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**HAZARDOUS WASTE ANALYSIS PLAN
FOR LLNL OPERATIONS**

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Table of Contents

	<u>Page</u>
I. INTRODUCTION.	1
II. RADIOACTIVE WASTE	1
III. NON-RADIOACTIVE HAZARDOUS WASTES.	3
IV. THE SAMPLE.	4
A. Liquid Waste (General).	4
B. Solid Waste (General)	6
C. Contained Gases	8
D. Characterization of Waste	8
E. Sludges and Semi-Solids	16
F. Solids.	17
V. THE ANALYSIS.	17
A. Waste Destined for On-Site Treatment.	17
B. Waste Destined for Off-Site Treatment	18
C. Unidentified Hazardous Waste.	18
D. Additional Waste Characterization	19
VI. HAZARDOUS WASTE MOVEMENT.	20
A. On-Site	20
B. Off-Site.	21
VII. THE LABORATORY.	21
REFERENCES.	24
APPENDIX A, REACTIVE MATERIALS LIST	25
APPENDIX B, HIGHLY REACTIVE WASTE	28
APPENDIX C, WASTE IDENTIFICATION SHEET.	33
APPENDIX D, REQUEST FOR ANALYSIS.	34
APPENDIX E, CHEMICAL COMPATIBILITY.	35
APPENDIX F, CHEMICAL CARCINOGENS.	48

I. INTRODUCTION

The Lawrence Livermore National Laboratory is involved in many facets of research ranging from nuclear weapons research to advanced Biomedical studies. Approximately 80% of all programs at LLNL generate hazardous waste in one form or another. Aside from producing waste from industrial type operations (oils, solvents, bottom sludges, etc.) many unique and toxic wastes are generated such as phosgene, dioxin (TCDD), radioactive wastes and high explosives. One key to any successful waste management program must address the following: proper identification of the waste, safe handling procedures and proper storage containers and areas.

This section of the Waste Management Plan will address methodologies used for the Analysis of Hazardous Waste. In addition to the wastes defined in 40 CFR 261, LLNL and Site 300 also generate radioactive waste not specifically covered by RCRA. However, for completeness, the Waste Analysis Plan will address all hazardous waste.

II. RADIOACTIVE WASTE

Radioactive material is defined in 49 CFR 171.8 as any material whose concentration is greater than 2 nCi/gm. However, all waste that has been exposed to radioactive material or to a system exposed to radioactivity is analyzed and a decision is made on how to dispose of it. As an example, we have disposed of contaminated soil as radioactive waste whose radioactivity was approximately .05 nCi/gm. The decision to treat a hazardous waste as radioactive waste is generally clear cut with only a few cases that are "borderline". In every case, these wastes are evaluated individually by the Toxic Waste Control Group and LLNL's Environmental Evaluations Group.

The general guideline used on liquid radioactive waste is the criteria established by NRC in 10 CFR 20 Chapter I, Appendix B, Table 2 concerning the Recommended Concentration Guide (RCG) for the uncontrolled population. In this respect the liquid radioactive waste is uniquely different from the solid radioactive waste. It should also be emphasized that 10 CFR 20 guidelines are used only if the liquid waste qualifies as a Hazardous Waste under 40 CFR 261 (RCRA) and is also radioactive. The NRC regulations distinguish whether or not the waste should be regulated by RCRA or DOE/NRC.

Most solid radioactive waste is containerized and isolated from the environment by burial in a secured landfill located at the Nevada Test Site (NTS), Zone 2, Area 5. The only environmental release of radioactivity that occurs from the solid waste at LLNL is through high temperature incineration of animals injected with tritium. This results in an airborne release of no more than 0.50 Ci per day. All liquid radioactive waste is processed through solidification, precipitation/filtration, incineration or evaporation. After precipitation/filtration the treated liquid is discharged to the sewer if it is within the guidelines established in Table I.

LLNL generates approximately 300 m³ of solid radioactive waste each year. This waste is primarily contaminated experimental apparatus, clothing, building equipment such as ventilation ducting and pipes and construction materials. Approximately 600,000 liters of radioactive liquid waste is generated each year by LLNL programs. These waste types vary in toxicity from low-level tritiated water (less than 10⁻² µCi/cc) to highly contaminated Plutonium-239 acids (some wastes have been as high as 5 mCi/cc). Most of this liquid waste is generated in decontamination operations on equipment, retention tanks from radioactive work areas where washdown operations occur and cutting fluids from the Uranium and Beryllium Machine Shop areas. The machine shop personnel containerizes the spent cutting fluid in 55 gallon DOT 17E drums while the decontamination or washdown wastes are placed in 1,000, 4,000, or 5,000 gallon tanks. The other liquid radioactive waste is generated in relatively small quantities packaged in DOT specification containers. This waste results from Biomedical studies with radioisotopes and sample counting solutions (liquid scintillation), Radioanalysis work at the chemistry buildings (Bldgs. 151, 222, 251, 331 and 332) and decontamination solutions such as trichloroethane and freons.

The waste analysis procedures used for radioactive waste is very similar to that for the non-radioactive hazardous waste and will be covered in detail further in this section. The major distinction is that the radioactive waste is first tested for radioactivity before any classification is made under RCRA. If the waste is liquid, it is processed through the methods described previously. Once the radioactivity is removed to below LLNL standards, the treated waste is evaluated according to our RCRA analysis plan and disposed of or recycled accordingly.

III. NON-RADIOACTIVE HAZARDOUS WASTE

The definition of a non-radioactive hazardous waste is stated in 40 CFR 261.3 and will not be elaborated on here. However, there are several points concerning hazardous solid waste that should be pointed out at the onset. According to the EPA a Hazardous Solid Waste "is any solid, liquid, semi-solid or contained gaseous material" that is produced from industrial commercial, mining, agricultural and community activities. Aside from the wastes listed by EPA, Hazardous wastes are generally identified by the following criteria:

1. Ignitability: A liquid that has a flash point of 60°C or a solid, semi-solid or contained gas that is capable under standard temperature and pressure, to cause a fire through friction, absorption of moisture or spontaneous chemical changes or when ignited burns persistently and vigorously that a hazard is present.
2. Corrosivity: A liquid that has a pH less than or equal to 2 or greater than or equal to 12.5. A liquid that corrodes steel (SAE 1020) at a rate greater than 6.35 mm per year at a temperature of 55°C.
3. Reactivity: Any solid, semi-solid, liquid or contained gas that is normally unstable and readily undergoes a violent change either with or without detonation. A waste that when reacted with water reacts violently, forms an explosive mixture or generates toxic gases, vapors or fumes. A cyanide or sulfide bearing waste which generates toxic gases, vapors or fumes when exposed to pH conditions between 2 and 12.
4. EP Toxicity: See 40 CFR 261.24.

There are other criteria used to classify hazardous wastes but these will not be gone into here. Further information is obtained from 40 CFR parts 261.3 through 261.33, 49 CFR 171.8 and Reference 1.

This Waste Analysis Plan will be broken up into two broad groups. These groups will be discussed primarily with the RCRA regulations in mind but will also be applicable for radioactive wastes. The two groups are: (1) sample and sample handling, (2) the analytical methodology and equipment.

IV. THE SAMPLE

A. Liquid Waste (General)

As mentioned earlier, the liquid wastes generated at LLNL usually are collected in small containers (5 gallon DOT approved containers) or large 1,000 or 5,000 gallon tankers. In Section D. Characterization of Waste, procedures are discussed concerning the methodology used by generators before waste is placed in small containers. This characterization results in a waste that is known and therefore sampling will be minimal. It is still necessary to sample all waste in a standard and representative manner to identify critical characteristics of both the small containerized wastes and large bulk waste.

The first step in any sampling plan is to determine how the contamination within the waste is distributed. Wastes can be classified into four types depending upon the uniformity of the waste distribution. These categories determine the approach that is used in sampling and the number of samples that should initially be tested. The four waste types are:

- 1) Uniformly homogeneous
- 2) Non-uniformity homogeneous
- 3) Uniformly, heterogeneous
- 4) Non-uniformly, heterogeneous

In these classifications uniformity is defined as constancy of waste composition over a period of time. Homogeneity refers to the degree to which the components of the waste are uniformly distributed throughout the waste.

A Type 1 waste (uniformly homogeneous) is one whose overall composition does not vary with time and for which the waste contaminants are evenly and randomly distributed. Much of the bulk liquid waste generated at LLNL falls under this type. A visual examination is always made of the waste to insure that solids have not settled out as a result of temperature changes or long standing time. Examples of this waste type are most building retention tank systems and the etching shop rinse water operations at Bldgs. 131 and 321 complex.

While any given unit quantity of waste would be homogeneous, a Type 2 waste is one whose overall composition changes with time. An example of this waste are wastes that undergo chemical changes with time such as ethyl ether,

hydrogen peroxide, etc. Ethyl ether undergoes oxide and super oxide formation with age, while hydrogen peroxide forms H_2O and O_2 with age.

Types 3 and 4 wastes are more complex. These two types deal with the cases where the composition as a whole remains the same but the contaminants are not uniformly distributed throughout the waste. In a uniformly heterogeneous waste (Type 3) the probability that a waste contaminant will be found at any given sampling point is the same within each layer or stratification. However, the distribution of the waste throughout the tank will not be uniform in Type 4 waste. An example of Type 3 waste is that generated by the floor sump washout operations at the Plating Shop. The waste feeds into a sump where sludge collects over several weeks. At any given sampling point, the concentration of a metal is not expected to be higher than any other metal within that layer. However, the overall concentration of metals would be expected to be uniformly higher in the sludge. Type 4 waste represents the situation where one contaminant distribution is preferentially higher in one stratification over another contaminant. An example of this waste type is the machine coolant oil generated in Bldg. 321. The proportionate distribution of Beryllium and metallic ions is not the same in the sludge and coolant oil. In this particular case, the Beryllium is in turnings or fines which collect in the sludge while the metallic ions remain soluble in the aqueous/oil emulsion.

The collection of samples from Types 1 and 3 wastes involves drawing a simple random sample and a randomly prepared composite sample, respectively, which will suffice as representative samples. Since Type 4 waste may be stratified with a disproportionate concentration of contaminants in different layers, the waste would have to be divided into a number of strata; each stratum would then have the properties of either Type 1 or 3 waste. A random sample of each stratum would then be used to form a composite sample. The number of random subsamples collected from each stratum would be a function of the relative proportion of that particular stratum in the waste as a whole. As an example, if dense particles comprise 50% of the waste and a total of 10 subsamples were used in forming the composite, then 5 of those subsamples should be randomly collected from the dense particle substratum.

Type 2 waste does not present any particular problems in sampling even though its composition changes with time. The main consideration here is that one must be aware that the waste is characterized at the time of sampling

and may be different by the time action is taken in treating or disposing of that waste. The rate of this change may be determined by collecting samples over a sufficient period of time.

A major concern in waste evaluation is the number of samples that should be evaluated. The sample size is determined by:

- a. The degree of accuracy desired
- b. The cost of collecting and testing the samples, and
- c. The variability of the population from which the samples are being taken (e.g., Type 1 wastes are uniform and thus fewer samples would have to be taken whereas Type 4 wastes may be very variable which will require more sample testing).

As the number of samples tested increases, the confidence interval gets smaller and the accuracy of the determination increases. At least 2 samples must be collected and tested before one can calculate an initial average and upper confidence limit.

B. Solid Waste (General)

For the purpose of this section, solid wastes are defined as solids, dried sludges, turnings, fines and powder type materials. Most of the operations at LLNL which generate solid non-radioactive wastes are such that the waste material is fairly well characterized at the time of generation. Solid wastes such as Beryllium turnings, lithium hydride, sodium/potassium metals and alloys, dry waste chemicals, etc., need not be resampled and tested when the history and nature of the waste is confidently known. However, dry waste sludges and unknown or questionable solids, and all mixtures must be sampled and tested. Solid wastes can also be categorized in the same manner as was done with liquid wastes as follows:

- 1) Uniformly homogeneous
- 2) Uniformly heterogeneous
- 3) Non-uniformly heterogeneous

Most Type 1 waste compositions are already known at the time they become waste. Examples of this waste are off-specification chemicals, beryllium turnings, lithium aluminum hydride, etc. However, uncharacterized wastes are produced at LLNL which must be sampled and analyzed.

Type 2 wastes are mixtures of waste that are collected in a common tank or container. The waste appears to be uniformly mixed with no apparent stratification or concentration of contaminants within the mixture. An example of this waste would be the dried sludges removed from retention tank systems.

Type 3 waste is the case where different waste materials are preferentially concentrated in the waste. This can result in a chemical reaction such as surface oxidation, or stratification of the waste caused by a non-uniform addition of a waste into a tank or container.

Type 1 wastes are easily sampled by collecting a simple random sample of adequate size for analysis. Type 2 wastes are essentially the same, for sample collection purposes, as Type 1 waste except that it will be necessary to collect more samples than for Type 1 in order to insure that the contaminants are uniformly distributed.

Type 3 waste represents a larger sampling problem. An evaluation must be made before sampling begins as to the nature of the waste. As an example, was the waste at one time homogeneous but through partial reactions has now become heterogeneous in nature. Any information that can be gathered, such as experiments this material was used in, age of waste, storage location, etc., should be collected. After as much information as possible is collected each contaminant zone, whether surface or stratified, must be collected proportionately to its representative contribution to the composite. The characterization of Type 3 waste will be the most difficult and subject to the greatest uncertainty. Consequently a greater number of samples need to be collected to minimize this uncertainty.

It is important to mention at this time that completely unknown wastes having no traceable history must be handled very cautiously and treated as reactive material. In cases such as these, remote handling equipment may be the only safe method that can be used. The following are some factors that should be evaluated before action is taken.

1. A temperature sensitive material is removed from a refrigerator and stored under ambient conditions.
2. Materials that required stabilization with water or oil but were improperly stored which evaporated the water or spilled the oil.

3. Highly corrosive materials which have been stored for long periods of time resulting in container/cap deterioration and damage to surrounding shelves and material.
4. Materials which were contaminated substances resulting in the formation of unstable mixtures or salts. For example,
 - a) Oxidizers - ammonium nitrate, hydrogen peroxide over 60%
 - b) Nitromethane
 - c) Explosives sensitized by metallic contamination
5. Substances which incorporate an inhibitor to remain stable but is discovered beyond the recommended storage life.

Appendix A is a reactive materials list found in 18 USC Chapter 40. Waste material in this category should be handled only after consulting with a Hazards Control Explosive Safety expert. Appendix B is an alphabetical list of many highly reactive materials and was obtained from Reference 2. Waste materials identified on this list should be handled according to appropriate procedures and/or consultation with Hazards Control.

C. Contained Gases

Contained gases are very rarely sampled since their identification is usually known by the cylinder identification or markings. If the gas cylinder has been stored for a long period of time and all exterior labeling is no longer present, it presents somewhat of a problem. However, almost all gas cylinders have identification numbers imprinted near the neck of the container. These numbers permit one to trace back, through the manufacturer, the contents of the cylinder. Under normal circumstances, gas samples do not need to be taken, since the waste characterization can be determined through other means.

D. Characterization of Waste

Broadly speaking, the waste at LLNL is generated by the various research programs such as weapons research and Laser fusion or support functions like Plant Engineering and the motor pool. A total of about 2.5 million gallons of hazardous liquid wastes and 20,000 ft³ of hazardous solid wastes are generated and processed this year with this volume increasing each year. Since LLNL is a research institution, the wastes generated are varied

and cannot often be characterized easily as is the case with industrial process operations. It is therefore expedient that this waste be controlled and where possible characterized at the point of generation. This latter point is very important because the better the waste can be characterized, both chemically and physically, at the point of generation, the less analysis is required further down the process line. Also by identifying and characterizing the waste at the source, it will be a simple matter to track the material from "cradle to grave". The system which has been established to achieve this end is administered through field oriented RCRA representatives. These representatives are assigned specific areas at LLNL and Site 300 where they administer the policies and procedures of the Toxic Waste Control Group.

Liquid hazardous waste is generated either in large bulk quantities such as the rinse water from Plating Shop operations, or in smaller quantities which are containerized in DOT approved drums. The large bulk quantities of waste are well characterized by the operations generating the waste such as Plating Shop rinse water or waste oils from the motor pool. This bulk liquid waste can be broken down into two categories: organic wastes and inorganic wastes.

D. (i) Organic Bulk Wastes (greater than 110 gallons)

The procedures to be used for this waste type are as follows:

- Identify the contributing sources of this waste and what materials make up the bulk waste. If the waste entering the collection tank does so by a plumbed drain pipe, sources that are connected to the drain pipe must be identified. In this manner the waste is well characterized before reaching bulk storage.
- Even though the waste sources are identified and the contaminant characterization is generally known, it will still be necessary to collect a sample(s) for analysis. This procedure ensures that unknown or unreported wastes did not enter into the system. The collection procedures that are to be used were outlined in Section I.A. of this report.

1) There are two analytical pathways that are used at LLNL. The first and most common will be to send the sample(s) to LLNL Hazards Control Analytical facility. Since this involves on-site analysis, the DOT guidelines

on packaging and labeling are not required. However, samples leaving the site (or coming from off-site such as Site 300) for analysis must meet DOT shipping regulations. The following collection/preparation procedures for waste sample(s) are primarily written for off-site analysis but can easily and clearly be adapted for the routine on-site analysis. The only off-site analysis that is required will be for our Inter-laboratory Quality Assurance Program.

2) The sample(s) should be collected and split into two portions and placed in appropriately sized glass, nalgene or polyethylene containers with a non-metallic lined screw cap. Sufficient ullage (approximately 10% by volume) should be provided so that the container is not full at 54°C. Mark the container with an identifying number(s).

3) Another sample is to be collected and a flash point determination made using the Pensky-Martens Closed Tester (ASTM D93-71) Standard Method, Tag Closed Tester (ASTM D56-70) or the Setaflash Closed Tester (ASTM D3278-73) Standard Method.

4) After the sample(s) is collected, the container is sealed and placed in a polyethylene bag no less than 4 mil thick, one sample per bag.

5) Affix to the bag the Request for Analysis Form found in Appendix D. Be sure to cross reference the identifying number on the container with the form.

6) For off-site analysis, the sealed bag(s) should be placed inside a metal can with noncombustible, cushioning material such as vermiculite to prevent breakage. Seal the can with appropriate closure mechanisms such as pressure seal, clips, tape, etc.

7) Mark the can with the appropriate DOT proper shipping name and LLNL address. Unless the flash point or other factors describing the sample indicate differently, the proper shipping name, in all likelihood, will be Flammable Liquid, n.o.s. UN 1993. Unless it is possible to class the sample as an ORM-A, B, or C, shipping papers are required even if classed as a limited quantity. Furthermore, specification packaging is required unless you are shipping under an exemption clause such as 49CFR 173.118.

8) Place one or more metal cans in a strong outside container such as a fiberboard box.

9) Complete the Request For Analysis Form (Appendix D) for all samples in the container. Attach this form to the DOT shipping papers. This Request for Analysis Form must be completed even if the sample is analyzed on-site.

10) Shipments to an off-site laboratory are made twice a week and should be collected at Bldg. 514 at least four hours before pickup by the courier service.

11) The second sample should be sent to the Hazards Control Analytical Laboratory for an identical analysis.

12) All samples leaving for off-site Analysis should be logged in at Bldg. 514. The information required is:

- a) Sample collection point
- b) Operation which generated the waste
- c) Responsible individual of the waste
- d) Flash point of sample (or pH as appropriate)
- e) Signature of person receiving sample (this acknowledges that, based on the information provided by the generator, the shipping papers, Analysis Form and packaging are proper).
- f) Receipt Date
- g) Analysis Results
- h) Comments

D. (ii) Inorganic Bulk Wastes (greater than 110 gallons)

The procedures to be used for this waste type are as follows:

- As with the Organic Bulk waste, it is necessary to identify the sources which contribute to the waste. This is relatively easy to accomplish if the collection tank or sump is filled with a plumbed drain line.

A sample(s) must be collected for analysis before any treatment or disposal operation can occur. The sample collection and analysis ensures that an unknown or unreported waste did not enter into the system. The sample collection procedures were outlined in Section I.A. of this report.

- 1) There are two analytical pathways that are used at LLNL. The first and most common will be to send the sample(s) to LLNL Hazards Control Analytical facility. Since this involves

on-site analysis the DOT guidelines on packaging and labeling are not required. However, samples leaving the site (or coming from off-site such as Site 300) for analysis must meet DOT shipping regulations. The following collection/preparation procedures for waste sample(s) are primarily written for off-site analysis but can easily and clearly be adapted for the routine on-site analysis. The only off-site analysis that is required will be for our Inter-laboratory Quality Assurance Program.

- 2) The sample(s) should be collected and split into two portions and placed in an appropriately sized glass, nalgene or polyethylene container with a non-metallic lined screw cap. Sufficient ullage (approximately 10% by volume) should be provided so that the container is not full at 54°C. Mark the container with an identifying number.
- 3) Another sample is to be collected and a field pH determination made using a calibrated pH meter or pH Hydrion paper divided in increments no less than 1 and preferably 0.5.
- 4) If there are any indications of organic material present the flash point must also be determined as indicated in Section D(i) Organic Bulk Wastes. An indication of organic material is evidenced by waste stratification (usually a supernatant) or odor. If organics are present the Request for Analysis Form must reflect this.
- 5) After the sample(s) is collected, the container is sealed and placed in a polyethylene bag no less than 4 mil thick, one sample per bag.
- 6) Affix the Request for Analysis Form found in Appendix D to the bag. Be sure to cross reference the identifying number on the container with the form.
- 7) For off-site analysis, the sealed bag(s) should be placed inside a metal can with noncombustible, cushioning material such as

vermiculite to prevent breakage and absorb any liquid in event of breakage. Seal the can with an appropriate closure mechanism such as pressure seal, clips, tape, etc.

- 8) Mark the can with the appropriate DOT proper shipping name and LLNL address. Unless the pH or other factors describing the sample indicate differently, the proper shipping name, in all likelihood, will be either Corrosive Liquid, n.o.s. UN 1760 or Alkaline liquid, n.o.s. NA 1719 depending upon its pH. Unless it is possible to class the sample as an ORM-A, B, or C, shipping papers are required, even if classed as a limited quantity. Furthermore, specification packaging is required unless you are shipping under an exemption clause such as 49CFR 173.244.
- 9) Place one or more metal cans in a strong outside container such as a fiberboard box.
- 10) Complete the Request for Analysis Form (Appendix D) for all samples in the outside container. Attach this form to the DOT shipping papers. This Request for Analysis Form must be completed even if the sample is analyzed on-site.
- 11) The second sample should be sent to the Hazards Control Analytical Laboratory for an identical analysis.
- 12) All samples leaving for off-site analysis must be logged in at Bldg. 514 according to Section D.(i) Organic Bulk Wastes.

D.(iii) Containerized Liquid Waste (less than 110 gallons)

The most important aspect of analysis for this type of waste is sample collection. Procedures in Section I. The Sample must be followed very closely in order to obtain a representative sample. The key to this sampling will be performing a more comprehensive field assessment.

As with the bulk liquid waste, it is important to identify the waste sources and characterize this material. Since hazardous waste is almost never plumbed directly into a container less than 110 gallons, the contributing sources are often varied and can be from radically different operations.

Therefore, control over the sources of waste added to these containers must be implemented to 1) Protect the Health and Safety of personnel from the addition of incompatible waste that may become reactive; 2) reduce the analysis required for fairly well defined wastes, and 3) facilitate treatment and/or disposal methods. This latter point is important because wastes are treated and disposed of in processes that depend upon their nature. As an example, an aqueous waste containing heavy metals such as copper, chrome, zinc, etc., is effectively treated using precipitation/oxidation techniques following filtration. However, if oil wastes are added to the aqueous wastes, the standard treatments cannot be used and a more elaborate process must be followed.

The following procedures must be followed for all containerized waste.

- 1) Designated areas where waste is collected, such as a centralized storage room for laboratories, will be the responsibility of one of the RCRA Representatives in the Toxic Waste Control Group. Liquid waste will be collected in either DOT approved 5 gallon or 55 gallon drums (the primary containers will be DOT 6D/2S or DOT 17E drums depending upon the waste). Containers will be designated for specific waste types based on the following:
 - a. Compatibility of the waste with the container types (see 49 CFR).
 - b. Compatibility with treatment and/or disposal methods (contact the Toxic Waste Control Group).
 - c. Compatibility of Waste Types (see Appendix E).
- 2) Each waste container shall have a list of wastes which may be added to the container. This list shall be visible and not obstructed from view by individuals entering the area. The waste list must have letters no smaller than 1/2" and be legibly printed in durable ink. The controls and location must be in accordance with the LLNL Security plan as it pertains to 40 CFR 265.14.
- 3) Each waste container shall have a Waste Identification Sheet (see Appendix C). Each addition of waste into a container must be entered on the Waste Identification Sheet by the waste generator.
- 4) Once the container has been filled to no more than 90% of its volume, it should be removed from the area and sampled.

The sampling technique to be used will vary according to its waste type but can be sampled according to the procedures covered by Section I of this report. Special problems are encountered with containerized wastes because they accumulate non-uniform waste from different operations over a long period of time. This is in contrast to the bulk waste which is usually uniform and generated from specific process operations. If the waste has been stored for a fair length of time, stratification and settling may occur. Stratification may be present because of dissimilar materials having varying solubilities are added to the same container, or because of physical conditions such as temperature which may precipitate out a waste component. This problem can be addressed by reviewing the Waste Identification Sheet. If, after reviewing the information on the Identification Sheet, it is concluded that a good possibility exists that waste stratification may have occurred, the following procedures are to be followed.

- 5) Determine the cause for waste stratification e.g., dissimilar waste added, high solids content in waste, etc. This determination should be made from the information provided on the Identification Sheet and a knowledge of the operations generating the waste.
- 6) If the cause for stratification is temperature change on long settling periods, such as a decreased solubility of sodium hydroxide in low temperature correct this situation by raising the temperature to ambient and remixing the waste. Sample the waste in accordance with Section I.
- 7) If the waste stratification is a result of dissimilar materials, high solids content, different solubilities of waste contaminants in layers etc., sampling should be done using a Coliwasa Liquid Waste Composite Sampler. The type of sampling tube chosen should be governed by the nature of the waste.

Some precautions to use are: 1) Do not use a plastic Coliwasa to sample waste containing organic materials, and 2) Do not use glass to sample hydrofluoric acid. The Coliwasa Sampler is a glass, plastic or metal tube which has a closure mechanism on its end which can be opened and closed while submerged in the waste. For stratified containerized waste, the sampling procedure is as follows (1):

- a) Clean the sampler of all contaminants.

- b) Insure that the locking mechanism provides a tight seal at the end of the tube.
- c) Open the sealing mechanism (usually a rubber stopper).
- d) Slowly lower the opened sampler into the waste at a rate which permits the level of liquid inside and outside of sampler to remain the same.
- e) When the sampler reaches the bottom of the waste container lock the closing mechanism in place.
- f) Withdraw the sampler from the waste and wipe the outside with a disposable cloth or paper wipe.
- g) Place the sampler at the mouth of a container and slowly discharge the sample. If there are obvious and clearly defined stratification layers in the sampler, an estimation of each layer's proportion to the whole waste composition should be made and separate samplers collected from each layer.
- h) After the sample(s) is collected, procedures stated in Sections I should be followed to ship them for analysis. It may be necessary to repeat this sampling technique to obtain adequate sample volumes. In any event a second sample should be drawn and submitted to Hazards Control for analysis.

E. Sludges and Semi-Solids

These waste types consist of sticky solids such as thick resins, coal tars, etc., and loosen solids like soil and chemicals. Samples of this type is to be taken using a trier which consists of a tube cut in half lengthwise having a sharpened tip allowing the sampler to cut into the semi-solid. A trier samples moist or sticky solids with a particle diameter less than 1/2 the diameter of the trier. The sampling procedures are as follows:

- 1) Clean the sampler.
- 2) Insert the sampler into the waste 0° to 45° from the horizontal. After the trier has reached the required depth, rotate to cut a core of the waste. Remove the sampler with the concave side up and transfer to the sample container.

F. Solids

The need to sample a truly solid, free-standing waste is rare. Most solid wastes are or can be pulverized and sampled using a trier. Judgement will have to be used as to the most practical and representative sampling technique to be used. Other sampling tools for solids that are available are augers, scoops, shovels, etc. Augers usually provide the best representative samples for soil sampling. In this case, a hole should be bored through the middle of sheet metal with the hole large enough to allow the auger blade to pass through. The sheet metal is then used to collect the sample brought to the surface by the auger.

V. THE ANALYSIS

The analysis requested for each sample will range from a simple gross radiation counting to a more complex determination of organic contaminants such as pesticides. However, the complexity of analysis for containerized waste should be greatly reduced by following the procedures established in this plan using the Waste Identification Sheet (Appendix C). Furthermore, the extent of analysis will vary depending upon the manner for treatment and disposal intended for the waste. For example, bulk or containerized waste generated by plating operations that will be treated using an ion exchange unit does not need to have individual concentrations of metal analysis performed. A field determination of pH, conductivity and TDS is adequate before treatment followed by an analysis for Ni, Cr, Zn and Cu ions.

A. Waste Destined for On-Site Treatment

This waste will usually be limited to radioactive liquids, reactive and explosive solids, and Plating Shop bulk waste. Most inorganic bulk waste is well characterized by the operations generating the waste and the only analysis required before on-site treatment is: pH, conductivity ($\mu\text{ohms/cm}$), gross α , β and tritium radioactive analysis. Organic bulk waste is extremely rare and usually consists of spent oils, solvents or fuels. In this event, the analysis required is for Polychlorinated Biphenyls (PCB), flash point, gross α , β and tritium radioactive analysis.

Containerized liquid waste is more varied and requires a judgemental approach to the problem of analysis. All containerized liquid waste must have

a radioactive analysis performed with the minimum of gross α , β and tritium. If the liquid is radioactive, it must be treated on-site. If the liquid is not radioactive, it will usually be characterized by identifying the operation which generated it. All waste containers will have the identification sheet accompanying it before receipt by the Toxic Waste Control Group. However, a cursory check to verify the contents listed on the identification sheet will always be made. This will usually be a simple check such as pH, flash point or conductivity.

B. Waste Destined for Off-Site Treatment/Disposal

If the liquid waste is non-radioactive, it may be a candidate for off-site treatment, disposal or recycling. This latter option is the preferable route and will be used when the waste is identified by the identification sheet as waste solvents (hydrocarbon, oxygenated or halogenated types), used petroleum products, mercury, unspent acids and alkalis and empty hazardous waste containers. Petroleum products that have been in hydraulic systems or used as dielectric oils will be analyzed for PCBs using Gas Chromatography (GC) and an electron capture detector (ECD).

The key to the LLNL waste analysis plan is the Waste Identification Sheet. At the time the Toxic Waste Control (TWC) Group receives the waste, it should be well characterized and analysis will be minimal. A cursory check will always be made using the pH, flash point and conductivity, but laboratory analysis will usually not be required. Waste which is not accompanied by the identification sheet will be held and the RCRA Representative for the area that the waste was generated from will be contacted. Through this individual, the origin of the hazardous waste will be traced.

C. Unidentified Hazardous Waste

This waste type represents a very unique and difficult problem. However, in the event that the waste is completely uncharacterized with the source of the material unknown, a much more extensive analysis is required.

The very first analysis required is one for radioactivity. Standard methods are to be used for gross α , β and tritium radioactivity. These determinations will be made using a gas proportional counter, scintillation or solid-state detectors and liquid scintillation counting. Secondly, the analysis of EPA designated priority pollutants⁽³⁾ is to be made. This will

be accomplished by a single step extraction in which a small amount of extraction solvent is added directly to the sample and the mixture agitated for one-half hour. The layers are permitted to separate and microliter portions of the organic phase are removed for gas chromatographic analysis. Pesticide mixtures, PCB's, and base neutral priority pollutants are extracted using cyclohexane.

Extraction of acidic priority pollutants (phenolic compounds) is accomplished using a solvent mixture of methylene chloride and hexane in a ratio of 30:70 on a volume basis. Saturation of an aqueous solution with sodium chloride provides optimum recovery of phenolics. Flame ionization (FI) gas chromatography (GC) is used for acidic priority pollutants whereas gas chromatography and an electron capture detector (ECD) is used for the base neutral pollutants.

The above two methods will quantify the organic pollutants in the unknown waste. In addition, tests must be made for ignitability, corrosivity, reactivity and EP Toxicity according to 40 CFR 261 Subpart C. Reference 1 provides the analytical procedures that are to be used to determine these characteristics.

D. ADDITIONAL WASTE CHARACTERIZATION

Both liquid and solid hazardous wastes are treated destructively in the LLNL dual chamber, gas-fired incinerator. This incinerator is principally used to destroy carcinogenic or presumptive carcinogenic material generated by our Bio-Medical research studies. All waste received for incineration is identified by the generator according to the contaminants listed in Appendix F. The liquid waste received for incineration is characterized by the Waste Identification Sheet and/or Laboratory analysis as previously outlined. There is no on-line stack monitor for the gaseous effluent on the incinerator. However, an extensive stack sampling project was undertaken this year and has been compiled in reference 5. Standard methods were used for organic emissions, carbon monoxide, sulfur oxides, and hydrogen sulfide. Table II summarizes the results with typical feeds of animal carcasses and liquids contaminated with Appendix F. type materials.

All inorganic wastes and certain halogenated wastes (PVC, Teflon, etc.) are not incinerated. The incinerator is not used for PCB destruction;

all oils, hydraulic fluids, and dielectric oils are analyzed for PCB before they are recycled or incinerated.

The Facility Supervisor must maintain a log on all waste being incinerated which includes:

- a) Weight or volume of waste incinerated
- b) Type of waste (e.g. laser dyes, animals, etc.)
- c) Type of contaminant (carcinogenic material, tritium content, etc.)
- d) High, Low, and average temperatures in both chambers during run
- e) Date of incineration
- f) Source of Waste (e.g. building, operation or research activity, and name of generator)

VI. HAZARDOUS WASTE MOVEMENT

A. On-Site

Small volumes of liquid wastes are placed in DOT specification containers at their point of generation. The exception to this is the 5 gallon glass or polyethylene carboys currently used. A program is being implemented to phase out these non-specification containers and use the DOT 17E and DOT 6D/2S 5 gallon drums for liquids. Non-radioactive solid wastes are usually in their original container or an equivalent. Wastes that are reactive are handled on a case by case basis and the container type is determined only from a safety point of view. For example, potassium metal is transported on-site in an open-headed stainless steel container filled with mineral oil. On-site transportation is performed either by one of three groups: Transportation, Materials Management, or The Toxic Waste Control Group. In every group the transportation personnel are trained drivers, and in the later group, trained hazardous waste handlers. All movement of waste (non-bulk) on-site must be accompanied with the Waste Identification Sheet found in Appendix C. Bulk liquid waste is transported currently in 1,000 and 4,000 gallon tanks that are non-spec tanks. We are currently phasing out these tanks and tankers and replacing them with DOT approved containers, such as DOT 103AW, 105A100W, etc. This waste type is moved by Transportation after approval is given by the Toxic Waste Control Group. An identification tag accompanies this waste.

B. Off-Site

Waste which is shipped off-site for treatment or disposal is packaged/labeled and marked according to Title 49CFR and Title 40CFR. All shipments are coordinated through the Toxic Waste Control Group and are accompanied by proper shipping papers (49CFR 172.200), California Liquid Waste Hauler Permit (where appropriate), a six part manifest according to 40CFR, part 262, Subpart B. If the hazardous waste qualifies as an extremely hazardous waste according to Title 22 of the California Administration Code, Article 10, then the Department of Health is notified and a permit obtained before off-site movement occurs.

VII. THE LABORATORY

The distinction between a high quality laboratory operation and one of marginal status primarily rests with quality control. The key to any quality control program is simply that nothing should be taken for granted. Our philosophy at LLNL is one that involves Interand Intra-laboratory quality control aspects.

LLNL has a blanket contract with a commercial analytical laboratory to provide both radiological and chemical analysis of waste samples. This Laboratory is accredited by the American Industrial Hygiene Association and the State of California Department of Health, among others. All waste samples are split and submitted to this laboratory for analysis, and also to the Hazards Control Analytical Laboratory at LLNL. This procedure allows two independent analysis to be performed on each waste to be treated or disposed of. Comparisons between these laboratories are made routinely with the results recorded on log records (card files). Significant discrepancies are noted and investigated with the investigation usually indicating which laboratory was in error. This inter-laboratory comparison provides an additional degree of confidence in the results obtained for the waste analysis. A discussion of the Laboratory's Quality Assurance Program will not be made here.

TABLE 1

LLNL SEWER DISCHARGE GUIDELINES

<u>CONTAMINANT</u>	<u>LIMIT</u>	<u>COMMENT</u>
Alpha Activity	1 Ci/1000 gal. Not to exceed 5 Ci/day.	As low as reasonably achievable (ALARA). DOE limit is 45 Ci/day.
Beta Activity	10 Ci/1000 gal. Not to exceed 50 Ci/day.	ALARA; DOE Limit is 150 Ci/day.
HTO	20 mCi/day*	ALARA; DOE Limit is 4.5 Ci/day.
Cr	100 ppm	Combination of Cr, Cu, Zn, Ni must be less than 100 ppm.
Cu	10 ppm	
Zn	50 ppm	
Ni	10 ppm	
pH	6.8 to 8.0	
TDS	325 ppm greater than incoming water.	Incoming water is typically 50 ppm.

*Unless approval is received from the Environmental Evaluations Group.

TDS is Total Dissolved Solids.

TABLE II

INCINERATOR STACK EFFLUENT DATA

RUN	ORGANIC EMISSIONS(9)				CARBON MONOXIDE				OPACITY					
	Average		Max.		ppm (v/v)		(8)		Ringelmann Number					
			Detected		Duration									
	DURATION	ppm(1)	lbs/hr(2)	ppm	lbs/hr	(ppm)	(seconds)	ppm(3)	ppm(v/v)	ppm(4)	gr/cf(5)	lb/hr	Avg.	Max
43 min	3	0.004	23	0.028	3	80/50						0	1.0	30 sec
82 min	18	0.022	32	0.039	3	>130/60(5)	34	< 0.2(10)	11	5.0E-04	0.003	0	1.0	45 sec
95 min	28	0.034	39	0.048	4	45/20						0	0.25	60 sec
19 min	39	0.048	56	0.068	5	30/300	20	2.8	136	2.0E-03	0.011	0	1.0	30 sec
82 min	-(7)-	-	-	-	3	17/600	52	<0.9	183	2.0E-03	0.011	0	0.5	45 sec

(1) ppm by volume as O₁.(2) pounds/hour as C₁.(3) ppm by volume as SO₂.

(4) ppm by volume as HCl.

(5) Grains per standard dry cubic foot of exhaust.

(6) Peak went off scale for approximately 20 Seconds.

(7) Insufficient organic emission data was collected.

(8) Integrated over each entire run from previous sample period.

(9) The condensate from this sampling line contained <1ppm organic.

(10) Below detection limit of 0.2.

1. U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste Physical/Chemical Methods", May 1980. SW.846.
2. J. T. Baker Chemical Co., "The Management and Disposal of Hazardous and Chemical Wastes," December, 1979
3. Federal Register, 1979, Vol. 44, No. 233, 69454 December 3
4. Cruenfeld, M., Frank, U., Remeta, D., "Rapid Methods of Chemical Analysis Used in Emergency Response Mobile Laboratory Activities." U.S. EPA National Conference on Management of Uncontrolled Hazardous Waste Sites. Oct 15-17, 1980, Washington, D.C.
5. Thompson, J. D., "Interim Report: Low-Level Waste, Institutional Waste Incinerator Program", EGG-WM-5115 April, 1980.
6. California Administrative Code, Title 22. Social Security Division 4. Environmental Health Chapter 30. Minimum Standard for Management of Hazards and Extremely Hazardous Wastes.

APPENDIX A

REACTIVE MATERIALS LIST - EXPLOSIVES

This is a list of materials and chemicals that are considered explosive and, therefore, highly dangerous. These chemicals should never be stored. They are use-specific, i.e., once their required use is fulfilled they must be destroyed. Because of the variable instabilities of these compounds, they conform to the reactive category under section 3001 of RCRA, the generator lists. The following list may be found in 18 USC Chapter 40.

Acetylides of heavy metals.

Aluminum containing polymeric propellant.

Aluminum phosphite explosive.

Amatex-20 [40% TNT, 20% RDX, 40% ammonium nitrate].

Amatex-30 [40% TNT, 30% RDX, 30% ammonium nitrate].

Amatex-40 [40% TNT, 40% RDX, 20% ammonium nitrate].

Amatol.

Ammonal.

Ammonium nitrate explosive mixtures (cap sensitive).

Ammonium nitrate explosive mixtures (not cap sensitive).

Aromatic nitro-explosive mixture.

Ammonium perchlorate having particle size less than 45 microns.

Ammonium perchlorate composite propellant.

Ammonium picrate [picrate of ammonia].

Ammonium salt fatrice with isomorphously substituted inorganic salts.

ANFO [ammonium nitrate-fuel oil].

Baratol [67% barium nitrate, 33% TNT].

Baronal [50% barium nitrate, 35% TNT, 15% aluminum].

BEAF [1,2-bis (2,2-difluoro-2-oxoacetoxyethane)].

Black powder.

Blasting agents, nitro-carbo-nitrates, including non cap sensitive slurry and water-gel explosives.

Blasting caps.

Blasting gelatin.

Blasting powder.

BTNEC [bis (trinitroethyl) carbonate].

BTNEN [bis (trinitroethyl) nitramine].

BTNN [1,3,4 butanetriol trinitrate].

Butyl tetryl.

Calcium nitrate explosive mixture.

Carboxy-terminated propellant.

Cellulose hexanitrate explosive mixture.

Chlorates and red phosphorus mixture.

Chlorates and sulphur mixture.

Composition A-3 [91% RDX, 9% Wax].

Composition B [40% TNT, 60% RDX].

Composition C-4 [91% RDX, 9% plasticizer].

Copper acetylides.

Crystalline picrate with lead azide explosive mixture.

Cyanuric triazide.

Cyclotrimethylenetrinitramine [RDX].

Cyclotetramethylenetrinitramine.

Cyclorol [75% RDX, 25% TNT].

DATB [diaminotritroetramethylene tetranitramine].

DATNB [diaminotritrobenzene].

DDNP [diazodinitrophenol].

DEGDN [diethyleneglycol dinitrate].

Delay powders.

Detonating cord.

Denonators.

Dimethylol dimethyl methane dinitrate composition.

Dinitroethyleneurea.

Dinitroglycerine.

Dinitrophenol.

Dinitrophenolates.

Dinitrophenyl hydrazine.

Dinitroresorcinol.

Dinitrotoluene-sodium nitrate explosive mixtures.

Dipicryl sulfone.

Dipicrylamine.

DNBP [dinitropentano nitrile].

DNPA [2,2-dinitropropyl acrylate].

Dynamite.

EDNP [ethyl 4,4-dinitropentanoate].

Erythritol tetranitrate explosives.

Esters of nitro-substituted alcohols.

EGDN [ethylene glycol dinitrate].

Ethyl-tetryl.

Explosive copolymers.

Explosive gelatins.

Explosive mixtures containing oxygen releasing inorganic salts and hydrocarbons.

Explosive mixtures containing oxygen releasing inorganic salts and nitro bodies.

Explosive mixtures containing oxygen releasing inorganic salts and water insoluble fuels.

Explosive mixtures containing oxygen releasing inorganic salts and water soluble fuels.

Explosive mixtures containing sensitized nitromethane.

Explosive nitro compounds of aromatic hydrocarbons.

Explosive organic nitrate mixtures.

Explosive liquids.

Explosive powders.

Fulminate of mercury.

Fulminate of silver.

Fulminating gold.
Fulminating mercury.
Fulminating platinum.
Fulminating silver.

Gelatinized nitrocellulose.
gem-dinitro aliphatic explosive mixtures.
Guanyl nitrosamino guanyl tetrazene.
Guanyl nitrosamino guanylidene hydrazine.
Guncotton.

Heavy metal azides.
Hexanit.
Hexanitrodiphenylamine.
Hexanitrosulfene.
Hexogen [RDX].
Hexogene or octogene and a nitrated N-methylaniline.
Hexolites.
HMX [cyclo-1,3,5,7-tetramethylene-2,4,6,8-tetranitramine;
Octogen].
Hydrazinium nitrate.
Hydrazinium nitrate/hydrazine/aluminum explosive system.
Hydrazoic acid.

Igniter cord.
Igniters

KDNBF [potassium dinitrobenzo-furoxane].

Lead azide.
Lead monnit.
Lead mononitroresorcinate.
Lead picrate.
Lead salts, explosive.
Lead styphnate [styphante of lead, lead
trinitroresorcinate].
Liquid nitrated polyol and trimethylolethane.
Liquid oxygen explosives.

Magnesium ophorite explosives.
Mannitol hexanitrate.
MDNP [methyl 4,4-dinitropentanoate].
Mercuric fulminate.
Mercury oxalate.
Mercury tartrate.
Minol-2 [40% TNT, 40% ammonium nitrate, 20% aluminum].
Mononitrotoluene-nitroglycerin mixture.
Monopropellants.

NIBTN [nitroisobutyl metritol trinitrate].
Nitrate sensitized with gelled nitroparaffin.
Nitrated carbohydrate explosive.
Nitrated glucoside explosive.
Nitrated polyhydric alcohol explosives.
Nitrates of soda explosive mixtures.

Nitric acid and a nitro aromatic compound explosive.
Nitric acid and carboxylic fuel explosive.
Nitric acid and explosive mixtures.
Nitro aromatic explosive mixtures.
Nitro compounds of furane explosive mixtures.
Nitrocellulose explosive.
Nitroderivative of urea explosive mixture.
Nitrogelatin explosive.
Nitrogen trichloride.
Nitrogen tri-iodide.
Nitroglycerine [NG, RNC, nitro, glyceryl trinitrate, trinitro-
glycerine].
Nitroglycide.
Nitroglycol [ethylene glycol dinitrate, EGDN].
Nitroguanidine explosives.
Nitroparaffins and ammonium nitrate mixtures.
Nitronium perchlorate propellant mixtures.
Nitrostarch. Nitro-substituted carboxylic acids.
Nitrourea.

Octogen [HMX].
Octol [75% HMX, 25% TNT].
Organic amine nitrates.
Organic nitramines.
Organic peroxides.

Pellet powder.
Penthrinite composition.
Pentolite.
Perchlorate explosive mixtures.
Peroxide based explosive mixtures.
PETN [nitropentaerythritol, pentaerythritol tetranitrate,
pentaerythritol tetranitrate].
Picramic acid and its salts.
Picramide.
Picrate of potassium explosive mixtures.
Picratol.
Picric acid.
Picryl chloride.
Picryl fluoride.
PLX [95% nitromethane, 5% ethylenediamine].
Polynitro aliphatic compounds.
Polyopoly-nitrate-nitrocellulose explosive gels.
Potassium chlorate and lead sulfocyanate explosive.
Potassium nitroaminotetrazole.

RDX [cyclonite, hexogen, T4, cyclo-1,3,5-trimethylene-
2,4,6-trinitra-mine; hexahydro-1,3,5-trinitro-5-triazine].

Safety fuse.
Salts of organic amino sulfonic acid explosive mixture.
Silver acetylide.
Silver azide.
Silver fulminate.
Silver oxalate of explosive mixtures.

Silver styphnate.
 Silver tartrate explosive mixtures.
 Silver tetrazene.
 Slurried explosive mixtures of water, inorganic oxidizing salt, gelling agent, fuel and sensitizer.
 Smokeless powder.
 Sodatol.
 Sodium amatol.
 Sodium dinitro-ortho-cresolate.
 Sodium nitrate-potassium nitrate explosive mixture.
 Sodium picramate.
 Squibs.
 Styphnic acid.

Tacot [tetranitro-2,3,5,6-dibenzo-1,3a,4,6a-tetrazapentalene].
 TATNB [triaminotrinitrobenzene].
 TEGDN [triethylene glycol dinitrate].
 Tetrazene [tetracene, tetrazine, 1(5-tetrazolyl)-4-guanyl tetrazene hydrate].
 Tetranitrocarbazole.
 Tetranitromethane explosive mixtures.
 Tetryl [2,4,6 tetranitro-N-methylaniline].
 Tetrytol.
 Thickened inorganic oxidizer salt slurried explosive mixture.
 TMEFN [trimethylolthane trinitrate].
 TNEF [trinitroethyl formal].
 TNEOC [trinitroethyl orthocarbonate].
 TNEOF [trinitroethyl orthoformate].
 TNT [trinitrotoluene, trotyl, trilit, triton].
 Torpex.
 Tridite.
 Trimethylol ethyl methane trinitrate composition.
 Trimethylolthane trinitrate-nitrocellulose.
 Trimonite.
 Trinitroanisole.
 Trinitrobenzene.
 Trinitrobenzoic acid.
 Trinitrocresol.
 Trinitro-meta-cresol.
 Trinitro-naphthalene.
 Trinitrophenetol.
 Trinitrophenol.
 Trinitrophenol.
 Trinitrophenol.
 Tritonal.

Urea nitrate.

Water bearing explosives having salts of oxidizing acids and nitrogen bases, sulfates, or sulfamates.

Xanthamones hydrophilic colloid explosive mixture.

APPENDIX B

IDENTIFICATION OF HIGHLY REACTIVE WASTE MATERIALS

The following is an alphabetical list of the most common highly reactive waste materials. The list includes explosives, dangerous when wet chemicals, pyrophoric and organic peroxides. Before handling these materials contact your area RCRA representative or the Toxic Waste Control Group (ext. 2-1925).

Abbreviations	Hazard
EXP	Explosive - may detonate by shock or heat
PF	Peroxide Former - fire or explosive hazard
PY	Pyrophoric - ignites spontaneously in dry or moist air at or below 130 F.
FS	Flammable Solid - Waste is liable to cause fires through friction, absorption of moisture or spontaneous chemical changes.
DWW	Flammable Solid, Dangerous When Wet - severe fire and/or explosion in contact with water
OP	Organic Peroxide - strong oxidizing agent, fire or explosion hazard; unstable if heated to Self Accelerating Decomposition Temperature (SADT)
POL	Polymerizable - temperature sensitive material.

DISPOSAL AND CONTROL OF REACTIVE CHEMICALS

A

Acetal PF
 Acetyl benzoyl peroxide EXP
 Acetyl cyclohexyl sulfonyl peroxide OP
 Acetyl peroxide EXP
 Acetylides EXP
 Aluminum borohydride PY
 Aluminum hydride DWW
 Aluminum phosphide DWW
 Ammonium nitrate (contaminated) EXP
 Ammonium picrate EXP
 Azo benzene FS
 2,2'-azobis(2-amidinopropane) dihydrochloride EXP

B

Benzoyl peroxide OP
 Bis (2-chloroisopropyl) ether PF
 Bis (2-ethoxyethyl) ether PF
 Bis (trinitroethyl) carbonate EXP
 Bis (trinitroethyl) nitramine EXP
 Black powder FS
 Boron dust PY
 Butadiene PF
 1,3,4-Butanetrioltrinitrate EXP
 t-Butoxycarbonyl azide EXP
 t-Butyl hydroperoxide OP
 oo-t-Butyl-o-isopropyl monoperoxy-carbonate OP
 n-Butyl lithium PY, PF
 s-Butyl lithium PY, PF
 t-Butyl peracetate OP
 t-Butyl perbenzoate OP
 t-Butyl per -2- ethyl hexoate OP
 t-Butyl perivalate OP
 t-Butyl perneodecanoate OP
 t-Butyl peroxycarbonate OP
 t-Butyl peroxydicarbonate OP
 t-Butyl peroxyacetate OP
 t-Butyl peroxybenzoate OP
 t-Butyl peroxy -2- ethylhexanoate OP
 t-Butyl peroxyisobutyrate OP

t-Butyl peroxy maleic acid OP
 t-Butyl peroxy neodecanoate OP
 t-Butyl peroxy pivalate OP
 Butyl tetryl EXP

C

Calcium carbide DWW
 Calcium hydride DWW
 Calcium metal DWW
 Calcium phosphide DWW
 Cesium metal DWW
 Chlorobutadiene PF
 Chloroperoxy benzoic acid OP
 Chlorotrifluoroethylene PF
 Copper acetylide EXP
 Cumene OP
 Cumene hydroperoxide OP
 Cyanuric triazide OP
 Cyanuric triazide EXP
 Cyclohexene PF
 Cyclohexanone peroxide OP
 Cyclopentadiene PF
 Cyclotetramethylene oxide OP
 Cyclotetramethylene tetranitramine EXP
 Cyclotrimethylene trinitramine (RDX) EXP

D

Decaborane FS
 Decanoyl peroxide OP
 Diacetylene PF
 Diazomethane EXP
 Di-t-butyl diperoxy phthalate OP
 Di-t-butyl perbenzoate OP
 Di-t-butyl peroxide OP
 1,1-Di(t-butyl peroxy) cyclohexane OP
 Di-t-butyl peroxy dicarbonate OP
 1,1-Di(t-butyl peroxy)-3,3,5-trimethyl cyclohexane OP
 Dicanoyl peroxide OP
 Dicetyl peroxy dicarbonate OP
 2,4-Dichlorobenzoyl peroxide OP
 Dicumyl peroxide OP

Dicyclohexyl peroxydicarbonate OP
 Dicyclopentadiene PF
 Diethyl aluminum chloride PY
 Diethyl aluminum hydride PY
 Diethylene oxide PF
 Diethyl ether PF
 Di-2-ethyl hexyl peroxydicarbonate OP
 Diethyl zinc PY
 2,5-Dihydroperoxy-2,5-dimethyl-
 hexane OP
 Diisobutyl peroxide OP
 Diisooctanoyl peroxide OP
 Diisopropylbenzene hydroperoxide OP
 Diisopropyl peroxydicarbonate OP
 2,5-Dimethyl-di(benzoylperoxy)
 Hexane OP
 2,5-Dimethyl-2,5-di(t-butylperoxy)
 Hexane OP
 2,5-Dimethyl-2,5-di(t-butylperoxy)
 Hexane OP
 2,5-Dimethyl-2,5-di(ethylhexanoyl-
 peroxy) Hexane OP
 Dinitroethylene urea EXP
 Dinitroglycerine EXP
 Dinitrophenol FS, EXP
 Dinitrophenolates FS, EXP
 Dinitroresorcinol EXP
 Dioxane PF
 Dipicrylamine EXP
 Dipicryl sulfide EXP
 Dipicryl sulfone EXP
 Di-(n-propyl) peroxydicarbonate OP
 Divinyl acetylene PF

E

Ether PF
 Ethylene glycol dimethyl ether PF
 Ethyl ether PF

F

Fulminate of mercury EXP
 Fulminate of silver EXP
 Fulminates EXP
 Fulminating gold EXP

Fulminating mercury EXP
 Fulminating platinum EXP
 Fulminating silver EXP

H

Heavy metal azides EXP
 Hexanitrodiphenylamine EXP
 Hexanitrodiphenyl sulfide EXP
 Hexanitrostilbene EXP
 Hydrazinium nitrate EXP
 Hydrazoic acid EXP
 Hydrogen peroxide (over 60%) EXP

I

Isopropenyl acetylene FS
 Isopropyl ether PF

L

Lauroyl peroxide OP
 Lead azide EXP
 Lead mannite EXP
 Lead mononitroresorcinate EXP
 Lead picrate EXP
 Lead styphnate EXP
 Lead trinitroresorcinate EXP
 Lithium aluminum hydride DWW
 Lithium amide FS
 Lithium borohydride DWW
 Lithium ferrosilicone DWW
 Lithium hydride DWW, PY
 Lithium metal DWW
 Lithium nitride DWW
 Lithium silicon DWW

M

Magnesium aluminum phosphide DWW
 Magnesium metal DWW
 Mannitol hexanitrate EXP
 Mercuric fulminate EXP
 Mercury oxalate EXP
 Mercury tartrate EXP
 Methyl acetylene PF
 Methyl cyclopentane PF
 Methyl ethyl ketone peroxide OP
 Methyl isobutyl ketone PF
 Methyl lithium PY, PF

N

Nitrocellulose (dry) EXP
 Nitrogen trichloride EXP
 Nitrogen triiodide EXP
 Nitroglycerine EXP
 Nitroglycide EXP
 Nitromethane (contaminated) EXP
 Nitroparaffins (contaminated) EXP
 Nitrostarch EXP
 Nitrourea EXP

O

Organic peroxides OP

P

2,4-Pentanedione peroxide OP
 Perisobutyric acid OP
 1-Phenylazo-2-naphthol EXP
 Phenyl lithium PY,PF
 Phosphorous (white, yellow) PY,FS
 Phosphorous (red) FS
 Phosphorous pentasulfide DWW
 Phosphorous sesquisulfide DWW
 Picramates EXP
 Picramide EXP
 Picratol EXP
 Picric acid (dry) EXP
 Picryl chloride EXP
 Picryl fluoride EXP
 Potassium azide (old) EXP
 Potassium borohydride FS
 Potassium t-butoxide FS
 Potassium metal DWW, PF

R

Rubidium metal DWW

S

Silver acetylide EXP
 Silver azide EXP
 Silver fulminate EXP
 Silver picrate EXP
 Silver styphnate EXP
 Silver tetrazene EXP

Smokeless powder FS
 Sodamide DWW, PF
 Sodium aluminum hydride DWW, PY
 Sodium amide DWW, PF
 Sodium azide (old) EXP
 Sodium borohydride DWW
 Sodium dithionite FS
 Sodium hydride DWW
 Sodium hydrosulfite FS
 Sodium metal DWW
 Sodium methoxide FS
 Sodium methylate (dry) FS
 Sodium phosphide DWW
 Sodium picramate EXP
 Sodium potassium alloy DWW
 Stannic phosphide DWW
 Styphenates EXP
 Styphnic acid EXP
 Styrene PF
 Succinic acid peroxide OP
 Sulfur/zinc mixtures FS

T

Tetrafluorethylene PF
 Tetrahydrofuran PF
 Tetrahydronaphthalene PF
 1,1,3,3-Tetramethyl-butyl hydro-
 peroxide OP
 Tetranitrocarbazole EXP
 Tetranitromethane EXP, FS
 Thermite FS
 Titanium dichloride PY
 Titanium trichloride PY
 1-0-Tolyazo-2-naphthol EXP
 Triaminotrinitrobenzene EXP
 Tributyl aluminum PY
 Tri-n-butyl borane PY
 Trichlorotrinitrobenzene EXP
 Triethyl boron PY
 Triethyl aluminum PY
 Triethyl aluminum chloride PY
 Triethyl borane PY
 Triisobutyl aluminum PY

Trinitroanisole EXP
Trinitrobenzene EXP
Trinitrobenzoic acid EXP
Trinitrocresol EXP
Trinitronaphthalene EXP
Trinitrophenol (picric acid) EXP
Trinitroresorcinol EXP
Trinitrotoluene (TNT) EXP

U

Urea nitrate EXP

V

Vinyl acetate PF
Vinyl acetylene PF
Vinylbenzene POL
Vinyl ether PF
Vinyl ethyl ether POL
Vinylidene chloride PF
Vinyl isobutyl ether POL
Vinyl methyl ether POL
Vinyl methyl ketone POL
Vinyl pyridine PF

Z

Zinc/sulfur mixtures FS
Zirconium hydride DWW
Zirconium metal FS, EXP
Zirconium picramate EXP

NOTE: This list is not intended to be all inclusive. All chemicals must be handled with respect and every effort made to understand their nature.

WASTE IDENTIFICATION SHEET

STORAGE LOCATION: _____

DRUM NUMBER _____

[illegible]

APPENDIX E

GUIDE TO COMPATIBILITY OF CHEMICALS

The Guide is based in part upon information provided to the Coast Guard by the National Academy of Sciences - U.S. Coast Guard Advisory Committee on Hazardous Materials and represents the latest information available to the Coast Guard on chemical compatibility.

The accidental mixing of one chemical cargo with another can in some cases be expected to result in a vigorous and hazardous chemical reaction. The generation of toxic gases, the heating, overflow, and rupture of cargo tanks, and fire and explosion are possible consequences of such reactions.

The purpose of the Compatibility Chart is to show chemical combinations believed to be dangerously reactive in the case of accidental mixing. It should be recognized, however, that the Chart provides a broad grouping of chemicals with an extensive variety of possible binary combinations. Although one group, generally speaking, can be considered dangerously reactive with another group where an "X" appears on the Chart, there may exist between the groups some combinations which would not dangerously react. The Chart should therefore not be used as an infallible guide. It is offered as an aid in the safe loading of bulk chemical cargoes, with the recommendation that proper safeguards be taken to avoid accidental mixing of binary mixtures for which an "X" appears on the Chart. Proper safeguards would include consideration of such factors as avoidance of the use of common cargo and vent lines and carriage in adjacent tanks having a common bulkhead.

The following procedure explains how the Guide should be used in determining compatibility information:

- (1) Determine the reactivity group of a particular product by referring to the alphabetical list in Table 7.1.
- (2) Enter the Chart with the reactivity group. Proceed across the page. An "X" indicates a reactivity group that forms an unsafe combination with the product in question.

For example, crotonaldehyde is listed in Table 7.1 as belonging in Group 19 (Aldehydes). The Chart shows that chemicals in this group should be segregated from sulfuric and nitric acids, caustics, ammonia, and all types of amines (aliphatic, alkanol, and aromatic). According to note A, crotonaldehyde is also incompatible with non-oxidizing mineral acids.

COMPATIBILITY CHART

CATIONIC GROUPS	REACTIVE GROUPS																					
	1. NON OXIDIZING MINERAL ACIDS	2. SULFURIC ACID	3. NITRIC ACID	4. ORGANIC ACIDS	5. CAUSTICS	6. AMMONIA	7. ALIPHATIC AMINES	8. ALKANOLAMINES	9. AROMATIC AMINES	10. AMIDES	11. ORGANIC ANHYDRIDES	12. ISOCYANATES	13. VINYL ACETATE	14. ACRYLATES	15. SUBSTITUTED ALLYLS	16. ALKYLENE OXIDES	17. EPICHLOROHYDRIN	18. KETONES	19. ALDEHYDES	20. ALCOHOLS, GLYCOLS	21. PHENOLS, CRESOLS	22. CAPROLACTAM SOLUTION
1. NON OXIDIZING MINERAL ACIDS	X																					
2. SULFURIC ACID		X																				
3. NITRIC ACID			X																			
4. ORGANIC ACIDS				X																		
5. CAUSTICS					X																	
6. AMMONIA						X																
7. ALIPHATIC AMINES							X															
8. ALKANOLAMINES								X														
9. AROMATIC AMINES									X													
10. AMIDES										X												
11. ORGANIC ANHYDRIDES											X											
12. ISOCYANATES												X										
13. VINYL ACETATE													X									
14. ACRYLATES														X								
15. SUBSTITUTED ALLYLS															X							
16. ALKYLENE OXIDES																X						
17. EPICHLOROHYDRIN																	X					
18. KETONES																		X				
19. ALDEHYDES																			X			
20. ALCOHOLS, GLYCOLS																				X		
21. PHENOLS, CRESOLS																					X	
22. CAPROLACTAM SOLUTION																						X
23. EPICHLOROHYDRIN																						
24. ALKYLENE OXIDES																						
25. ALCOHOLS, GLYCOLS																						
26. PHENOLS, CRESOLS																						
27. CAPROLACTAM SOLUTION																						
28. EPICHLOROHYDRIN																						
29. ALKYLENE OXIDES																						
30. ALCOHOLS, GLYCOLS																						
31. PHENOLS, CRESOLS																						
32. CAPROLACTAM SOLUTION																						
33. EPICHLOROHYDRIN																						
34. ALKYLENE OXIDES																						
35. ALCOHOLS, GLYCOLS																						
36. PHENOLS, CRESOLS																						
37. CAPROLACTAM SOLUTION																						
38. EPICHLOROHYDRIN																						
39. ALKYLENE OXIDES																						
40. ALCOHOLS, GLYCOLS																						
41. PHENOLS, CRESOLS																						
42. CAPROLACTAM SOLUTION																						
43. EPICHLOROHYDRIN																						

NOTES TO COMPATIBILITY CHART:
REACTIVITY DIFFERENCES (DEVIATIONS) WITHIN CHEMICAL GROUPS

- A Acrolein (19), Crotonaldehyde (19), and 2-Ethyl-3-propyl acrolein (19) are not compatible with Group 1, Non-Oxidizing Mineral Acids.
- B Isophorone (18), and Mesityl Oxide (18) are not compatible with Group 8, Alkanolamines.
- C Acrylic Acid (4) is not compatible with Group 9, Aromatic Amines.
- D Allyl Alcohol (15) is not compatible with Group 12, Isocyanates.
- E Furfuryl Alcohol (20) is not compatible with Group 1, Non-oxidizing Mineral Acids.
- F Furfuryl Alcohol (20) is not compatible with Group 4, Organic Acids.
- G Dichloroethyl Ether (36) is not compatible with Group 2, Sulfuric Acid.
- H Trichloroethylene (36) is not compatible with Group 5, Caustics.
- I Ethylenediamine (7) is not compatible with Ethylene Dichloride (36).

ALPHABETICAL LISTING OF COMPOUNDS

<u>Name</u>	<u>Group No.</u>	<u>Name</u>	<u>Group No.</u>
Acetaldehyde	19	Butyl Benzyl Phthalate	34
Acetic Acid	4	Butylene	30
Acetic Anhydride	11	1,3-Butylene Glycol	20
Acetone	18	Butylene Oxide	16
Acetonitrile	37	Butyl Ether	41
Acrolein (inhibited)	19	Butyl Methacrylate	
Acrylic Acid (inhibited)	4	(inhibited)	14
Acrylonitrile		Butyraldehyde	19
(inhibited)	15	Butyric Acid	4
Adiponitrile	37		
Allyl Alcohol	15		
Allyl Chloride	15	Camphor Oil (light)	18
Aminoethyl ethanolamine	8	Caprolactam Solution	22
Ammonia, Anhydrous	6	Carbolic Oil	21
Ammonium Hydroxide		Carbon Disulfide	38
(28% or less)	6	Carbon Tetrachloride	36
Ammonium Nitrate, Urea,		Caustic Potash Solution	5
Water Solutions		Caustic Soda Solution	5
(containing Ammonia)	6	Chlorine	*
Ammonium Nitrate, Urea,		Chlorobenzene	36
Water Solutions (not		Chloroform	36
containing Ammonia)	43	Chlorosulfonic Acid	*
Amyl Acetate	34	Corn Syrup	43
Amyl Alcohol	20	Creosote, Coal Tar	21
Amyl Tallate	34	Cresols	21
Aniline	9	Cresylate Spent Caustic	
Asphalt	33	Solution	5
Asphalt Blending Stocks:		Crotonaldehyde	19
Roofers Flux	33	Cumene	32
Straight Run Residue	33	Cycloaliphatic Resins	31
		Cyclohexane	31
Benzene	32	Cyclohexanol	20
Benzene, Toluene		Cyclohexanone	18
Xylene (crude)	32	Cyclohexylamine	7
Butadiene (inhibited)	30	Cymene	32
Butane	31		
Butyl Acrylate		Decaldehyde	19
(inhibited)	14	Decane	31
Butyl Acetate	34	Decene	30
Butyl Alcohol	20	Decyl Alcohol	20
Butylamine	7	Decyl Acrylate	
		(inhibited)	14

ALPHABETICAL LISTING OF COMPOUNDS (Continued)

Decylbenzene	32	Distillates:	
Dextrose Solution	43	Straight Run	33
Diacetone Alcohol	20	Flashed Feed Stocks	33
Dibutylamine	7	Diundecyl Phthalate	34
Dibutyl Phthalate	34	Dodecane	31
Dichlorobenzene	36	Dodecanol	20
Dichlorodifluoromethane	36	Dodecene	30
1,1-Dichloroethane	36	Dodecylbenzene	32
Dichloroethyl Ether	41		
Dichloromethane	36	Epichlorohydrin	17
1,1-Dichloropropane	36	Ethane	31
1,2-Dichloropropane	36	Ethanolamine	8
1,3-Dichloropropene	15	Ethoxylated Alcohols	
Dicyclopentadiene	30	C11-C15	40
Diethanolamine	8	Ethoxy Triglycol	40
Diethylamine	7	Ethyl Acetate	34
Diethylbenzene	32	Ethyl Alcohol	20
Diethylene Glycol	40	Ethyl Acrylate	
Diethylene Glycol Mono-		(inhibited)	14
butyl Ether	40	Ethylamine	7
Diethylene Glycol Mono-		Ethyl Benzene	32
butyl Ether Acetate	34	Ethyl Butanol	20
Diethylene Glycol Mono-		Ethyl Chloride	36
ethyl Ether	40	Ethylene	30
Diethylene Glycol Mono-		Ethylene Chlorohydrin	20
methyl Ether	40	Ethylene Cyanohydrin	20
Diethylenetriamine	7	Ethylenediamine	7
Diethylethanolamine	8	Ethylene Dibromide	36
Diheptyl Phthalate	34	Ethylene Dichloride	36
Diisobutylene	30	Ethylene Glycol	20
Diisobutyl Carbinol	20	Ethylene Glycol Mono-	
Diisobutyl Ketone	18	butyl Ether	40
Diisodecyl Phthalate	34	Ethylene Glycol Mono-	
Diisopropanolamine	8	butyl Ether Acetate	34
Diisopropylamine	7	Ethylene Glycol Mono-	
Dimethylamine	7	ethyl Ether	40
Dimethylethanolamine	8	Ethylene Glycol Mono-	
Dimethylformamide	10	ethyl Ether Acetate	34
Dinonyl Phthalate	34	Ethylene Glycol Mono-	
Diocetyl Phthalate	34	methyl Ether	40
1,4-Dioxane	41	Ethylene Oxide	*
Diphenyl-Diphenyl Oxide	33	Ethyl Ether	41
Diphenylmethane Diiso-		Ethylhexaldehyde	19
cyanate	12	2-Ethyl Hexanol	20
Di-n-propylamine	7	2-Ethylhexyl Acrylate	
Dipropylene Glycol	40	(inhibited)	14

ALPHABETICAL LISTING OF COMPOUNDS (Continued)

Ethyl Hexyl Tallate	34	Jet Fuels:	
Ethyl Methacrylate		JP-1 (Kerosene)	33
(inhibited)	14	JP-3	33
2-Ethyl-3-Propyl		JP-4	33
Acrolein	19	JP-5 (Kerosene, Heavy)	33
Formaldehyde Solution			
(37-50%)	19		
Formic Acid	4	Kerosene	33
Furfural	19		
Furfuryl Alcohol	20		
		Latex, Liquid Synthetic	43
Gas Oil:			
Cracked	33	Mesityl Oxide	18
Gasoline Blending Stocks:		Methane	31
Alkylates	33	Methyl Acetate	34
Reformates	33	Methyl Acetylene, Pro-	
Gasolines:		padiene Mixture	
Casinghead (natural)	33	(Stabilized)	30
Automotive (containing		Methyl Acrylate	
over 4.23 grams lead		(inhibited)	14
per gallon)	33	Methyl Alcohol	20
Aviation (containing		Methyl Amyl Acetate	34
not over 4.86 grams		Methyl Amyl Alcohol	20
lead per gallon)	33	Methyl Bromide	36
Polymer	33	3-Methyl Butyraldehyde	19
Straight Run	33	Methyl Chloride	36
Glutaraldehyde Solution	19	Methyl Ethyl Ketone	18
Glycerine	20	2-Methyl-5-Ethyl	
Glycol Diacetate	34	Pyridine	9
Glyoxal Solution	19	Methyl Formal (Dimethyl	
		Formal)	41
Heptane	31	Methyl Isobutyl Ketone	18
Hexamethyleneimine	7	Methyl Isobutyl Carbinol	20
Hexane	31	Methyl Methacrylate	
Hexanol	20	(inhibited)	14
Hexene	30	(alpha-) Methyl Styrene	
Hexylene Glycol	20	(inhibited)	30
Hydrochloric Acid	1	Mineral Spirits	33
Hydrofluoric Acid	1	Monochlorodifluoro-	
		methane	36
		Morpholine	7
Isophorone	18	Motor Fuel Antiknock Com-	
Isoprene (inhibited)	30	pounds Containing Lead	
		Alkyls	*

ALPHABETICAL LISTING OF COMPOUNDS (Continued)

Naphtha:			
Coal Tar	33	Lard	34
Solvent	33	Olive	34
Stoddard Solvent	33	Palm	34
Varnish Markers' and		Peanut	34
Painters' (75%)	33	Safflower	34
Naphthalene (molten)	32	Soya Bean	34
Nitric Acid (70% or		Tucum	34
less)	3	Vegetable	34
Nitric Acid (95%)	*	Miscellaneous Oils,	
Nitrobenzene	43	including:	
1- or 2-Nitropropane	43	Absorption	33
Nitrotoluene	43	Aromatic	33
Nonane	31	Coal Tar	33
Nonene	30	Heartcut Distillate	33
Nonyl Alcohol	20	Linseed	33
Nonyl Phenol	21	Lubricating	33
Nonyl Phenol		Mineral	33
(ethoxylated)	40	Mineral Seal	33
		Motor	33
Octane	31	Neatsfoot	33
Octene	30	Penetrating	33
Octyl Alcohol	20	Range	33
Octyl Aldehyde	19	Resin	33
Octyl Epoxystallate	34	Resinous Petroleum	33
Oils:		Rosin	33
Clarified	33	Sperm	33
Coal Oil	33	Spindle	33
Crude Oil	33	Spray	33
Diesel Oil	33	Tall	34
Fuel Oils:		Tanner's	33
No. 1 (Kerosene)	33	Turbine	33
No. 1-D	33	Oleum	*
No. 2	33		
No. 2-D	33	Pentadecanol	22
No. 4	33	Pentane	31
No. 5	33	Pentene	30
No. 6	33	Pentyl Aldehyde	19
Residual	33	Perchloroethylene	36
Road	33	Petrolatum	33
Transformer	33	Petroleum Naphtha	33
Edible Oils, including:		Phenol	21
Castor	34	Pentachloroethane	36
Coconut	34	Phosphoric Acid	1
Cotton Seed	34	Phosphorus	*
Fish	34	Phthalic Anhydride	
		(molten)	11

ALPHABETICAL LISTING OF COMPOUNDS (Continued)

Polybutene	30	Tetradecanol	20
Polyethylene Glycols	40	Tetradecene	30
Polymethylene Polyphenyl- isocyanate	12	Tetradecylbenzene	32
Polypropylene	30	Tetraethylene Glycol	40
Polypropylene Glycol		Tetraethylenepentamine	7
Methyl Ether	40	Tetrahydrofuran	41
Polypropylene Glycols	40	Tetrahydronaphthalene	32
Propane	31	Tetrasodium Salt of EDTA Solution	43
Propanolamine	8	Toluene	32
Propionaldehyde	19	Toluene Diisocyanate	12
Propionic Acid	4	1,2,4-Trichlorobenzene	36
Propionic Anhydride	11	Trichloroethylene	36
Propyl Acetate	34	Tridecanol	20
Propyl Alcohol	20	Tridecene	30
Propylamine	7	Tridecylbenzene	32
Propylene	30	Triethanolamine	8
Propylene Butylene Polymer	30	Triethylamine	7
Propylene Glycol	20	Triethyl Benzene	32
Propylene Oxide	16	Triethylene Glycol	40
Propylene Tetramer	30	Triethylenetetramine	7
Propyl Ether	41	Tripropylene Glycol	40
Pyridine	9	Turpentine	30
Sodium Hydrosulfide Solution (45% or less)	5	Underanol	20
Sorbitol	20	Undecene	30
Styrene (inhibited)	30	Undecylbenzene	32
Sulfolane	39		
Sulfur (molten)	*	Valeraldehyde	19
Sulfuric Acid	2	Vinyl Acetate (inhibited)	13
Sulfuric Acid, Spent	2	Vinyl Chloride (inhibited)	35
		Vinylidene Chloride (inhibited)	35
Tallow	34	Vinyl Toluene (inhibited)	30
Tallow Fatty Alcohol	20		
1,1,2,2-Tetrachloro- ethane	36		
		Xylene	32

* Because of very high reactivity or unusual conditions of carriage, this product is not included in the Compatibility Chart. If compatibility information is needed for a shipment, contact Commandant (G-MHM-1/83), U.S. Coast Guard, 400 Seventh Street, S.W., Washington, D. C. 20590.

REACTIVITY GROUPS

1. Non-Oxidizing Mineral Acids

Hydrochloric Acid
Hydrofluoric Acid
Phosphoric Acid

2. Sulfuric Acids

Spent Sulfuric Acid
Sulfuric Acid (98% or less)

3. Nitric Acid

Nitric Acid (70% or less)

4. Organic Acids

Acetic Acid
Butyric Acid
Formic Acid
Propionic Acid
Acrylic Acid (inhibited)

5. Caustics

Caustic Potash Solution
Caustic Soda Solution
Cresylate Spent Caustic Solution
Sodium Hydrosulfide Solution
(45% or less)

6. Ammonia

Ammonia, Anhydrous
Ammonium Hydroxide (28% or less)
Ammonium Nitrate, Urea, Water
Solutions (containing Ammonia)

7. Aliphatic Amines

Butylamine
Cyclohexylamine
Dibutylamine
Diethylamine
Diethylenetriamine
Diisopropylamine
Dimethylamine
Di-n-propylamine
Ethylamine
Ethylenediamine
Hexamethylenimine
Methylamine
Morpholine
Propylamine
Tetraethylenepentamine
Triethylamine
Triethylenetetramine

8. Alkanolamines

Aminoethylethanolamine
Diethanolamine
Diethylethanolamine
Diisopropanolamine
Dimethylethanolamine
Ethanolamine
Propanolamine
Triethanolamine

9. Aromatic Amines

Aniline
Pyridine
2-Methyl-5-Ethylpyridine

10. Amides

Dimethylformamide

REACTIVITY GROUPS (Continued)

11. Organic Anhydrides

Acetic Anhydride
Phthalic Anhydride
Propionic Anhydride

12. Isocyanates

Diphenylmethane Diisocyanate
Polyphenyl Polymethylene-
isocyanate
Toluene Diisocyanate

13. Vinyl Acetate

Vinyl Acetate (inhibited)

14. Acrylates

Butyl Acrylate (inhibited)
Butyl Methacrylate (inhibited)
Decyl Acrylate (inhibited)
Ethyl Acrylate (inhibited)
2-Ethylhexyl Acrylate (inhibited)
Ethyl Methacrylate (inhibited)
Methyl Acrylate (inhibited)
Methyl Methacrylate (inhibited)

15. Substituted Alkyls

Acrylonitrile (inhibited)
Allyl Alcohol
Allyl Chloride
1,3-Dichloropropene

16. Alkyene Oxides

Propylene Oxide
Butylene Oxide

17. Epichlorohydrin

Epichlorohydrin

18. Ketones

Acetone
Camphor Oil
Cyclohexanone
Diisobutyl Ketone
Isophorone
Mesityl Oxide
Methyl Ethyl Ketone
Methyl Isobutyl Ketone

19. Aldehydes

Acetaldehyde
Acrolein (inhibited)
Butyraldehyde
Decaldehyde
Ethylhexaldehyde
Formaldehyde
Glutaraldehyde Solution
Glyoxal Solution
Methylbutyraldehyde
Octyl Aldehyde
Pentyl Aldehyde
Propionaldehyde
Valeraldehyde

20. Alcohols. Glycols

Amyl Alcohol
Butyl Alcohol
1,3-Butylene Glycol
Cyclohexanol
Decyl Alcohol
Diacetone Alcohol
Diisobutyl Carbinol
Dodecanol
Ethanol
Ethoxylated Alcohols
C₁₁-C₁₅

REACTIVITY GROUPS (Continued)

Ethyl Alcohol
Ethylbutanol
Ethylene Chlorohydrin
Ethylene Cyanohydrin
Ethylene Glycol
2-Ethyl Hexanol
Furfuryl Alcohol
Glycerin
Hexanol
Hexylene Glycol
Methanol
Methyl Alcohol
Methylamyl Alcohol
Methylisobutyl Carbinol
Octyl Alcohol
Nonyl Alcohol
Pentadecanol
Propyl Alcohol
Propylene Glycol
Sorbitol
Tallow Fatty Alcohol
Tetradecanol
Tridecanol
Undecanol

21. Phenols and Cresols

Carbolic Oil
Creosote, Coal Tar
Cresols
Nonyl Phenol
Phenol

22. Caprolactam Solution

Caprolactam Solution

23 - 29. Unassigned

30. Olefins

Butadiene (inhibited)
Butene

Butylene
Decene
Dicyclopentadiene
Diisobutylene
Dodecene
Ethylene
Hexene
Isoprene (inhibited)
Methyl Acetylene, Propadiene
Mixture (stabilized)
(alpha-) Methyl Styrene
(inhibited)
Nonene
Octene
Pentene
Polybutene
Polypropylene
Propylene
Propylene Butylene Polymer
Propylene Tetramer
Styrene (inhibited)
Vinyl Toluene (inhibited)
Tetradecene
Tridecene
Turpentine
Undecene

31. Paraffins

Butane
Cycloaliphatic Resins
Cyclohexane
Decane
Dodecane
Ethane
Heptane
Hexane
Methane
Nonane
Octane
Pentane
Propane

REACTIVITY GROUPS (Continued)

32. Aromatic Hydrocarbons

Benzene
Benzene, Toluene, Xylene (crude)
Cumene
Cymene
Dacylbenzene
Diethylbenzene
Dodecylbenzene
Ethylbenzene
Naphthalene
Tetradecylbenzene
Tetrahydronaphthalene
Toluene
Tridecylbenzene
Triethylbenzene
Undecylbenzene
Xylene

33. Misc. Hydrocarbon Mixtures

Asphalt
Asphalt Blending Stocks
Diphenyl - Diphenyl Oxide
Distillates
Gas Oil, Cracked
Gasoline Blending Stocks
Gasolines
Jet Fuels
Kerosene
Mineral Spirits
Naphtha
Oils, Crude
Oils, Diesel
Oils, Coal
Oils, Fuel (No. 1 thru No. 6)
Oils, Residual
Oils, Road
Oils, Transformer
Petrolatum
Petroleum Naphtha

34. Esters

Amyl Acetate

Amyl Tallate
Butyl Acetate
Butyl Benzyl Phthalate
Castor Oil
Coconut Oil
Cottonseed Oil
Dibutyl Phthalate
Diethylene Glycol Monobutyl
Ether Acetate
Diheptyl Phthalate
Diisodecyl Phthalate
Dinonyl Phthalate
Dioctyl Phthalate
Diundecyl Phthalate
Ethyl Acetate
Ethylene Glycol Monobutyl
Ether Acetate
Ethylene Glycol Monoethyl
Ether Acetate
Ethylhexyl Tallate
Fish Oil
Glycol Diacetate
Lard
Methyl Acetate
Methyl Amyl Acetate
Octyl Epoxy Tallate
Olive Oil
Palm Oil
Peanut Oil
Propyl Acetate
Safflower Oil
Soybean Oil
Tallow
Tucum Oil
Vegetable Oil

35. Vinyl Halides

Vinyl Chloride (inhibited)
Vinylidene Chloride (inhibited)

36. Halogenated Hydrocarbons

Carbon Tetrachloride
Chlorobenzene

REACTIVITY GROUPS (Continued)

Chloroform
Dichlorobenzene
1,1-Dichloroethane
Dichloroethyl Ether
Dichloromethane
1,1-Dichloropropane
1,2-Dichloropropane
Ethyl Chloride
Ethylene Dibromide
Ethylene Dichloride
Methyl Bromide
Methyl Chloride
Pentachloroethane
Perchloroethylene
1,1,2,2-Tetrachloroethane
1,2,4-Trichlorobenzene
Trichloroethylene

37. Nitriles

Acetonitrile
Adiponitrile

38. Carbon Disulfide

39. Sulfolane

40. Glycol Ethers

Diethylene Glycol
Diethylene Glycol Monobutyl Ether
Diethylene Glycol Monoethyl Ether
Diethylene Glycol Monomethyl Ether
Dipropylene Glycol
Ethoxy Triglycol
Ethylene Glycol Monobutyl Ether
Ethylene Glycol Monethyl Ether

Ethylene Glycol Monomethyl Ether
Nonylphenol, Ethoxylated
Polyethylene Glycols
Polypropylene Glycols
Polypropylene Glycol Methyl Ether
Soybean Oil, Epoxidized
Tetraethylene Glycol
Triethylene Glycol
Tripropylene Glycol

41. Ethers

Butyl Ether
1,4-Dioxane
Ethyl Ether
Methyl Formal (Dimethyl Formal)
Propyl Ether
Tetrahydrofuran

42. Nitrocompounds

(mono-) Nitrobenzene
1- or 2-Nitropropane
Nitrotoluene

43. Miscellaneous Water Solutions

Ammonium Nitrate, Urea, Water Solutions (not containing Ammonia)
Corn Syrup
Dextrose Solution
Latex Solutions
Tetrasodium Salt of EDTA Solution

Appendix F

Chemical Carcinogens and Liquids for Incineration

The equipment used for carcinogenic destruction is a dual chamber controlled air incinerator capable of destroying 400 lbs/hour of Type IV Waste. Type IV Waste is defined as human and animal remains, consisting of carcasses, organs and solid organic wastes consisting of up to 85% moisture, 5% incombustible solids and having a heating value of 1,000 BTU per pound as fired.

A liquid injection system is also installed which feeds into the lower chamber. Organic liquid wastes are mixed in a 30 gallon mixing tank to obtain a uniform feed and injected through a 70° dispersion conical spray into the primary chamber. The BTU content of the liquid ranges from approximately 500 BTU/lb up to 20,000 BTU/lb for some of the aromatic compounds. The following is a list of carcinogenic chemical wastes that are processed in this system. Most of these wastes are present as contaminants in solvents or rinse solutions, and therefore have a negligible contribution to the BTU content of the liquid waste. The cases where the chemicals could be the actual injection solutions have the heat of combustion listed.

CHEMICALChemical Carcinogens (CC)Heat of CombustionKg-cal (BTU/lb)

Aflatoxin B	
Alpha-Naphthylamine	
4-Aminodiphenyl (PAB)	
2-Aminofluorine	
Benz(a)anthracene	
Benzene	781 (18,210)
Benzidine	
Benzo(a)pyrene	
Beta-naphthylamine	
Beta-propiolactone	
Bis-chloromethyl ether	600 (10,000)
Diazomethane	
Dibenz(a,c)anthracene	
3,3-Dichlorobenzadine (& its salts)	
Dibenz(a,h)anthracene	
9,10 Dimethyl	
1,2 Benzanthracene	
4-Dimethylaminoazobenzene	
Ethyleneimine (EI)	
1-Ethyl nitrosourea	
Hydrazine sulfate	
Methanesulfonic acid, ethyl ester	
Methylazoxy methanol acetate	
3-Methyl cholanthrene	
Methyl Chloromethyl ether	
4,4-Methylene bis (2-chloroaniline)	
Methyl Methane Sulfonate (MMS)	

CHEMICAL

Chemical Carcinogens (CC) (Continued)

N-METHYL-N-Nitro-N-Nitrosoguanidine
Mitomycin C
4-nitrobiphenyl (PNB)
N-Nitrosodiethylamine
N-Nitrosodimethylamine
Triethylenethiophosphoramidate

Presumptive Chemical Carcinogens (PCC)

2-Aminoanthracene
Anthracene
Azaserine
Benzo(e)pyrene
Bromomethylbenzanthracene
N-Butyl-N-(4-hydroxy-butyl)
nitrosoamine or BBN

Chrysene
Cyclophosphamide
Decarbamoyl mitomycin C
2,7-Dinitrofluorene
Epichlorohydrin
Ethionine
Ethylene Dibromide
8-Hydroxyquinoline

4-Methoxy-2-Naphthylamine
Methylenedianiline
Nitrogen Mustard
N-Nitrosodiphenylamine

CHEMICALChemical Carcinogens (CC) (Continued)

Heat of Combustions

kg-cal (BTU/lb)

Phenanthrene
Picene
Porfiromycin
Quinoline, 4-Nitro, 1-Oxide
Tetraethylthiuram disulphide (disulfiram)
Thiourea
Vinylcyclohexene dioxide

Toxic Chemicals (TC)

Acridine and its derivatives (includes

Acridine Orange)

Acriflavine
9-Aminoacridine
2-Aminopurine
5-Bromo-deoxyuridine
Chromomycin A-3
Colchicine
Cyanogen Bromide
Cytosar (Ara-C)
2,2-Dichloro-N-Methyl-diethylamine
Ethidium Bromide (and congeners)
5-Fluorouracil
Hydroxylamine
Naphthalene
P-Nitrosodiphenylamine
Pyrene
Quercetin
Toluene 934 (18,440)
Methyl alcohol 173 (10,250)
Ethyl alcohol 326 (13,325)
Turpentine 850 (17,000)
Kerosene 950 (18,900)