safety meetings and training of new employees. It should assist management by directing attention to the need for specific control engineering, work practices, and protective measures to ensure safe handling and use of the material. It will aid the safety and health staff in planning a safe and healthful work environment and suggesting appropriate emergency procedures and sources of help in the event of harmful exposure of employees.

MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION	
MANUFACTURER'S NAME	REGULAR TELEPHONE NO. EMERGENCY TELEPHONE NO.
ADDRESS	
TRADE NAME	
SYNONYMS	

II HAZARDOUS INGREDIENTS		
MATERIAL OR COMPONENT	%	HAZARD DATA

III PHYSICAL DATA			
BOILING POINT, 760 MM HG		MELTING POINT	
SPECIFIC GRAVITY (H_2O=1)		VAPOR PRESSURE	
VAPOR DENSITY (AIR=1)		SOLUBILITY IN H_2O, % BY WT	
% VOLATILES BY VOL.		EVAPORATION RATE (BUTYL ACETATE=1)	
APPEARANCE AND ODOR			

IV FIRE AND EXPLOSION DATA

FLASH POINT (TEST METHOD)		AUTOIGNITION TEMPERATURE	
FLAMMABLE LIMITS IN AIR, % BY VOL.	LOWER		UPPER
EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES			
UNUSUAL FIRE AND EXPLOSION HAZARD			

V HEALTH HAZARD INFORMATION

HEALTH HAZARD DATA

ROUTES OF EXPOSURE

INHALATION

SKIN CONTACT

SKIN ABSORPTION

EYE CONTACT

INGESTION

EFFECTS OF OVEREXPOSURE

ACUTE OVEREXPOSURE

CHRONIC OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

EYES

SKIN:

INHALATION:

INGESTION

NOTES TO PHYSICIAN

VI REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY

INCOMPATIBILITY

HAZARDOUS DECOMPOSITION PRODUCTS

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

NEUTRALIZING CHEMICALS

WASTE DISPOSAL METHOD

VIII SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY (SPECIFY IN DETAIL)

EYE

GLOVES

OTHER CLOTHING AND EQUIPMENT

IX SPECIAL PRECAUTIONS

PRECAUTIONARY STATEMENTS

OTHER HANDLING AND STORAGE REQUIREMENTS

PREPARED BY _____

ADDRESS: _____

DATE _____