**FINAL EVALUATION OF PETC
COAL CONVERSION SOLID AND HAZARDOUS WASTES**

Final Report

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ABSTRACT

Hazards and pollutional impacts from residuals generated at the Pittsburgh Energy Technology Center are explained in the context of hazardous waste regulations proposed by the federal government (RCRA). Nine hazard characteristics are defined and an overview of their significance to PETC is presented. Pollutional impacts on air, water and land are discussed in the energy research perspective. Legislative and statutory relationships between the Center and local, county, state and federal enforcement agencies are listed and analyzed. Expected liability resting on the Center in this framework is outlined.

One hundred and seven different chemical and indeterminate wastes were reported in an inventory conducted as an earlier task of this project. All of these are tabulated, classified in accordance with the latest proposed federal regulations, with recommended treatment and disposal methodologies included. Three extremely toxic chemicals appeared on the list and should be eliminated from all activities at the Center. All components of a general residuals management system (storage, transport, processing and disposal) are described with special emphasis on viable alternatives for management of PETC residuals.

The existing residuals management system is described to establish baseline conditions in preparing the recommended system. Management policies as they are presently practiced are included in the presentation. Regional resources applicable to the wastes generated at PETC are described in detail and located geographically with respect to the Center. Evolving techniques are presented where they have some promise for processing the specialized waste streams.

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A recommended residuals management plan is offered for consideration. It includes the organizational arrangement of PETC personnel, a description of authority and responsibilities of the various human elements of the plan, an information network with detailed data sheets and installation of a mandatory manifest system, a carefully designed hazardous chemical storage area, and short as well as long term choices. In the short view, laboratory waste chemicals should be consigned to a responsible waste broker (as it is now handled). The indeterminate wastes (slags, chars, flyash and coal residues) should be characterized. An on-site incinerator to process flammable liquid residuals should be considered as a long range option. Joint venture processing and land disposal activity with other Energy Technology Centers is suggested.

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CHAPTER I

HAZARDS AND POTENTIAL POLLUTIONAL IMPACTS

1.0 Introduction

Virtually all of the handbooks available on comprehensive industrial waste management are based on pure materials within the occupational health and safety perspective. Recommended methodologies for treatment and disposal of mixed wastes for a wide range of substances are practically nonexistent. The hazard parameters for most organic and inorganic materials are well-known.(1)(2)(3). Pure chemicals and homogenous materials may become wastes due to age (no longer fresh), lack of demand for the specific chemicals by the research projects being implemented, or simply due to housekeeping needs in the technology laboratory complex. Some test process waste streams may be relatively pure as they emerge from the operation of pilot plants demonstration units, or from full scale manufacture of specific energy products: however, trace amounts of highly toxic organics or heavy metals may render the entire waste stream hazardous in a statutory sense.

Energy technology centers generate pure wastes from the operation of chemical and physical testing laboratories as well as specific research operations. If materials are homogenous (unmixed), they may be easily defined with regard to the statutory requirements for handling, treatment and disposal. If the chemical wastes are aggregated for reduction of volume and ease of handling during transportation from the technology center site, they become more complex residuals requiring expertise in classifying the resultant material for regulatory purposes. In addition, greater risk of an industrial accident is present if two

violently interactive substances are combined. Concentrations of toxic fractions are altered and chemical reactions may occur due to mixing- resulting in new chemical compounds with radically different hazardous characteristics.

In the context of this report, the hazard definitions are taken from the latest Environmental Protection Agency proposed regulations (4) mandated by the Resource Conservation and Recovery Act (P.L. 94-580) of 1976. Due to the thrust of the legislation, the regulations are intended to encompass the hazardous (synonymous with pollution) aspects of wastes in the disposal mode as well as the occupational safety and public health framework. The legal definition of a 'hazardous waste' dictates the approach taken by the regulations.

"A solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may- (a) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible illness; or (b) pose a substantial present or potential hazard to human health or the environment, when improperly treated, stored, transported, or disposed of, or otherwise managed." (5)

The statutes address the dangers of flammability (ignitable), reactivity, corrosivity, toxicity, pathogenicity and radioactivity as separate entities. Toxicity is mainly considered with regard to heavy metals in drinking water. This category is sub-divided into additional characteristics which include mutagenicity, bioaccumulation and organic fractions which are toxic to humans, animals and aquatic biota. Figure 1-1 diagrams the protocol utilized in making the determination of a statutory 'hazardous waste'.

Pollutional impacts from the wastes generated at the Energy Technology Center are in the context of receiving media (air, water or land) which influences the pathways for health effects. Changes in quality of

of the environment must be considered in addition to the potential for harmful effects on man and animal. In order to set water discharge limitations and determine the necessity for and level of treatment of the hazardous wastes, the various environmental impacts must be assessed.

Legislation and regulations have been promulgated for control of wastes from the various energy technology centers. Air pollution control ordinances cover the control of emissions to the air media. Water quality criteria and discharge limitations in addition to land disposal requirements are in force for regulating transportation and disposal of waste streams on land and discharges to ground and surface waters.

The governmental institutions charged with enforcing the statutes include local, county-wide, regional, state and federal departments. All may have some authority with regard to control and enforcement of their particular ordinances covering the energy technology center activities. The regulations and pollution control requirements may differ with each institution. In some cases authority overlaps and some delegation of powers to the lower eschelon of government is instituted.

1.1 Significance of Internal Waste Management

Internal management of the wastes generated by the laboratories and testing activities at the Center will have considerable influence over the ultimate toxicity and hazardous nature of the residues. As an ancillary consequence, cost of handling and difficulty in disposing of the final waste product may increased significantly. There may be a synergistic increase in the toxicity or hazards due to mixing of two chemical wastes (which may not be considered hazardous separately). There is also the opportunity for diminishing the pollution impacts.

An opportunity may be available to neutralize the waste acids by mixing (properly) with waste alkaline substances also on-site.

Perhaps the most critical consequence of mixing non-interactive waste streams is the increase in volume of the overall waste which will be defined as hazardous in the statutory framework. A small concentration (.1 ppm) of cyanides or arsenic in the mixed conglomerate will be sufficient to render the total material 'hazardous' by regulation. Of greater importance to the Energy Technology Center is the presence of any organic substance with a calculated human LD₅₀ (Lethal Dose 50 Percent Kill) less than 800 mg/kg in concentrations which may be as low as .04 mg/l depending on the toxicity. Some organic substances with these characteristics should be eliminated entirely from the complex.

The statutory 'hazardous classification' places constraints and special conditions on storage, transfer, transport and disposal of waste material. Consequently, a well-conceived policy for management of the variety of wastes streams generated at the Pittsburgh Energy Technology Center is necessary. Segregation and control at the generating locale can have a dominant effect on reducing hazards and costs.

Costs will not be substantially reduced in the processing of laboratory wastes due to the relatively small quantities to be processed. Classifying all of these wastes as 'hazardous' and proceeding according to the regulations can be a satisfactory management policy for this facet of the operations. The important parameter is proper handling and storage of the laboratory wastes to protect personnel exposed to the hazards (high toxicity chemicals, violent reactions and explosions). However, there is a substantial volume of spent solvents, waste oils and flammable liquids in addition to contaminated liquids from

housekeeping and cleaning procedures. Periodic maintenance on test reactor vessels and storage tanks are also a source of relatively high volume residues which will exhibit the hazardous characteristics. Some cost savings may be realized with implementation of a management plan for these intermediate waste streams.

The greatest emphasis should be focused on developing the necessary data regarding the hazardous characteristics of the potentially gigantic (by volume) waste streams generated by pilot plant, demonstration units, and full-scale production facilities for conversion of coal to more convenient energy forms. Some process changes or pretreatment mechanisms may be necessary to avoid generating 'hazardous' wastes. There is an urgent need for directed research in this field.

1.2 Classification of Hazardous Wastes

The Resource Conservation Recovery Act of 1976 (P.L. 94-580) sets the criteria for designating hazardous wastes (Section 3001) within the context of the legislation. There are some special circumstances and exclusions from the Act. See Figure 1-2 for the protocol which can be used to determine the applicability of the federal legislation.

Two mechanisms are employed to define the wastes. Listing of particular chemical compounds, chemicals, and waste streams from listed processes are considered hazardous (statutory definition) simply by their presence on the list. The other basis for classification is based on the substance characteristics as stated in the regulation:

"due to its intrinsic characteristics, properties, and potential hazard to human health or the environment when improperly managed, regardless of whether any individual waste is in fact managed safely." (4)

Figure 1-2 Protocol for Determination of Applicability of RCRA.

Another path may be used to declare a waste stream 'hazardous'- it can be placed in this category at the request of the Governor of a state or commonwealth, or an individual. This is the most likely route for coal conversion wastes to be included on the hazardous waste list. At the present time, utility wastes (flyash and fine gas desulfurization sludges) have been placed in a special category while research is conducted to make a determination. The fate of coal conversion wastes is in an ambiguous position and can be decided either way. Need for clarification is critical as the costs of treatment and disposal of massive volumes of materials can be effected in orders of magnitude. EPRI (Electric Power Research Institute) estimates the cost of disposing of one ton of wastes may rise to ninety dollars as compared to the present costs ranging from two to nine dollars. (6)

The characteristics selected to define a hazardous waste are:

(1) ignitability; (2) reactivity; (3) corrosivity; (4) infectivity; (6) radioactivity; (7) and toxicity (using a toxicant extraction procedure to simulate the leaching of pollutants from the material when it is deposited in an open dump with municipal refuse). Toxicity is assessed with regard to the migration of heavy metals, mutagenicity of the simulated leachate, tendency to bioaccumulate, and the potential toxicity of organic fractions. Infectivity and radioactivity may not be relevant to the wastes generated at the Pittsburgh Energy Technology Center. Coal wastes and flyash have exhibited radioactivity. The possibility of radioactive elements in the wastes must be researched before this parameter can be dismissed from consideration. See Figure 1-1 for the protocol that will be useful in making the necessary classification.

1.3 Ignitable Waste

1.3.1 Definition

A solid waste is an ignitable waste (hazardous due to this characteristic) if a representative sample of that waste:

- A. (1) has a flash point less than 60°C (140°F) in the liquid state,
(2) or under conditions incident to the management of the waste is liable to cause fires through friction, absorption of moisture, spontaneous chemical changes, or retained heat,
(3) or when ignited burns so vigorously and persistently as to create a hazard.
- B. is a compressed gas as defined flammable in the federal DOT regulations 49 CFR 173.300.
- C. is an oxidizer as defined in federal DOT regulations i.e.

"is a substance such as chlorate, permanganate, peroxide, nitrocarbo nitrate, or a nitrate that yields oxygen readily to stimulate combustion." (7)

1.3.2 Overview

This hazard parameter (ignitable waste) must be considered with respect to pure substances (liquids), mixed chemical wastes in the liquid state with ignitable fractions, solid state of combustible wastes, and ignitable chemicals in an aqueous solution. For the relatively pure materials listed as laboratory wastes in Table 2-1, a determination is not difficult. The flash point value of the particular substance is sufficient to classify the waste as hazardous. Thirty three of the listed laboratory waste chemicals were classified in this manner. Mixtures of the flammable liquids would also fall in this category. Most

of the ignitable liquid wastes generated in the Pittsburgh Energy Technology Center can be mixed without reactions.

Most of the bulk wastes are mixed materials both in make-up and state. Semi-solids (sludges) and solids (flyash and slag) will make up the major portion of the waste streams generated by the pilot plant operations and proposed demonstration facilities for coal conversion projects. Waste water treatment plant residues will not be ignitable wastes as defined by the statutes. Tank residues from intermediate process materials storage may be ignitable. There is need for research and investigation to make this determination.

Analytical measurement of the chemical fraction of mixed waste streams is one approach in assessing the ignitable characteristics of the material. However, most of the ignitable wastes are organic in nature which will influence the cost of analysis. After an analysis is made, the concentrations of the flammable fractions can be assessed to provide some data for classification. A viable procedure for classifying the wastes produced at the technology center would include:

- a. Checking the value of the flash point of the pure chemical from the available handbooks.
- b. Determination of the concentration ranges of the flammable constituents in the mixed waste stream.
- c. Consider the physical state of the waste i.e. approximately two percent concentration of the critical constituent in an aqueous liquid would certainly not be an ignitable waste.
- d. Actual laboratory testing to determine the flash point of the mixed material. If the waste stream is non-hazardous in every other respect, it would be advisable to perform the recommended tests.

However, toxic organic fractions may be the critical factor in classification of the waste as hazardous. More research is needed to identify the kinetics of ignitability of substantial waste streams expected from the process activities at the Pittsburgh Energy Technology Center.

There are two approaches to be considered in handling of ignitable materials after they become wastes. One is to segregate the waste streams into ignitable and non-ignitable groups. The ignitable wastes would then be processed as a hazardous substance during the storage, transfer, transport and disposal phases. The feasibility of this methodology is highly dependent on quantities generated. Regulations are very specific with regard to handling and packing the materials for transport. Disposal facilities (incinerators) are available for proper destruction of this material. Installation of a small (50 gallons per hour) liquid waste incineration may be economically feasible. Cost is the factor for comparing this alternative to off-site burning of the ignitable wastes.

If the flammable (in the pure state) substance can be agglomerated into another waste stream (optimally with a fine particle, chemically inert waste such as flyash or slag) concentrations may be reduced to the point that the waste is no longer ignitable. The hazard of ignitability may be eliminated allowing a less costly transport and disposal alternative. However, it is difficult to predict all possible circumstances when handling and disposing of the treated waste to assure complete control at all times. This is an alternative worthy of study as the costs of transport and disposal can be reduced in orders of magnitude. Quantities to be processed will have a strong influence on the choice.

1.4 Reactive Waste

1.4.1 Definition

"A solid waste is defined as a reactive waste if it:

- A. (1) is normally unstable and readily undergoes violent chemical change but does not detonate,
 - (2) forms potentially explosive mixtures with water, or
 - (3) generates toxic fumes when mixed with water, or
 - (4) is a cyanide or sulfide bearing waste which might generate toxic fumes under mildly acidic or basic conditions.
- B. (1) is capable of detonation or explosive reactions, but requires a strong initiating source or must be heated under confinement before initiation takes place, or
 - (2) which reacts explosively with water.
- C. is readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
- D. is a forbidden explosive as defined by DOT regulation 49 CFR 173.51, 173.53, or 173.58" (4)

A mixed waste can be tested to determine its reactivity by one of two tests recommend in the regulations: an Explosion Temperature Test is described in Appendix 'A' of the regulations, and a Thermal Stability Test described in the federal DOT regulation.

1.4.2 Overview

The expected critical parameter which will place the residual into the statutory hazardous classification is either the toxic organic fraction or the ignitable nature of the material. There are some compounds listed in Table 2-1 which can be classified as reactive based on the character of the pure material. A few of the laboratory waste

chemicals are oxidizers and should be segregated throughout the handling and disposal operations. The ethers (when aged) may form unstable peroxides which become highly explosive with initiation of the blast by shock or heat. A number of the chemicals will generate toxic fumes if heated and some substances will become reactive in the presence of an oxidizer. If all other tests including ignitability are negative when assessing the hazard parameters, then it might be advisable to conduct the tests for a reactivity determination. The tests may be avoided if the general nature of the mixed waste is known.

In some cases it might be possible to assess the probability of violent reactions due to mixing of two wastes. The available literature does list some well known reactive waste classes. Table 1-1 was developed by the California Department of Health (8) and the chemical industry has accumulated a data base regarding first level reactions of various chemical wastes.

Coal conversion processes are not expected to produce reactive wastes as a consequence of the operation of pilot plant and demonstration operations. The major bulk (volume) of wastes are residues from pyrolysis or combustion processes in which the reactive fractions have gone through chemical changes. However, there is no data in the literature regarding this aspect of the waste characteristics. Some study should be devoted to ascertaining the accuracy of the intuitive reasoning utilized.

While it may be advantageous to keep any reactive wastes segregated throughout the research process or pilot plant study stage - there are very few disposal services in existence that are able to properly handle this type of waste stream. Unit costs would be extremely high (a minimum cost regardless of volume would be assessed to cover potential risks).

<u>Group 1-A</u> Acetylene sludge Alkaline caustic liquids Alkaline cleaner Alkaline corrosive liquids Alkaline corrosive battery fluid Caustic wastewater Lime sludge and other corrosive alkalies Lime wastewater Lime and water Spent caustic	<u>Group 1-B</u> Acid sludge Acid and water Battery acid Chemical cleaners Electrolyte, acid Etching acid liquid or solvent Liquid cleaning compounds Pickling liquor and other corrosive acids Spent acid Spent mixed acid Spent sulfuric acid
<u>Potential consequences:</u> Heat generation, violent reaction.	
<u>Group 2-A</u> Asbestos waste and other toxic wastes Beryllium wastes Unrinsed pesticide containers Waste pesticides	<u>Group 2-B</u> Cleaning solvents Data processing liquid Obsolete explosives Petroleum wastes Refinery waste Retrograde explosives Solvents Waste oil and other flammable explosive wastes
<u>Potential consequences:</u> Release of toxic substances in case of fire or explosion.	
<u>Group 3-A</u> Aluminum Sodium Beryllium Magnesium Lithium Potassium Calcium Zinc powder and other reactive metals and metal hydrides	<u>Group 3-B</u> Any waste in Group 1-A or 1-B
<u>Potential consequences:</u> Fire or explosion; generation of flammable hydrogen gas.	
Many wastes, when mixed with others at a hazardous waste facility can potentially produce adverse human health and environmental effects through means such as the following: (1) heat generation, (2) violent reaction, (3) release of toxic fumes and gases as a result of mixing, (4) release of toxic substances in case of fire or explosion, (5) fire or explosion, and (6) generation of flammable or toxic gases.	

Table 1-1 Potential Consequences of Mixing Incompatible Wastes (8)

<u>Group 4-A</u> Alcohols Water	<u>Group 4-B</u> Any concentrated waste in Groups 1-A and 1-B Calcium Lithium Potassium Metal hydrides Sodium SO_2Cl_2 , SOCl_2 , PCl_3 , CH_3SiCl_3 , and other water-reactives
<u>Potential consequences:</u> Fire, explosion, or heat generation; generation of flammable or toxic gases.	
<u>Group 5-A</u> Alcohols Aldehydes Halogenated hydrocarbons Nitrated hydrocarbons and other reactive organic compounds Unsaturated hydrocarbons	<u>Group 5-B</u> Concentrated Group 1-A or 1-B wastes Group 3-A wastes
<u>Potential consequences:</u> Fire, explosion or violent reaction.	
<u>Group 6-A</u> Spent cyanide and sulfide solutions	<u>Group 6-B</u> Group 1-B wastes
<u>Potential consequences:</u> Generation of toxic hydrogen cyanide or hydrogen sulfide gas.	
<u>Group 7-A</u> Chlorates and other strong oxidizers Chlorine Chlorites Chromic Acid Hypochlorites Nitrates Nitric acid, fuming Perchlorates Permanganates Peroxides	<u>Group 7-B</u> Acetic acid and other organic acids Concentrated mineral acids Group 2-B wastes Group 3-A wastes Group 5-A wastes and other flammable and combustible wastes
<u>Potential consequences:</u> Fire, explosion, or violent reaction.	
Above is a summary list of potentially incompatible waste materials or components and the adverse consequences resulting from mixing of waste in one group with waste in another group.	

Table 1-1 Potential Consequences of Mixing Incompatible Wastes (contd)

Proper internal control and handling of reactive wastes would be difficult without highly trained, careful personnel at the Technology Center. Reactive (very highly reactive) materials should be avoided if possible, and substitutes used in the research activities. If there are no alternative materials available to meet project objectives, a safety officer should direct the use of the substances of concern. Table 2-1 identifies some of the reported waste chemicals that are classified in this category.

There is a dearth of specific information on the reactivity of second order (two mixed chemicals) and practically no data exists on waste mixtures of more than two chemical substances. A study should be implemented to determine if a special program is needed to insure the safety of Technology Center personnel during internal handling of laboratory wastes.

Although there may be reactive components in the wastes streams that are generated during the pilot plant and demonstration phase of the ongoing projects, the concentrations reported (which may be trace amounts) lead to the conclusion that they are not reactive wastes. Accumulated residues in the storage tanks and reactors may be classified as reactive substances depending on the physical and chemical characteristics of the specific materials. There is a need for study to characterize them with some accuracy.

1.5 Corrosive Waste

1.5.1 Definition

A waste defined in this category is corrosive if a representative sample of the waste is:

- A. aqueous (liquid with water) and has a pH less than or equal

to 3.0 or greater than or equal to 12.0.

B. a substance which has a corrosion rate greater than 0.25 inches per year on SAE 1020 steel at a temperature of 130°F.

1.5.2 Overview

Only the first part of the above definition has relevance to the activities at the Pittsburgh Energy Technology Center. The corrosion rate when steel is exposed to the substance is necessary to develop specifications for the containers utilized in storing and transporting the corrosive materials. The high and low pH aqueous solutions can be injurious to any exposed skin tissue and especially to the eyes. Proper occupational safety precautions must be taken in the handling of the corrosive materials in all phases of handling and disposal. Handling of acids and bases must be controlled and internal personnel must be trained to avoid serious injuries and prevent accidents. Laboratory chemicals will always include some sulfuric and hydrochloric acids, as well as sodium hydroxide and ammonium hydroxide which are within the statutory definition of a hazardous waste.

Concern for the proper pretreatment and disposal of this waste category is based on the higher solubility of toxic heavy metal ions at low and high pH values in aqueous solutions. Possible release and migration of toxic metals to potable water supplies and thereby to humans with concomitant health effects is of utmost concern. Consequently, controlled handling and disposal of spent acids and alkali is required.

There may be some opportunity to practice on-site neutralization of the corrosive wastes when both alkaline and acidic materials are available as wastes. A careful analysis is needed to determine feasibility

as the chemical reaction is quite strong, and fumes generated during the neutralization process must be controlled. Large volumes of sludge (approximately equal to the original acid volume) are one consequence of the treatment. In full scale coal conversion operations it may be feasible to construct and operate an on-site neutralization plant if there are sufficient quantities of both waste available. A viable sludge disposal scheme is also needed before on-site treatment can become practical. Some research is needed in this area.

1.6 Infectious Wastes

1.6.1 Definition

The regulations address the question of infectivity (pathogenicity) by listing the types of activities that will generate wastes which contain pathogenic agents. In addition, specific bacteria and viruses are listed. Covered in this category are hospitals, surgeries, veterinary clinics, etc.

1.6.2 Overview

In the perspective of coal conversion facilities and energy technology centers, this sub-classification would not appear to be relevant. Normal precautionary operating procedures used in the daily operation of the clinic or medical facility (contained in a large technology center) should be sufficient to eliminate any applicability of this category.

Other regulations will cover the handling of sanitary wastes at the site. All precautions to protect the public health (internal and external to the source) are taken in response to state and local health department requirements.

1.7 Radioactive Wastes

1.7.1 Definition

A solid waste is a hazardous waste if it is not covered by the Atomic Energy Act of 1954 and if a representative sample of the waste has either of the following properties:

- (1) The average radium-226 concentration exceeds 5 picocuries per gram for solid wastes or 50 picocuries (radium-226 and radium-228 combined) per liter of liquid wastes; as determined by specific tests in the appendix of the regulations.
- (2) The total radium-226 activity equals or exceeds 10 microcuries for any single discrete source. (4)

1.7.2 Overview

The radioactive characteristic does not appear to apply to any laboratory wastes reported in the inventory (9). If radioactive isotopes are used as tracer elements in the research activity at the energy technology center, it would be included in the wastes covered by the Atomic Energy Act of 1954 and not subject to RCRA.

Some references in the literature report radioactive nucleides in wastes generated by coal cleaning plants and coal-fired power plants. An adequate data base is not available at this time to make a judgement on the relevancy of radioactive wastes to coal conversion processes. It would appear that the characteristics of the coal would be influential in effecting the radioactivity level in discharges to air, water, or land receptors. Some study would be helpful in obtaining the data base needed to make informed decisions, but should be considered (at this stage) as a low priority.

1.8 Toxic Wastes

1.8.1 Definition

A. A solid waste is a hazardous waste if an extract, obtained by applying the prescribed toxicant extraction procedure (TEP) to a representative sample of the waste, has concentrations of a contaminant that exceeds any concentrations listed in Table 1-2.

B. In addition to wastes subjected to the toxicant extraction procedure, specific waste streams and residues from specific processes listed in the regulations are considered hazardous by administrative decision of the Administrator of the U.S. Environmental Protection Agency.

C. In addition to the above, a list of controlled chemicals which are considered priority pollutants are considered hazardous by administrative decision as above.

D. In addition to all of the above, a list of substances classified by the U.S. Department of Transportation as Poison A, Poison B, or ORM-A are also classified as hazardous.

At this point in time, only the substances listed in the Interim Primary Drinking Water Standards are considered to determine a yes/no

toxicity hazard rating. The Environmental Protection Agency is considering the application of the Water Quality Criteria (under the Clean Water Act) as a basis for setting other extract substance levels for the hazardous waste definition under this heading. Table 1-3 lists other substances or parameters which may become applicable when considering toxicity.

The application of interim primary drinking water standards to the concentrations (of the substances listed) in the toxicant extract is all

CONTAMINANT:	Extract level, milligrams per liter
Arsenic.....	0.50
Barium.....	10.0
Cadmium.....	0.10
Chromium.....	0.50
Lead.....	0.50
Mercury.....	0.02
Selenium.....	0.10
Silver.....	0.50
Endrin (Pesticide).....	0.002
Lindane (Pesticide).....	0.040
Methoxychlor (Chlorinated Biphenyl).....	1.0
Toxaphene (Pesticide).....	0.050
2,4-D (Pesticide).....	1.0
2,4,5-TP (Pesticide).....	0.10

Table 1-2. Extract Levels of Heavy Metals & Pesticides-Hazardous Wastes
Classification. Ten Times Primary Drinking Water Standards.(4)

CONTAMINANT:

Extract level,
milligrams per liter

Chloride	2500
Copper.....	10
Foaming Agents.....	5
Hydrogen Sulfide.....	0.5
Iron.....	3
Manganese.....	0.5
Sulfate.....	2500
Total Dissolved Solids.....	5000
Zinc.....	50
Color.....	150 Color Units
Odor.....	30 TO Numbers
pH	6.5 - 8.5

Table 1-3 Extract Levels of Heavy Metals and Other Water Quality
Parameters-Hazardous Wastes Classification. Ten Times
Secondary Drinking Water Standards. (4)

that is required for determining whether a waste (which is not specifically listed in the statutes) is to be classified as hazardous due to its toxicity.

1.8.2 Overview (Toxicity-Trace Metals)

Most laboratory chemicals (or waste chemicals resulting from laboratory activity) fall into two main categories of statutory hazardous wastes. They are either inorganic chemicals with toxic metals fractions or organic wastes which are toxic to humans, plants and animals. Because the residues are mainly coal derived chemicals or similar in nature to coal fractions, approximately ninety percent (90%) are organic. Precedence indicates that this group of wastes will be classified as 'hazardous' by administrative decision based on the type of generating activity (similar to coking operations). Many of the laboratory toxic wastes are highly flammable and will be regulated under the ignitable wastes section of the regulations. The vast majority (by bulk) of the laboratory wastes reported will not be considered toxic by virtue of release of toxic heavy metal ions.

A reasonable policy for handling and disposal of the laboratory residues at the Pittsburgh Energy Technology Center is to declare all of the wastes as being hazardous (by legislative definition). This would be feasible except in the case of some non-hazardous wastes which may constitute a large proportion (by volume) of the total wastes generated on the site. Of critical importance in the viability of the above policy is the miscellaneous waste group reported as flyash, slag, lime sludge, and wastewater. They appear to make up eighty percent (80%) of the total volume of wastes reported in the inventory. The wastes listed in this

group are of undeterminable classification with the data available at the present time. More study is required to determine the characteristics of this particular group of materials. Expenses incurred in handling and disposal of these residues will have a dominant influence on the overall costs of operation. Consequently, a program for developing the data needed to characterize (with regard to the statutory classification of hazardous wastes) this group of wastes is of utmost importance.

Residues generated by pilot and demonstration plants will mainly be in the form of flyash, char, wastewater treatment plant sludges and some water treatment chemicals. The main bulk of the wastes will fall into the indeterminate category. Of greatest concern will be the possible listing of the residues as hazardous wastes by administrative decision due to the type of generating activity. The flyash and chars will be classified as 'hazardous' due to the heavy metal ions which may leach from them when disposed of on land. There is some potential for the application of the hazardous waste classification on all coal conversion plant residues. A cost-effective handling and disposal program will be imperative, but it must be based on data which is not available at this point in time. More research and study is needed if reasonable handling schemes are to be formulated.

1.9 Other Hazardous Characteristics

In addition to toxic heavy metal fractions which may be released from the residues with resulting migration to potable water supplies, the hazard characteristics of mutagenicity, bioaccumulation (by aquatic organisms, animal, plants, and man), and toxic organic substances must be considered in the statutory definition of a hazardous waste. The testing

procedures listed in the regulations are applied to the toxicant extract which is induced by prescribed sample preparation methods. Perhaps the most significant aspect of the methodology is the direct inclusion of the liquid fraction of the residues (separated by pressure filtration or centrifugation). This supernatant or filtrate will, in the case of the laboratory chemicals, be made up of the chemical itself (if any portion of the waste is in the liquid state). Concentrations of organic substances as high as one hundred percent of the waste may be considered to be the toxicant extract. Dependence on low concentrations to exhibit non-hazardous characteristics with regard to mutagenicity or bioaccumulation is questionable. In the case of mutagenicity and bioaccumulation a threshold which will give negative results from the prescribed tests may not exist. A concentration of one part per million of toxic organic substances is sufficient to classify the residue in the 'hazardous' category.

1.9.1 Mutagenicity

1.9.1.1 Definition

A waste stream is defined as mutagenic if (a) the substance contains at least one mg/l of any compound found on the Controlled Substance List for mutagenic activity. This list is presented as Appendix IX in the proposed regulations (4) and includes thirty three chemicals.

1.9.1.2 Overview-Mutagenicity

A review of Table 2-1 reveals at least three compounds found in the laboratories at the Pittsburgh Energy Technology Center are on the list of controlled substances. The most ubiquitous substance with known mutagenic potential is benzene. This chemical may also be the largest

volume waste stream of the laboratory residues. Carbon tetrachloride appears on the list but is reported in very small quantities. Other substances reported in the inventory of laboratory chemical wastes - not on the controlled substances list - are cited in the literature as mutagens and carcinogens. These are indicated in the tabulation in Table 2-1. The major mitigating circumstance regarding the mutagenic substances is that they are also highly flammable and would be classified as hazardous substances regardless of their mutagenic characteristic. Consequently, this hazard would have little influence on an overall management plan for laboratory wastes.

There is some question regarding the mutagenic activity of the high volume wastes generated by the usual activities at the Energy Technology Center. The flyash, slag and lime sludge reported is approximately 95-98 percent (by weight) of all the industrial wastes generated at the site. These materials are not characterized with regard to the trace fractions of potential mutagenic substances. Polycyclic aromatic hydrocarbon (PAH) compounds, some of which exhibit highly mutagenic activity, are found in some of the residues listed above. An administrative classification of "hazardous due to mutagenic activity" on some of the above waste streams is a distinct possibility. There is a lack of data at the present time to make an assessment of the mutagenic characteristics of energy center waste streams. A need for study is urgent as the costs of handling and disposal of the materials in this category will have a dominant effect on overall expenses. Due to the volumes generated, disposal costs may be increased by order of one or two magnitudes (10-100 times).

It is even more imperative to develop some data on the process wastes that will result from demonstration and full size coal conversion facilities. The design of acceptable disposal techniques for the solid waste streams originating from coal conversion processes and sludges resulting from wastewater treatment is of primary concern in the feasibility of the alternative processes. Costs of handling and disposal can dictate the need for pretreatment or process changes in the entire operation.

1.9.2 Bioaccumulation

1.9.2.1 Definition

A waste stream will be considered bioaccumulative (and therefore 'hazardous') if a positive result is obtained in a prescribed Bioaccumulation Potential Test. Reverse-phase liquid chromatography techniques are utilized in the measurement of octanol/water partition coefficients which exhibit a specific correlation to bioconcentration of substances in fish. Compounds (toxicant extract) with a P log coefficient greater than or equal to 3.5 are considered bioaccumulative if the compound is not biodegradable. A biodegradation assay is used to finally rule out bioaccumulation of the suspect (positive) substance before it can accumulate.

1.9.2.2 Overview-Bioaccumulation

Most of the bioaccumulative compounds identified in the literature are high molecular weight polynuclear aromatic hydrocarbons and pesticides. (11) This hazard classification is not expected to be a critical problem in the handling of laboratory wastes at the facility. Most of the substances that may fall in this category will exhibit two other hazard characteristics i.e. ignitability and toxic organic fraction. Carbon tetrachloride would be a chemical of concern in this context. Some consideration for the elimination of carbon tetrachloride should be studied.

Demonstration project and coal conversion waste streams have not been researched to any extent in the perspective of generating bioaccumulative substances. Wastewater treatment plant residues may have some bioaccumulation potential and should be examined to determine the general characteristics of this waste stream due to the potentially large volumes of wastes that may be generated. Twenty thousand gallons per day of a biologically active sludge are produced by the wastewater treatment plant of the coke works of United States Steel Corporation at Clairton. (11) There is a dire need for research in this area.

1.9.3 Toxic Organic Fraction

1.9.3.1 Definition

The toxicant extract must be assessed for any organic substance which has a calculated human LD_{50} (lethal dose resulting in 50 percent kill) less than 800 mg/kg at a concentration (in the extract) in mg/l greater than or equal to 0.35 times its LD_{50} value expressed in units of mg/kg. Table 2-1 lists the laboratory waste chemicals that fall into this class.

1.9.3.2 Overview-Toxic Organic Fraction

Some laboratory wastes reported in the inventory (9) fall into the hazardous category by virtue of their toxicity as measured by the oral lethal dose (LD_{50}) for rats. On the basis of a calculated LD_{50} = 800 mg/kg for humans (the methodology for calculated values is $LD_{50} = 0.16 \times LD_{50}(\text{rats})$). Table 2-1 lists the allowable concentrations (in the toxicant extract) of the various organic chemicals which fall into this classification. Of concern is the pure chemical in the liquid form which becomes an integral portion of the toxicant extract.

On the basis of listing of the substances (by DOT) as a poison i.e. phenol (which has an allowable concentration of 23 mg/l as calculated by the methodology listed in the regulations), all of the non-listed organic compounds reported at the facility associated with lower allowable concentrations should be of great concern in the occupational health perspective. Twelve waste chemicals listed in Table 2-1 should be handled as highly toxic substances by this criterion. Great care must be taken in the handling of acetonitrile, phenyl mercaptans, benzyl mercaptans, benzyl isothiourea hydrochloride, dicyclopentadiene, dimethyl gloxamine, rhodanine, and quinoline. Dimethylene triamine appears to be an especially potent poison.

Process wastes generated by the individual test projects usually implemented at the Pittsburgh Energy Technology Center cannot be categorized from the present data base. Quinolines have been reported in the literature in concentrations up to 100 mg/l (10). The presence of other toxic organic chemicals are also likely as the process wastes streams contain most of the coal chemicals listed in the inventory. The fate of the various organic fractions produced (coal chemicals derived by the conversion process) is unknown. Considerable research efforts will be needed to determine the possible environmental impacts of the high volume waste streams (flyash, char, raw wastewater, and wastewater treatment plant residues).

1.10 Pollutational Impacts

1.10.1 Air Pollution

Environmental impacts from gaseous emissions at the Energy Technology Center are divided into two classes i.e. internal work space and the external environment. Discharges of fumes and vapors must be viewed in the context of occupational health and safety. All precautionary measures covering toxic gaseous emissions are dictated by OSHA (U.S. Occupational Safety and Health Administration) with implementation in the laboratory design and construction. State building licences cover the fire safety elements of the facility. This aspect is not in the purview of this study project. Exhaust ducts and hoods over working areas in the laboratory are usually contained in the original laboratory design. Specific laboratory procedures in which toxic fumes are generated are well known and incorporated in standard procedures established by science management.

Fume pretreatment prior to release to the unconfined environment may be a requirement established by the rules and regulations promulgated by OSHA, EPA or the cognizant state authority (PennDER-Occupational Health). General emissions to the air environment are covered by regulations of the state (PennDER-Bureau of Air Quality Monitoring) or the county (Allegheny County Health Department-Bureau of Air Pollution). In general, the low volume releases of toxic gases to the atmosphere from laboratory operations have a very low enforcement priority at all of the aforementioned agencies. At the present time, this particular environmental impact does not appear to present a problem that must be addressed by the Pittsburgh Energy Technology Center.

The potential stack emissions resulting from pilot plant operations are of undetermined significance due to the relatively low volume releases

of exhaust gases with specifically controlled environmental pollutants (particulates, sulfur oxides, nitrogen oxides). Hydrocarbon releases may be of concern with new regulations that are now being promulgated. Demonstration scale units and full scale coal conversion plants will of necessity require flue gas emission control (where there are emissions) as part of the overall plant design. This aspect is beyond the scope of this project.

Fugitive dusts and vapors must be controlled by existing enforcement regulations in the operation of on-site and off-site waste processing and disposal facilities. In the case of incineration, all of the units processing hazardous wastes (without exception) will need stack gas cleaning elements (wet scrubbers or baghouses) due to the wide spectrum of toxic and odorous gas fumes which result from the combustion of these wastes. Concomitant with wet scrubbing, the cleaning water will need pretreatment prior to discharge.

1.10.2 Water Pollution

Potential environmental impacts from direct discharge of spent laboratory chemicals are dependent on waste quantities, concentrations, and characteristics of the receiving medium. Phenols will combine with disinfecting chlorine used in water treatment plants to result in compounds which have taste and odor impacts on the treated water at extremely low concentrations. Little is known of the material transport mechanisms, consequently there is a risk of slugs (with little dilution) of toxic chemicals reaching animal or man. Aquatic organisms - especially in the embryonic stage of their growth - are susceptible to toxic effects (at low concentrations) of many of the listed laboratory chemical wastes.

A productive stream can be rendered sterile if particularly potent chemical wastes were released.

Of concern in the migration of laboratory chemical wastes is their high toxicity and concentrations, but the quantities generated at the Center afford opportunities for the environment to buffer the impacts. The usual migration dynamics indicate a slow release (when the chemical migrates indirectly to the water) and tremendous dilution ratios will attenuate the environmental insults to the extent that they will be too small to be measured. Effluent limits and water quality criteria will not be exceeded if direct discharges to the receiving stream are avoided.

Large volume wastes produced at the Energy Technology Center evoke a different set of impacts. Although the wastes may not be highly toxic and concentrations of the toxic fraction may be low, the consequences of direct placement in the water are of great concern. Deposition of lime sludge (which may be in the chemical form of calcium sulfite) in the stream may radically change the DO of the water. Consequences can include the elimination of most of the aquatic biota. The calcium sulfite will be oxygen demanding and cause a sag in the dissolved oxygen required for survival by the fish in the stream. Water quality for drinking, recreation, industrial and other uses can be seriously effected.

Flyash and slag may leach toxic heavy metal ions which in the long term will cause detrimental health effects in plants, animals, aquatic biota and man. As stated previously, the characteristics (chemical and physical) of the high volume, relatively non-toxic wastes are not documented sufficiently to predict all of the potential pollutional impacts. Placement of large masses of very fine particle wastes will act as a siltation blanket (although the material may not release heavy metals)

to cover the bottom benthic organisms that are necessary to maintain the aquatic ecology of the receiving stream.

1.10.3 Land Contamination

Impacts from the disposal of wastes on land are assessed in the context of ground and surface waters. Using this perspective, any assessment must include chemical nature of the wastes, hydrogeological and topographical features of the disposal site, design and operation of this facility.

Chemical characteristics of the laboratory chemical wastes are known in terms of the pure substances. Many of the materials are toxic, corrosive, and/or flammable. The flammable wastes may be highly volatile and present some fume problems. Actual handling of the materials at the land disposal location must be carried out with the safety of the operating personnel as the primary objective. Potential danger from fires or explosions must be minimized. Hazardous nature of the various wastes must be identified in order to safely handle them in the disposal phase of management.

Leaching of toxic fraction are a concern but the hydrogeological features of the disposal site and the design can attenuate and in some instances actually prevent migration of the substances of concern. The very small (relatively) volumes involved would preclude serious consequences of pollution from land disposal as the soils have some clean-up capabilities. However, legally the operation will be subject to many stringent requirements which must be carefully considered in order to make this alternative feasible. More study is needed to determine the material transport kinetics involved in toxic waste migration from land management.

Fly ash, slag, flue gas desulfurization sludges and coal cleaning wastes have been managed by land disposal methods for a long time. The operations have been successful where engineered sites were used. In most locations, fly ash and slag have not caused severe environmental problems to the water medium, but this appears to be dependent on the chemical nature of the particular waste. FGD sludges have been pretreated to prevent stabilization problems. Coal cleaning residues were successfully managed at locations which were engineered properly. Due to the projected volumes to be generated by full-scale coal conversion facilities and demonstration plants, environmental pollution problems are likely in this activity. Potential environmental impacts due to storage (on land) of vast quantities of wastes with soluble heavy metal fractions and the costs of disposing of large masses of materials are factors of concern.

Site selection (for minimal environmental pollution) is the main mechanism for pollution prevention in designing the disposal site. A properly (hydrogeological and topographical) selected location is the one most effective method for minimization of environmental insults. Effective surface water diversion structures to minimize infiltration to the deposited solid wastes is necessary to reduce or even prevent (by precluding saturation-field capacity of the wastes) leachate formation and resulting migration from the disposal area. Daily operational techniques (efficient compaction) and effective maintenance of the structures, as well as designed grading will also effect the potential impacts from the operation. The above is essential for viable land disposal of the high volumes of wastes usually generated at coal conversion facilities.

Pretreatment (stabilization or solidification) of some of the residues, especially the sludges, may be necessary to minimize, attenuate or

prevent leaching of toxic heavy metal ions from the high volume waste streams. As the federal regulations are now proposed, stabilization will be mandatory in the case of all liquid and semi-solid hazardous wastes.

1.11 Legislation and Regulations

Three, and possibly four, tiers of governmental agencies are now involved in enforcement of environmental controls with regard to transport, processing and disposal of solid wastes normally generated at the Pittsburgh Energy Technology Center. Table 1-4 is a tabular presentation of the political entities involved and the sphere of operations for each category. The following presentation will describe the relevant regulations and enforcement agency policy and procedures that are followed at the present time.

1.11.1 Local Requirements

At the present time, there are no local ordinances on the books to control the types of wastes generated at the Pittsburgh Energy Technology Center. Local statutes do exist to cover storage and collection of municipal refuse. The local fire marshal may have some authority to dictate safety requirements for handling and storage of flammable products and ignitable wastes generated at the facility. OSHA regulations which are more detailed and stringent may supercede the marshall's authority. State police permits may be required for any buried storage tanks containing flammable substances.

	BOROUGH OR TOWNSHIP	ALLEGHENY COUNTY	COMMONWEALTH OF PENNSYLVANIA	FEDERAL U.S. ENVIRONMENTAL PROT. AGENCY
GENERATOR	Storage and/ or Collection Ordinance (for refuse only)		Storage Regulations-on site Identification of Industrial Waste Characteristics. Chapter 75 (Act 241-S.W. Mgt. Act)	
TRANSPORTER	Licensing of Transport Vehicle (fee only). Some functional regulations i.e. a covered body is required (municipal refuse only) <u>VEHICLE LICENSE</u>	Licensing and Registration of Transport Vehicle. (fee only) Check compliance with state regulations. All liquid and solid waste carriers require licensing <u>VEHICLE LICENSE</u>	General Requirements i.e. Proper vehicle design for industrial wastes-Chapter 75 State P.W.C. Licensing-limitation on hauling in restricted areas.	U.S. DOT regulations cover container specifications 49 CFR Subchapter C. Vehicle spec. i.e. stainless steel tanks for acid, safety design for flammables, etc. Warning signs on vehicles. Partial Manifest System.
TREATMENT & PROCESSING	Building and Occupancy Permits. Zoning variance if necessary <u>BUILDING PERMIT</u>	Delegation of Authority from Commonwealth to County for inspections and monitoring.	Industrial Waste Permit is required if there are any water discharges or impoundments from the BSAQM (PennDER). A Solid Waste Processing Permit is needed. <u>I.W. & S.W. PERMITS</u>	NPDES permit from EPA is required for any water discharges. May need a permit from Corp of Engrs or Coast Guard in case of oil processing. <u>NPDES PERMIT</u>
INCINERATION	Building and Occupancy Permits. Zoning variance if necessary. <u>BUILDING PERMIT</u>	Delegation of Authority by Commonwealth (PennDER) to County for inspection and enforcement. ACHD Air Pollution Control Bureau Permit for prototype which includes a performance test after installation. Article XVIII (County Regulation) <u>FACILITY PERMIT</u>	Authority Delegated to County by PennDER. (BSAQM) by renewable contract. State incinerator permit is required (County will monitor performance tests). Clean Air Act <u>INCINERATOR PERMIT</u> <u>EFFLUENT DISCHARGE PERMIT (Water)</u>	Primacy given to Commonwealth by EPA for approved plan. EPA acts to enforce Clean Air Act if other agencies are not effective.
LAND DISPOSAL	Construction or Occupancy Permit. Grading Ordinance may apply. Zoning variance may be required <u>OCCUPANCY PERMIT</u>	Delegation of Authority by Commonwealth (PennDER) to County (by contract) for inspection and enforcement. County disposal site permit is required. <u>DISPOSAL SITE PERMIT</u>	Act 241 (Chap. 75 Regulations) Div. SWM-PennDER reviews design. State S.W. Permit is required. If water discharge must be treated I.W. Permit is needed. Dams & Encroachment Permit may be required for impoundments. Soil Erosion & Sedimentation Plan must be app'd. <u>S.W. PERMIT I.W. PERMIT</u> <u>DAMS & ENCROACHMENT PERMIT</u>	Primacy given to Commonwealth. NPDES permit is required for treatment plant discharges. <u>NPDES PERMIT</u>

Table 1-4 Institutional Framework for Environmental Control Enforcement in 1979 (Prior to RCRA Implementation)

The Solid Waste Management Act of 1968 (Pennsylvania Act 241) mandates local involvement in control of industrial and hazardous wastes. Interpretation of this clause of the Act implies responsibility of municipalities to collect and dispose of industrial wastes safely, if the generator fails to comply with the covering statutes. This authorization has not been challenged in the courts, nor has any local government chosen to carry the burden of collection, transport and disposal of industrial wastes produced within its borders.

Federal legislation (Resource Conservation and Recovery Act-P.L. 94-580) has preempted both state and local institutions with regard to proper management of solid wastes. Primacy for enforcement of federally approved regulations will be taken by the Commonwealth within eighteen months of promulgation of the federal statutes. Local involvement will be limited to issuance of building and occupancy permits for processing facilities, zoning variances where needed, and grading restrictions in the case of land disposal operations. Special use permits may be required if specifically indicated in the local zoning ordinance.

1.11.2 Environmental Pollution Control-Allegheny County

Allegheny County's mandate to enforce environmental statutes is founded on delegation of authority by annual contract with the state. Article VIII for solid waste management, Article IX for water quality monitoring, and Article XVIII for air pollution control are the county regulations which apply to the activities at the Pittsburgh Energy Technology Center. They are the major mechanisms utilized by county personnel to enforce compliance with the statutes which are compatible with the state and federal regulations (12).

Air Pollution Control Bureau (Allegheny County Health Department) involvement covers controlling fumes and flue gas emission from the stacks and exhausts at the Center. Fugitive dusts from disposal site operations and determination of compliance capability of waste incinerators used to process the residues generated are also under the jurisdiction of this bureau.⁽¹³⁾ OSHA (federal Occupational Safety and Health Agency) is mainly concerned with the environment of the work place. The regulations are directed to controlled worker exposure and management of highly hazardous substances. Beryllium and asbestos concentration in the internal ambient air are limited to estimated safe levels with respect to injury and health effects on the operating personnel. This aspect of environmental hazards is beyond the scope of this presentation. There may be some relevant statutes (OSHA) covering the discharges of particularly hazardous substances to the atmosphere from the internal air ducting system. A new hydrocarbon release regulation, now in the process of promulgation by the county, may have some compliance requirements on the Center's laboratory and pilot plant projects.

Of some importance to any proposed management plan for solid and liquid residues generated at the Pittsburgh Energy Technology Center is the regulatory requirement of an operating permit (issued by the county) for any incinerator within the geographical bounds of the county. This permit is issued in two stages -the first stage provides for a technical design review and assessment of test data resulting from prototype unit operations which assure the incinerator's ability to comply with emission standards. After installation, the actual unit must undergo performance tests to prove that compliance. The final permit is then issued. Due to the delegation of authority by PennDEP, a state permit

is given simultaneously with the county document. In order for the PETC staff to determine full legality (at the present time) of processing and disposal of the Center's flammable wastes, two permit identification numbers are needed for documentation when off-site incineration is claimed to be the disposal method.

Liquid and solid wastes which will be processed by other techniques fall into the purview of the Solid Waste and Water Quality Monitoring Bureau (Allegheny County Health Department). Authority by annual contract has been delegated by the Commonwealth to the County. This section does not specifically issue permits for industrial waste treatment installations (PennDER issues them). If the final disposition of the waste substances will be on land within the County, a permit is needed. A concurrent technical review of proposed sites is conducted by both state and county personnel. Dual permits are issued at the same time. (14).

County personnel are used as the primary enforcement mechanism. They make periodic inspections and investigations into compliance with the relevant regulations. County regulations (Article VIII and IX) cover the requirements for management of industrial and municipal wastes. The state and county statutes are almost identical. A special vehicle license tag is required for all transport units operating in the county. This is not a control mechanism, but is used as a revenue collection procedure.

1.11.3 Environmental Control & Enforcement -Pennsylvania

The Commonwealth's activity in enforcement of pollution control derives its authority from the federal constitutional mandate to "protect the public health." State's rights primacy with respect to environmental quality is firmly established by legal precedents. Control of liquid and solid residues produced at the Energy Technology Center are monitored by three bureaus (Bureau of Air Quality Monitoring,

Bureau of Water Quality Management, and the Bureau of Solid Waste Management) of the Pennsylvania Department of Environmental Resources. Regional and central office (Harrisburg) staff are involved in review and inspection activity. Authorization for enforcement and establishment of specific criteria were by legislation, specifically by Pennsylvania's Clean Air Act, Clean Streams Law and Solid Waste Management Act.

Fugitive dusts and fumes are under the aegis of the Bureau of Air Quality Monitoring. This enforcement activity has been delegated to Allegheny County by renewable contract dependent on equal or more stringent regulations. A low priority has been placed on this phase of air quality control, consequently the state and county have expended minimal, if any, resources for enforcement of the statutes. The apparent policy of both organizations appears to be that of acting only on specific citizen's complaints.

Effluent discharges to surface and ground water are controlled by the Bureau of Water Quality Management on a regional basis. Stream monitoring is conducted by this bureau which operates an analytical laboratory in Pittsburgh. Control (and enforcement) is accomplished by implementation of a permit system (industrial waste permits,

impoundment permit, and/or dams and encroachment permit) for any waste water treatment facility, with corresponding federal NPDES (National Pollutant Discharge Elimination System) permits for the specific discharges involved. The regional water quality planner (PennDER) sets the limits on discharges using heavy metal ion concentrations, biological parameters, and water quality measurements as the criteria for the receiving stream. Additional permits from Dams & Encroachment Division (BuWQM) may be needed if the stream flow or river bed is significantly altered. If run-off character of the drainage basin is changed (by encapsulation of tributaries, etc.) this permit would be required before installation. All impoundments with volumes exceeding 250,000 gallons require a BuWQM permit.

Solid waste management is the major tool for protecting the water and land environment. The Bureau of Solid Waste Management

has the major responsibility to ensure proper processing and disposal of liquid, semi-solid and solid wastes on land. A state permit is mandatory before a solid waste disposal site or processing facility can be operated. Process facilities include incinerators, pre-processing solid waste operations, disposal sites and transfer stations. The Solid Waste Management Act (Act 241) and the PennDER regulations (Chapter 75) cover the criteria for compliance with the statutes relevant to physical and hydrogeological character of the site, design and operations of the facilities and disposal locations. Main concern of this division (in the case of incineration) are the proper disposal of the residues resulting from the incineration process and liquid effluents which may reach the water environment.

The regulations do not address the subject of liability in the case of pollution episodes from transport, storage, processing and disposal of chemical and hazardous wastes. The statutes do require the generator (Pittsburgh Energy Technology Center) to identify the wastes and inform the transporter of the constituents and the hazards associated with them (PennDER Regulations - Chapter 75, paragraph 40).

At the present time, there is no mandatory requirement for a detailed manifest and reporting system which traces the movement of the wastes from the generator to the ultimate disposal location.

Proposed processing and disposal methodologies must be submitted to the county and state authorities for approval on a case-by-case basis if the wastes are to be disposed of in Allegheny County. Only state approval is required if the material moves across county lines. Under the present enforcement system, hazardous wastes moving out of the state are not controlled by PennDER agencies. The extent of state involvement in this instance is to inform the cognizant out-of-state agency of the ultimate fate of the residues (as reported by the waste disposal vendor). Theoretically the regulations of the adjoining states -West Virginia and Ohio- would prevail regarding proper processing and disposal.

A special relationship exists between the Commonwealth and federal facilities (PETC) within its borders. The Department of Environmental Resources (Pennsylvania) interprets federal and state statutes to determine the limits of their authority with regard to federal installations. They believe their regulations (Chapter 75) are applicable to the Pittsburgh Energy Research Center. Authority for this

applicability is not the state law, but a presidential directive to all federal agencies to comply with state environmental statutes. However, the policy of PennDER does not require licensing or permits for processing and disposal operations on federal lands (if the activity is implemented as part of a federal program). Cooperation between federal (on-site) personnel and state enforcement officials is the mechanism used to ensure compliance. (26)

1.11.4 Environmental Protection -Federal Involvement

Prior to passage of RCRA (P.L. 94-580), the federal Environmental Protection Agency was active in the solid and hazardous waste field only with educational and funding programs. The Solid Waste Act of 1965 provided authority to fund state enforcement agencies (manpower grants) and demonstration projects. Federal enforcement took the form of legal assistance to the state and county enforcement authorities in court disputes over pollution incidents. Initiation of the legal action was left to the local institution. Some environmental protection measures are enforced by the federal Department of Transportation (in the case of non-compliance with federal regulations covering transport of hazardous substances) and by the Coast Guard for oil or chemical spills into navigable rivers or tributaries. The NPDES program also attempts to control effluents to the surface waters.

USEPA involvement in control of solid wastes generated at the Center is minimal at the present time. As stated above, a presidential directive has been the instrument for cooperation and compliance with state and local ordinances by the federal installations in Pennsylvania. This situation has been radically altered with passage of the Resource

Conservation and Recovery Act (P.L. 94-580) on October 21, 1976. This act specifically includes federal agencies as one of the entities covered by the legislation.

The Pittsburgh Energy Technology Center will be subject to compliance with the federal statute as a "generator" of hazardous wastes. Although the laboratory waste chemicals may not accumulate at a rate in excess of 220 pounds (100 kilograms) per month, the comparatively large waste streams (characteristics mainly unknown) will qualify the facility. This is one important reason for developing data and classifying the indeterminate residues. Potential on-site processing and/or disposal alternatives will be under the purview of this new legislation. Federal permits will be needed for any PETC involvement. At the very least, manifest system implementation, identification (which is now required under the state regulations) and reporting requirements must be met when the proposed regulations are promulgated and adopted.

1.11.5 PETC Liability - Solid Waste Management

During the interim period prior to promulgation of federal regulations and state acceptance of primacy regarding solid waste management, liability relationships existing at the present time are in force. Some time will be allowed (five years after promulgation) for compliance with RCRA statutes. Pittsburgh Energy Technology Center liability is limited to accidents and pollution episodes only on-site. The Center must identify the hazards and the wastes in sufficient detail to allow the transporter and processor to take the necessary precautions and implement the legal packaging and marking

specifications dictated by U.D. Department of Transportation. In the case of spills or damage occurring during the moving phase of the operation, the transporter is fully covered by general liability insurance. At the present time, there is no liability coverage at the disposal site for slow releases of hazardous materials into the water environment. Either the landowner or operator of the disposal facility is subject to legal and civil actions for any damage resulting from pollution at the facility. If the discharges can be uniquely traced to a specific generator, he may be held liable for negligence in not insuring safe disposal of the hazardous residues. There is no legal precedent which establishes this liability to a federal facility.

The Resource Conservation and Recovery Act attempts to remedy this inconsistent and confusing situation regarding liability and damage due to hazardous substance discharges. Disposal sites will be required to show financial responsibility to insure continuity of the operation and proper closure of the site without environmental impacts. The owner/operator will need to establish a closure trust fund and deposit the cash required before the facility permit is issued. As of this date, there are no insurance companies or bonding agencies that will cover liability due to pollutional releases or bond performance. Establishment of a national trust fund with financing from surcharges assessed against the wastes processed by the disposal industry has been suggested.

CHAPTER II

MANAGEMENT OF SOLID WASTES

2.1 Energy Center Waste Classification

An inventory of the laboratory chemicals and general process wastes generated by the research activities at the Pittsburgh Energy Technology Center was conducted during Fiscal Year 1977. (9) As a result of that survey, the laboratory chemical wastes, solvents, dusts, sludges and slag reported are listed in tabular form in Table 2-1. Although the quantities reported may have been as low as twenty milliliters, we have included all substances found in order to develop a comprehensive listing. Quantities of the specific waste categories that are generated at the facility will have great influence on the optimal methodology to be used for the transport and disposal of the residues. In order to provide the proper perspective, Table 2-2 lists the waste streams (and volumes) in the order of volumes generated.

Table 2-1 is based on statutory definitions proposed by the regulations now being promulgated by the U.S. Environmental Protection Agency. Upon determination or assignment of the probable hazard class (using handbook data) of the residues, a suggested processing and/or disposal technique is indicated. The management alternatives are selected on the basis of the waste parameters and the system which will be approved by the cognizant enforcement authorities. Some laboratory chemical wastes exhibit more than one hazardous feature and (in this instance) a judgement was made to select the processing or disposal method most suitable for the multiple hazards.

WASTE SUBSTANCE	I Ignit.	R React.	C Corros.	T Toxic, Heavy Met.	M Mutag.	B Bioacc.	O Toxic Fraction	Pretreat	Inciner.	Land Disposal	Remarks
Acetone, CH_3COCH_3	X	- *	-	-	-	-	-		X		
Acetonitrile (methylocyanide)	X	X *	-	-	?	-	X	X			LD_{50} = .2 mg/l ELIMINATE!!!
Alcohol, Ethyl $\text{CH}_3\text{CH}_2\text{OH}$	X	- *	-	-	-	-	-		X		
Alcohol, Methyl CH_3OH	X	- *	-	-	-	-	-		X		
Alcohol, Isopropyl	X	- *	-	-	-	-	-		X		
Alumina Al_2O_3	-	-	-	-	-	-	-			X	May be carcinogenic inhaled
Aluminum Sulfate (Alum) $\text{Al}_2(\text{SO}_4)_3$	-	-	X (wet)	-	-	-	-			X	Uncontaminated (no organics)
Ammonium Hydroxide NH_4OH	-	X	X (wet)	X	-	-	-	X		X	Neutralize if necessary
Ammonium Sulfide $(\text{NH}_4)_2\text{S}$	-	X *	X (wet)	X	-	-	X	X		X	On DOT Poison List
Benzene C_6H_6	X	-	-	-	?	-	X		X		
Benzene Thiol (Thiophenol) $\text{C}_6\text{H}_5\text{SH}$	-	-	-	-	-	-	X	X	X		Human LD_{50} = 2.6 mg/l Potent Poison
2-Benzyl-					X	?			X		
Benzyl-isothiourea Hydrochloride	-	-	-	-	X	?	X	X		X	LD_{50} = 8.4 mg/l POISON
Benzyl Mercaptan (Alpha toluenethiol)	-	- *	-	-	-	?	X		X		
Boric Acid	-	-	-	-	-	-	-			X	
Betyl Chloride (1 Chlorobutane)	X	X *	-	X	-	-	X	X		X	Will release chlorine-burned
1-Butane Thiol (n Butyl-mercaptan)	X	X *	-	-	?	-	X	X	X		
Cadmium Sulfide	-	- *	-	-	-	-	-	X		X	
Calcium Carbonate CaCO_3	-	-	-	-	-	-	-			X	
Calcium Chloride CaCl_2	-	-	-	-	-	-	-			X	
Calcium Hydroxide (lime) CaOH	-	-	X (wet)	-	-	-	-			X	
Carbon, Spent Activated	-	-	-	-	-	-	-	?		X	Depends on contaminant
Carbon Disulfide	X	-	-	X	?	-		X		X	Releases toxic fume on burn.
Carbon Tetrachloride	-	- *	-	-	X	?		X		X	On Controlled Substance List
Chloroform	-	-	-	-	-	-	X	X		X	
Coal Dust	-	-	-	?	?	?	?		X	X	Insufficient Data
Coal/oil/Catalyst Mix				?	?	?	?		X		Insufficient Data
Coal/Oil/Surfactant Slurry	-	-	?	?	?	?	?		X		Insufficient Data
Coal Derived Liquids	?	?	?	?	?	?	?		X		Insufficient Data
Cyclohexane	X	- *	-	-	-	-	-		X		

Table 2-1 PETC Laboratory Waste Listing, Hazardous Classifications and Recommended Disposal Methodology.

WASTE SUBSTANCE	I Ignit.	R React.	C Corros.	T Tox. Env. Mat.	N Mutag.	B Bioacc.	D Toxic Org. Fr.	Pretreat	Inciner.	Land Disposal	Remarks
Decahydronaphthalene (Decalin)	-	- *	-	-	-	?	X			X	
Dichloromethane (methylene chlor.)	-	- *	-	-	-	-	X			X	
Dicyclopentadiene	-	- *	-	-	-	-	X			X	
Dimethylene triamine	-	- *	-	-	-	?	X	X			LD ₅₀ = 0.4 mg/l ELIMINATE!!!
Dimethylglyoxime	-	-	-	-	-	?	X			X	
Ethanol (Grain alcohol)	X	- *	-	-	-	-	-		X		
Ether, Petroleum (See Benzene)	X	X	-	-	-	-	-		X		
Ethyl Acetate	X	- *	-	-	-	-	-		X		
Ferric Chloride FeCl ₃	-	X	X	-	-	-	-			X	
Ferric Nitrate Fe(NO ₃) ₃	-	X *	X	-	-	-	-			X	
Fluorocarbon (Chloropenta fluorothane)	-	-	-	-	-	?	-			X	
Formaldehyde (Formalin)	-	-	-	-	-	-	X			X	
Freon IV	-	-	-	-	-	-	-			X	
1-Heptane Thiol	X	X *	-	-	-	-	-		X		Reactive. Caution in handling.
Heptadecanol	-	-	-	-	-	-	-			X	
Heptane (Heptyl Hydride)	X	-	-	-	-	-	-		X		
2,4-Hexadinal	-	-	-	-	-	?	X			X	
Hexane (Hexyl Hydride)	X	- *	-	-	-	-	-		X		
Hydrochloric Acid	-	-	X	-	-	-	-	X		X	
Hydrofluoric Acid	-	-	X	-	-	-	-	X		X	
Isocetane (2-methyl heptane)	X	- *	-	-	-	-	-		X		
Kerosene (Kerosene)	-	-	-	-	-	-	-		X		
Lithium Alkylhydride (in ether)	X	X	?	?	-	-	-		X		Use Caution in Burning.
Lithium Borohydride	X	X	X	?	-	-	-		X		Use Caution in Burning.
Magnesium Chloride	-	-	-	-	-	-	-			X	
Mercuric Sulfide	-	-	-	?	-	-	-	X		X	
Methanol	-	-	-	-	-	-	X			X	

Table 2-1 Facility Waste Listing, Hazardous Classifications and Recommended Disposal Methodology (continued)

WASTE SUBSTANCE	I Ignit.	R React.	C Corros.	T Toxic Inh. Met.	H Htag.	B Bioacc.	O Toxic Org. Fr.	Pretreat	Inciner.	Land Disposal	Remarks
1-methyl menthylolene $C_{10}H_{17}OH$	-	-	-	-	-	?	-			X	
Methylene Chloride (Dichloromethylene)	-	- *	-	-	?	-	X	X		X	On EPA Priority Chemicals list
n-Butyl Chloride (carbinyl)	X	- *	-	-	-	-	X		X		
n-Capric acid (decanoic acid)	-	- *	-	-	-	-	-			X	Odorous
n-Butyl Acids (1-aminobutane)	X	- *	-	-	?	?	X		X		
Nitric Acid	-	-	X	-	-	-	-	X		X	Neutralize
Nitromethane	-	X *	-	-	-	?	-	X		X	Highly Reactive-Segregate
Oil, Compressor	-	-	-	-	?	?	?		X		By Statute-Oils are hazardous
Oil, Fuel	-	-	-	-	?	?	?		X		See Above. Impurities toxic
Oil, Pine	-	-	-	-	-	-	-			X	Non-petro. base not included
Oil, Pump	-	-	-	-	?	?	?		X		Hazar. by Statute
Oil (C_5-C_{10})	-	-	-	-	?	?	?		X		See Above
Oil and Tar	-	-	-	-	?	?	?		X		See Above
Octane	X	X *	-	-	-	-	-		X		
p-Chlorothiophenol (Chlor. Phenol)	-	X(fumes)	-	-	-	-	X			X	
Pentane	X	X(heated)	-	-	-	-	-		X		
Perchloric Acid	-	X	X	-	-	-	-			X	Segregate-Oxidizer
Phenol C_6H_5OH	-	X *	-	-	-	-	X	X		X	On DOT Poison B list
Phenyl 2-thiocytl Ketone	-	X(heated)	-	-	-	-	X	X		X	Potent Poison
Phenothiazene $C_{15}H_9NS$	-	X *	-	-	-	-	X	X		X	
Phosphoric Acid	-	X(heated)	X	-	-	-	-	X		X	Neutralize
Phosphorous Pentoxide	-	X	X	-	-	-	-	X		X	Neutralize
Potassium Chloride	-	-	-	-	-	-	-			X	
2-Propanol (Propyl Alcohol)	X	-	-	-	-	-	-		X		
Pyridene	X	X	-	-	-	-	X		X		
2-Pentanol (methyl propyl carbinol)	-	X *	-	-	?	?	X	X		X	
Quinoline	-	X(heated)	-	-	-	-	X	X		X	
Sodium, Metal	-	X	-	-	-	-	-	X		X	Highly reactive in water

Table 2-1 Facility Waste Listing, Hazardous Classifications and Recommended Disposal Methodology (Continued)

WASTE SUBSTANCE	I Ignit.	R React.	C Corros.	T Toxic Non. Met.	H Mutag.	B Bioacc.	O Toxic Org. Pr.	Pretreat	Inciner.	Land Disposal	Remarks
Sodium Borohydride (Powder) NaBH_4	-	X	-	?	-	-	-			X	
Sodium Hydroxide	-	X	X	-	-	-	-	X		X	Neutralize
Solvent, Mylar	X	?	-	-	?	?	?		X		Impurities determine toxicity
Solvent, Degreaser	X	-	-	-	?	?	?		X		See above
Solvent, Cleaning Mgr. 60	X	?	-	-	?	?	?		X		See above
Sulfuric Acid	-	-	X	-	-	-	-	X		X	Neutralize
Tetrahydrofuran (ether)	X	X	-	-	-	-	-	X		X	May form unstable peroxide
Thiobenzamide	-	X *	-	-	-	?	?			X	
Thiodiethyl	-	X *	-	-	?	?	?			X	
Thiofuran	X	X *	-	-	-	?	-		X		Reactive-Care in Handling
Thiophenol (Phenyl mercaptan)	-	X *	-	-	-	-	X	X			LD_{50} = 2.6 mg/l. ELIMINATES
Thioxyanil $\text{C}_6\text{H}_5\text{SS}$	X	X *	-	-	-	-	-		X		
Toluene (methyl benzene) $\text{C}_6\text{H}_5\text{CH}_3$	X	X *	-	-	-	-	X		X		
Trans-2-Butene	X	X *	-	-	-	?	X		X		
1-2-4 Trimethylbenzene	-	-	-	-	?	?	-			X	(paraodocumene)
Tri-sodium phosphate	-	-	C	-	-	-	-	X		X	Neutralize
Isoprene	X	X *	-	-	-	-	X		X		
OTHER WASTES											
Flyash	-	-	-	?	?	?	?			X	Depends on the impurities
Slag	-	-	-	?	?	?	?			X	See Above
Lime Sludge	-	-	-	?	-	-	?			X	Depends on impurities
Coal Conversion Waste Water	-	-	?	?	?	?	?			X	See Above
Process Char	-	-	-	?	?	?	?			X	See Above
Coal Conversion Solid Wastes (Char)	-	-	-	?	?	?	?			X	Depends on Impurities
Liquefaction Residues	?	?	?	?	?	?	?			X	See Above

Table 2-1 Facility Waste Listing, Hazardous Classifications and Recommended Disposal Methodology (Continued)

	GALLONS
1. Oil (lubricating)	5000
2. Condensate Water-Untreated	3000
3. Coal-Oil Slurries.....	2500
4. Coal Fines.....	2000
5. Slag.....	2000
6. Coal Liquifaction Products.....	1950
7. Flyash and Char.....	1500
8. Aqueous Solutions (Indeterminate).....	750
9. Oil and Water Emulsions.....	600
10. Organic Laboratory Solvents.....	550

Note: Mixed Laboratory Chemicals - 2750 gallon capacity (55 gallon drums packaged with absorbents).

Table 2-2 Pittsburgh Energy Technology Center Waste Streams
Processed by Disposal Vendors in FY1978. (22)

The inventory conducted at the Pittsburgh Energy Technology Center reported one hundred and seven (107) different residues that could be defined in the hazardous waste perspective. Many of the wastes are generic or generally described materials such as oils, coal/oil/catalyst, solvents, slags, flyash and sludge. Analyses may be necessary to fully characterize these substance for the purpose of rationally choosing a management plan.

A. Ignitable Wastes -Some thirty four (34) of the reported residues exhibit the characteristics which classifies them statutorily as hazardous wastes due to ignitability. Most of the substances are liquid hydrocarbons generally derived from coal chemical processing. Most would be amenable to mixing with each other to enhance the opportunities for bulk handling. There are some solid wastes included in the list, but the volumes generated are quite small and can be packaged or dissolved (with organic waste solvents) to enable agglomeration into bulk quantities.

B. Reactive Residues -Thirty-six of the reported laboratory chemical wastes would be considered reactive under the proposed federal regulations. The material may be reactive in the presence of oxidizers, when exposed to acids or strong alkalis, may generate fumes when in contact with water, or when heated. The waste may exhibit strong oxidizing characteristics. All of the above circumstances were considered in the classification of the residues listed in Table 2-1. More detail regarding reactivity could be included in an individual waste data sheet (see Figure 2-1) to be developed for a comprehensive solid waste management plan.

Many of the indeterminate wastes cannot be identified in this

ACETONE

I. Identification:

Commodity Safety System No. 0057 NIOSH Listing AL31500

Chemical Name ACETONE CAS No. 000067641

Molecular Formula NQFM: O-C3-H6

Chemical Synonyms: ACETON (German, Dutch, Polish) * ACETONE(DOT) *
DIMETHYLKETAL * DIMETHYL KETONE * KETONE, DIMETHYL *
beta-KETOPROPANE * METHYL KETONE * 2-PROPANONE *
PYROACETIC ETHER

II. Hazard Classification:

DOT : Flammable Liquid, Label: Flammable Liquid, Exemptions and packing-
Exempt from specification packaging, marking, and labeling re-
quirements if packed in metal containers not over 1 quart capacity
each, or in containers not over 1 pint or 16 ounces by weight each,
both packed in strong outside containers.

Degree of Risk: Serious due to flammable material and can injure through
breathing or touching. Acetone is narcotic in high con-
centrations. In industry, no injurious effects from its
use have been reported other than skin irritation and
headaches from prolonged inhalation.

Precautions: Keep away from heat, sparks, open flames.
Avoid breathing fumes and vapors.

First Aid: Immediately flush skin with plenty of water. Flush eyes with
water for at least 15 minutes.

Danger of Fire: Can be ignited at almost any temperature.

Control of Fire: Use "alcohol" foam, water may be ineffective or increase
danger.

Stability: (Reactivity) Can react vigorously with oxidizing materials.

Toxicity: Lowest Published Lethal Dose (LDLo): 50 mg/kg -Oral Human
Oral Rat LD50 : 9750 mg/kg.

Processing & Disposal: First Choice: Incineration (with flue gas scrub.)
Others: Deep Well Injection.

Recycle Potent.: Can be distilled and recycled. Economics: Not Feasible

Figure 2-1 Sample Data Sheet for Hazardous Chemical Wastes-General Data

CSS=Commodity Safety System
CAS=Chemical Abstract Service
MOFM=Molecular Formula

WASTE MANAGEMENT DATA SHEET

- A. IDENTIFICATION: CSS # _____ NIOSH Listing _____
CAS No. _____ Chemical Name _____ MOFM _____
Chemical Synonym: _____
- B. Mixed Waste: _____ (Liquid, Sludge, Solid) Major Constituents: _____
EPA Hazard Classification _____ Certified By _____
- C. Storage: Code _____ Location _____
DOT Container _____ (5 gal., Drum # _____)
SPECIAL PRECAUTIONS _____
- D. TRANSPORT: Labeling _____ Identification _____
Manifest _____ Signed By _____
Contractor _____ Contr. Signature _____
Removal Date _____
Permit No's (for treatment and disposal) _____
- E. ACCIDENT PLAN: FIRE _____ PROTECTIVE MEASURES _____
Explosion _____
Spills _____

Figure 2-2 Sample Data Sheet for Hazardous Wastes-Operations

category because additional data regarding the constituents and their fractional make-up of the total waste is required to determine the potential reactivity of the residue.

C. Corrosive Wastes -Fifteen (15) corrosive wastes are identified by using text book information on the residues generated at the Center. Most of the tabulated substances listed as corrosive included laboratory waste acids (disposed of mainly through the laboratory drainage system) and alkaline chemicals. Some organic chemicals are also corrosive, but they would also be categorized as hazardous due to ignitable or reactive characteristics. Quantities do not appear to be a factor at the Center in the management of corrosive wastes, however the inventory may have missed some larger waste streams.

D. Toxic Wastes -Establishment of toxicity criteria by implementation of the prescribed toxicant extraction procedure is aimed at toxic heavy metal ions dissolved in the waste material. Most likely candidates for this classification would be the inorganic chemicals listed in the inventory. Approximately ninety percent (90%) of the wastes (by weight) generated at the facility fall into this group. The flyash, slag, and sludges from wastewater treatment may all be defined as toxic (hazardous) due to character of the extract obtained by using the mandated test procedures. It is extremely important to make an assessment of heavy metal leaching from the flyash and slag generated by the coal conversion processes. This is critical as the disposal requirements are radically altered and the costs of proper management may be increased by one or two orders of magnitude. None of the inventoried substances can be categorized due to lack of data.

Some chemicals reported at the Center are on the lists (EPA) of substances that have displayed a high level of mutagenic activity. Mutagenicity testing would be needed to definitely establish the hazardous nature of the specific waste streams involved as they may not be pure chemicals. Three chemical wastes were found to have some reference to mutagenic or carcinogenic potential in the literature. Most mutagenic substances are organic or organo-metallic materials. Some active mutagenicity characteristics has been reported for the polycyclic aromatic hydrocarbons (PAH), benzo-a-pyrene being the most ubiquitous species. This compound has been analyzed in solid and liquid residues from coal conversion processes. A program to provide data for mutagenic assessment of the high volume waste streams would be of great value in determination of required treatment levels for the solid wastes generated at the Center.

Bioaccumulative aspects of coal chemicals are documented in the literature. Many of the derived coal chemicals are long chain polymers which would theoretically give a positive result in the suggested test procedures. Consequently, some measurements should be carried out on the more significant waste streams (criteria is volume) to establish or rule out this hazard in the perspective of waste management at the Energy Technology Center.

Of serious consequence to any formulated management plan for the residues generated at the Center is the statutory hazardous waste ruling due to toxic organic fractions. Following the proposed calculation procedure, thirty-one (31) of the reported laboratory chemical wastes would be declared "hazardous" depending on concentrations of the chemical in the toxicant extract. Since most of these chemicals are in the liquid or semi-solid state, and the procedure dictates their inclusion (all the liquid

fraction becomes a part of the extract) in the sample to be analyzed for classification, it would appear that the concentration limit of one mg/l would be exceeded. The unknown nature of twenty-two of the entries in Table 2-1 is also of some concern. The chemical kinetics of the undeterminate materials should be of some interest as their influence on potential environmental impacts and subsequent management costs can be significant.

One aspect of this category is that it serves to acquire a realization of the potency of some poisons appearing on the list of residues. Four waste chemicals with a calculated LD_{50} of less than 2.6 mg/l appear in the tabulation. Acetonitrile, benzene thiol, dimethylene triamine and thiophenol should be eliminated from the laboratory shelves. If the chemicals are absolutely required for the research operations, then extreme care and warnings over and above poison labels on the bottles should be implemented. Any proposed management plan should develop a control mechanism for chemicals of this type.

2.2 Waste Management - STORAGE

Management of the solid residues resulting from ongoing operations at the Pittsburgh Energy Technology Center must include some storage management procedures. This is necessary to implement a system that minimizes environmental pollution and does so at a reasonable cost. Safe and efficient practices must be designed into the system. Handling and storage of spent laboratory chemicals in their myriad of forms and hazards must be addressed. The management of the bulk wastes produced at the center may be of greater importance from a cost effective view.

A. Laboratory Wastes -Storage

Some segregation measures must be utilized to furnish a safe and efficient system of storage of laboratory chemical wastes at the Center. The general groupings for segregation purposes and ultimate processing include: flammables - liquid and solid residues aggregated to facilitate bulk transport and incineration or processing whether it takes place on or off-site; reactive chemicals - oxidants and highly reactive (explosives, heat sensitive materials, water activated) chemicals; toxic chemical wastes (that are not reactive or flammable) with heavy metal fractions, mutagenically active constituents or toxic organic substances which render them hazardous; corrosive liquids - weak and strong acids and alkalis which may also be reactive with other chemical wastes to create highly toxic fumes on contact; and non-hazardous bulk and containerized wastes. Resource recovery is an alternative that should be assessed due to the potential enhancement of the option if segregation is practiced at this phase of the management cycle.

1. Flammables -(a) Liquids-Many of the hydrocarbons listed as laboratory waste chemicals are considered ignitable by statutory definition. Heptane, octane, benzene, etc. would be included in this category. The alcohols, benzenes, and hydrocarbon liquids can be combined in a single bulk container. It is advisable to determine the compatibility of the liquid wastes in question by testing with minute quantities of each fluid. A small sample of the flammable waste (5 ml. or less) and the already agglomerated liquid should be combined in a well ventilated and flame free area (or under a laboratory hood in a metal crucible).

Combination of this group of liquid wastes in 55 gallon drums with storage in a cool, well ventilated area (until pickup by the disposal contractor) is a viable storage technique. This protocol will furnish the economies of bulk handling (if volumes generated are sufficiently large, installation of an outside underground storage tank with capacity ranging from 1000 to 3000 gallons may be justified) and the opportunity to recover the heating value of the material in a fuel blending operation. It will also reduce the cost of processing (incineration is the disposal process of choice) as the incineration process will be self-sustaining and will not require auxiliary fuel. Transport and disposal costs can be reduced to one-third to one-half of that of small volume lot processing.

(b) - There are only a few solid flammable wastes involved in the Center's operations. Agglomeration of solid flammable waste materials is not so attractive a technique (as with liquids) as the possibility of mixing two reactive wastes is greater. A testing program to determine reactivity of the various flammable solid waste streams may be necessary, but this program is not feasible at Bruceton unless larger volumes of this type of residue are generated. Solid flammable wastes must be containerized separately in accordance with U. S. Department of Transportation regulations, and Factory Mutual requirements. Due to the very small quantities involved at PETC, some thought should be given to the possibility of liquifying the solid flammables by mixing with the waste solvents to combine them into one waste stream.

2. Reactive Chemicals -Some highly reactive oxidizing agents may be included among the laboratory waste chemicals reported in the facility inventory. Main groups of chemical oxidizers are listed in Table 1-1

under group 7-A. Oxygen will be released by these substances to enhance the potential for combustion. Other chemicals may be especially reactive when combined with the oxidizers. This class is identified in Table 2-1 with an asterisk in the reactivity column. Overage ether (kept on the laboratory shelf for an extended time period) may break down to form unstable peroxides which could detonate on exposure to vibration, shock, or heat. Development of a detailed data sheet (see Figure 2-1) for each chemical discarded from laboratory operations could be a valuable tool in devising and maintaining a safe, efficient hazardous waste program at the Technology Center.

Storage of spent chemicals at the Center must be planned with this particular hazard in mind. Segregation of mutually reactive chemicals must be practiced to minimize the danger of explosion, fire and generation of toxic fumes. The storage area must be well ventilated (to prevent accumulation of toxic or reactive fumes, kept cool and located in a relatively isolated setting.

3. Corrosive Materials: Strong acids and alkali (although both are corrosive) should be kept separated to preclude violent reactions which accompany their combination. Most import is the use of proper containers (corrosion resistant to that particular chemical) to prevent accidental leakage during the storage phase of waste management. The hazardous waste inventory did not pinpoint large volumes of acids and alkalis at the Pittsburgh Energy Technology Center. This finding should be double-checked (especially in the program project areas) as this class of waste is almost ubiquitous. Proper labeling and close supervisory control of the storage area will be the most effective tool for insuring safe handling of this type of waste.

4. Toxic Chemical Wastes- This class of materials usually does not exhibit the hazards described above. Consequently, storage restrictions may be less stringent with regard to these residues. Containerization will be the most likely method used for isolating and storing the laboratory chemical wastes. General storage requirements which follow will cover this class of materials. Identification and labeling of the wide range of materials and their specific hazard classification is an important component of any comprehensive solid waste management plan implemented at the Pittsburgh Energy Technology Center.

B. Process Wastes-Storage

The indeterminate wastes which may be classified in the toxic waste category (slags, char, flyash, sludges, etc.) will not usually be stored with the other chemical wastes. Volumes generated will call for other design concepts in the storage phase. Sludges should be stored in specially designed containers which facilitate loading into transport vehicles. Many container types (closed vessels-tank, leak-proof open boxes and drums) are available and will be selected to provide optimum service depending on the physical and chemical properties of the residue. Flyash, char and slag are not usually containerized. Small volumes are discharged directly into the open box container in which they will be transported off-site for disposal. Larger volume becomes a function of the generating process and disposal techniques. This group of waste materials will be stored on-site in lagoons or impoundments which act as the dewatering unit as well. If vacuum filters or other dewatering devices are employed as a part of the process, the dry (or relatively dry) residue is stored in open piles. Control of run-off and discharges

(which may need further treatment) must be considered in the design and construction of proper storage areas.

If the slags, chars, and other solid residues are determined to be non-hazardous (statutory definition), they will still be subject to the same storage design requirements as the toxic bulk material. Discharges from the storage pile would need to be controlled, but may not require treatment. Hydrological isolation may be a prerequisite of the storage construction in the case of toxic substances.

C. General Storage Considerations

Establishment of a central chemical waste storage area should be considered at the Pittsburgh Energy Technology Center. Typical design and operational procedures to be incorporated in the activity include:

1. The chemical waste storage area should be located in a separate, remotely located building to minimize damage from potential violent reactions and fires.
2. The building should be adequately ventilated to prevent accumulation of toxic and flammable vapors.
3. Chemical wastes must be stored in a controlled arrangement with potential reactivity in case of accidental mixing as the main criteria. Each of the listed chemical wastes in Table 2-1 should be coded on the operations data sheet for storage proximity compatibility. A general guide that may be useful is the partial listing (chemical classes relevant to those reported at PETC) of the U.S. DOT Loading and Storage Chart of Hazardous Chemicals tabulated in Table 2-3.
4. The laboratory chemical wastes should be packed and stored in

Group Classification & Number		10	11	12	13	14	15
Flammable liquids or flammable gases; Flammable liquid or flammable gas label.....	10	-	-	-	-	X	-
Flammable solids or oxidizing materials; Flammable solid, oxidizer, or organic peroxide label.....	11	-	-	*X	-	X	-
Corrosive liquids; Corrosive label.....	12	-	*X	-	-	X	-
Nonflammable gases; Nonflammable gas label.....	13	-	-	-	-	-	-
Poisonous gases or liquids, in cylinders, projectiles or bombs, Poison gas label.....	14	X	X	X	-	-	-
Radioactive materials.....	15	-	-	-	-	-	-

The above table shows the hazardous materials which must not be loaded or stored together.

The letter X at an intersection of horizontal and vertical columns shows that those articles must not be loaded or stored together, for example: Flammable liquids or gases should not be loaded or stored with poisonous gases or liquids.

* Unless loaded in opposite ends of car, corrosive liquids must not be loaded with flammable solids, oxidizing materials, except that shippers loading carload shipments of corrosive liquids and flammable solids or oxidizing materials and who have obtained prior approval from the Department may load such materials together when it is known that the mixture of contents will not cause a dangerous evolution of heat or gas

Table 2-3 Loading and Storage Chart of Hazardous Materials. (7)

containers complying with U.S. DOT specifications. In this manner, they will be ready for pickup and shipment by the contractor, thus minimizing preparation and demurrage charges.

5. Placement of acids, solvents, or chemical wastes in breakable containers should be arranged for minimum probability of accidents i.e. store glass containers close to the floor. Shelving and arrangement of the storage area must be designed to prevent and eliminate poor handling practices as much as possible.

6. Access to the storage area must be rigidly controlled to avoid or prevent poor management practices. Central authority by delegation of responsibility for operation of the storage area should be implemented to insure success of the selected management plan.

7. A running inventory of waste materials and their location in the storage area should be maintained.

2.3 Waste Management - TRANSPORT

U.S. DOT regulations (7) are used as the primary instrument to control the movement of hazardous wastes from generation point to treatment or disposal location. The statutes are comprehensive in scope, ranging from packaging requirements in great detail to design requirements for railroad tank cars. Design criteria mandated include safety precautions for protection of personnel, selection of materials of construction of containers, transport vessels and storage units. Protocol for compliance with DOT regulations is outlined in Figure 2-3.

The laboratory waste chemicals are packed in drums (filled with vermiculite) which are fabricated to DOT specifications. Small quantities of spent chemicals are usually kept in the original bottles and

Part 172 - Lists hazardous materials shipping names of all materials subject to CFR-49).

Part 173 - Covers regulations pertaining to Shippers (PETC).

- Sub. a. Classification, motor carrier regulations.
Preparation of articles for transportation.
- b. Explosives
- c. Flammable, combustible and pyrophoric liquids.
- d. Flammable solids and oxidizing materials.
- e. Corrosive materials.
- f. Compressed gases.
- g. Poisonous materials, etiologic agents and radioactive materials.
- h. Marking and labeling of hazardous materials.

Figure 2-3 Protocol for Use by PETC to Comply with DOT Regulations.

and cans and stowed in the metal drums. The individual containers are cushioned by the vermiculite, which acts both as shock absorber to prevent breakage and as a fire retardant absorbent (in the case of leakage of flammable liquids. Care and judgement must be exercised in selecting the waste chemicals to be placed in the same transport drum.

Liquid and solid wastes in drum (5, 30 and 55 gallon sizes) quantities should be stored and shipped in the approved container for that particular class of waste. Accumulation of truck load lots (78 drums) is necessary to take advantage of discounted transportation charges. Proper labeling and identification are imperative as punitive fines are levied for violations of the DOT regulations.

Bulk wastes generated at the Pittsburgh Energy Technology Center are transported in the appropriate vehicle- tank truck for liquid wastes; open or closed truck bodies which are leakproof (for sludges) for the solid wastes. Transport distances become critical in the economic sense when carrying large masses of waste materials from one location to another.

2.4 Waste Management - PROCESSING & DISPOSAL

The final component in the waste management chain embodies processing (if necessary) and ultimate disposal. Because there are only three final sinks for the constituents produced during the coal conversion process- air, water and land - this phase of the system essentially redistributes the wastes to each of them.

Some processing alternatives will change the chemical nature of residues to an end product which is no longer toxic or polluting. One example is that of the reduction of cyanides (a highly potent toxic

chemical) to carbon and nitrogen by chemical reactions of hyperchlorination. Other treatment techniques include volume reduction (and redistribution) such as incineration which reduces the volume of liquid or solid wastes by rapid oxidation (combustion). The combustion products are redirected to the air sink, mainly in the form of oxides and water vapor. Very little solid residue remains when burning liquid wastes. Residues from the combustion of solid wastes may present greater environmental problems than the original material.

Industrial wastewater treatment employs processes which include chemical reactions (in the treatment for heavy metals) to concentrate the toxic fractions into forms which are insoluble in water. The precipitate forms a semi-solid and the supernatant (water fraction) becomes a treated effluent. Lime or soda ash neutralization of acids which contain high concentrations of heavy metal ions in solution is one example of this category. Other unit processes include biological treatment which utilizes bacteria (usually in an aerobic pathway in order to take advantage of higher removal efficiencies) and air or oxygen to enable bacterial biota degrade the organic contaminants in industrial wastewater.

Direct land disposal techniques may be satisfactory in the management of some residues generated at the Center. Sanitary landfills with daily covering of deposited residuals with soils is not really applicable to the undeterminate wastes expected from coal conversion processes. However, specially engineered facilities (with prevention of releases of toxic substances to the water media as the primary design criterion) may be adequate in protecting the environment and public health. Adequacy is highly dependent on physical, biological and chemical characteristics

of the particular wastes (chars, flyash, slag, wastewater treatment plant sludges). Phenol attenuation (and other similar organics) by selective organisms in biologically active soils may be an attractive and economic alternative for processing of some high volume wastes which have as much as ten percent organic fractions. (23)

Chars or residues from combustion processes (flyash and bottom ash) which are usually made up of 99.5 percent inorganic compounds may need pretreatment prior to disposal using a land sink. Stabilization if it is in a thixotropic sludge form (flue gas desulfurization wastes); chemical fixation to render the heavy metal fractions insoluble and prevent leaching with release to the water sink are two management alternatives.

Encapsulation of the pollutant with a counteracting material as part of the land disposal concept is also a choice. The counteractant may be crushed limestone which may keep any water discharges low in heavy metal ions. Man-made material liners and natural clay materials may be considered to act as a hydrological barrier between the waste and groundwater. Again, all of the alternatives indicated are influenced by the nature of the residue. Consequently, the importance of determining the character of the large volume waste streams resulting from coal conversion operations becomes critical to the economic feasibility of the conversion process itself.

2.4.1 Chemical Processing

Due to the very small volumes of highly toxic wastes generated by laboratory activities at the Pittsburgh Energy Technology Center, this option does not appear to be one of the choices open to the decision-makers. As stated previously, these reported toxic chemical wastes

would be candidates for chemical destruction, but the quantities indicated are very small. Elimination of the substances from the laboratory or dispatch to a disposal contractor who uses a centralized treatment facility is more feasible. Acetonitrile is the only residue from the laboratory that fits this category. All of the highly toxic chemical wastes generated by this particular laboratory are combustible thus making controlled incineration (with gas cleaning auxiliaries) the processing and disposal choice.

2.4.2 Incineration

This processing (or disposal) alternative is the most promising for proper management of most of the waste laboratory chemicals. Table 2-4 contains a list of the reported laboratory waste chemicals in which incineration is the recommended management option. In some instances the unit will need gas scrubbing devices due to air pollutants released during the combustion process.

Of the many types of industrial waste incinerators available, two basic designs are applicable to the residues being considered, rotary kilns and liquid injection units. Rotary kilns employ large horizontal or slanted chambers which rotate as the waste is burned inside. The slowly rotating cylinder provides tumbling action to improve efficiency of complete combustion of the solid or liquid wastes. The technology for this type was adapted from lime and cement processing operations. Most organic wastes in solid, semi-solid (sludge) or liquid form can be handled. Residence time in the kiln can be adjusted from several seconds to hours to assure complete destruction of some highly toxic pesticides and pollutants. Combustion temperatures range from 1500°F

Chemical Waste	Potent. Combustion Products					Other Criteria
	HCL/ COCl ₂	SO _x	NO _x	Other	Heavy Metals	
Acetone						
Acetonitrile			X			
Alcohol						
Anthracene						
Benzene						(2)
Butane						(2)
Butyl Mercaptan		X		H ₂ S		(1)
Butyl Phenol						
Carbolic Acid (Phenol)						
Carbon Disulfide		X				(1)
Carbon Tetrachloride	X			Cl ₂		(1)
Creosots (Coal Tar)						(2)
Cresol (Cresylic Acid)						
Cyclohexane						(2)
Dichloromethane	X			Cl ₂		(3)
Dicyclopentadiene						(2)
Dimethylamine			X			(1)
Ethane						(2)
Ethanol						
<p>(1) Controlled incineration of materials acceptable if equipped with a scrubber, catalytic or thermal unit to reduce NO_x, or SO_x emissions.</p> <p>(2) Incineration of concentrated materials and dilute organic mixtures is acceptable.</p> <p>(3) Incineration acceptable -preferably after mixing with another combustible fuel; a scrubber is necessary to remove halo acids produced.</p>						

Table 2-4 Technology Center Selected Chemicals-Incineration Recommended. (17)

Chemical Waste	Potent. Combustion Products					Other Criteria
	HCL/ COCl ₂	SO _x	NO _x	Other	Heavy Metals	
Ethyl Acetate						(2)
Formaldehyde						
Freon	X			Cl ₂ HF		(3)
n-Heptane						(2)
Hexane						(2)
Isopentane						(2)
Methanol						
Methyl Mercaptan		X		H ₂ S		(1)
Napthalene						(2)
Nitromethane			X			(1)
n-Pentane						(2)
Phenols						
n-Propyl Alcohol						
Propylene						(2)
Pyridene			X			(1)
Quinone						Needs Dwell
Toluene						(2)
Xylene						(2)
Note: Partial table taken from reference (18)						

Table 2-4 Selected Chemicals-Incineration Recommended (Continued) (17)

to 3000°F. This type of incinerator can process all combustible and non-combustible liquid and solid wastes generated at the Center. Units are manufactured to handle 100 lbs./hr to 4000 lbs/hr. Reported capital costs for the incinerator are \$2500-\$10,000/daily ton.⁽¹⁹⁾ A skid-mounted rotating kiln incinerator is available for transport to the waste generating site.

The other combustion unit of interest is the liquid injection unit. This type of incinerator would be the most likely choice for the Center based on the laboratory chemical wastes generated there. The combustible liquid waste is filtered and then atomized through nozzles to be injected into the combustion chamber of the vertical or horizontally mounted vessel. An on-site unit for the Pittsburgh Energy Technology Center may be viable because the variability of liquid wastes is relatively narrow. A more or less uniform combustible residual fuel is available for heat recovery to evaporate residues with low BTU content. Utilization of waste heat for productive purposes is an attractive side issue in the present climate of expensive fuel supplies. The apparent limiting parameter for the liquid injection incinerator is the rate of heat release. A high BTU combustible waste cannot be fired at high flows, although throughput of the unit can be increased if non-flammable aqueous waste streams are evaporated simultaneously in the combustion chamber.

If sufficient volumes of combustible waste liquids are generated at the Pittsburgh Energy Technology Center and regulatory enforcement drives the contracted price for disposal to a high level, this option (on-site incineration or a variation) may be a very feasible choice. Management of liquid combustible wastes at two Energy Centers (Pittsburgh and Morgantown) may be economically feasible at this time for a truck

mounted portable unit that can be operated at both locations. A feasibility study to determine the economics and constraints of a joint effort by both facilities should be mounted. Choices to be considered include: (a) a skid-mounted rotary kiln incinerator for liquid and solid wastes, which is portable and can be operated at both locations as needed; (b) a liquid injection unit (portable or stationary) without gas scrubbing capabilities; and (c) a liquid injection incinerator (portable or stationary) with gas scrubbing capabilities in order to handle a wider spectrum of residuals. In order to avoid maintenance problems and use ordinary personnel for operation, it is recommended that liquid wastes which generate hydrochloric acid, chlorine gas, or hydrogen sulfide be avoided.

2.4.3 Land Disposal

In the context of coal conversion residues and laboratory chemical wastes, land disposal techniques can be classified as: (1) pretreatment of the waste by dewatering, stabilization, solidification or leachate attenuation; (2) ordinary landfill operations and control; and (3) Special landfill design for hydrological isolation, encapsulation in situ, codisposal with attenuating mechanisms, and biological reduction opportunities.

1. Waste Pretreatment (at disposal site).

Some processes have evolved for treating of hazardous solid wastes prior to land disposal. Major objectives of the processes are chemical and/or physical alteration of the solubility characteristics of the waste to prevent release of heavy metal ions, permanent isolation by

container encapsulation in non-biodegradable leakproof plastics. In the case of sludges, if volumes justify the economics, further dewatering or separation techniques such as pressurized ultrafiltration and centrifugation will be implemented for volume reduction (if the supernatant can be discharged without further treatment).

(a) Chemical Fixation and Stabilization - This process generally is accomplished by the addition of a fixative which will chemically or mechanically bind the pore water in thixotropic sludge (such as FGD wastes). Lime and flyash, calcined slag and lime, or a combination of lime, cement and bentonite are incorporated into the semi-solid residue. The material will stabilize and solidify from a pumpable fluid to a soil-like material in eight to twenty-four hours. The reactions continue over time with maximum strength and fixation occurring in twenty-eight to forty days. The final product exhibits better leaching characteristics (lower heavy metal ion concentrations in the extract). The soluble biological and organic fractions are not altered to any great extent by the application of this process type.

This pretreatment may be required by the proposed EPA regulations in order to prevent a hydraulic head on the impermeable liner, thus theoretically eliminating leaching of heavy metals through an impermeable membrane. Chemical fixation is practical only where huge volumes of semi-solid wastes are generated, heavy metals in soluble form are present in the residue, and organic fractions are of no concern. Further study of coal conversion residues are needed to assess this management alternative. It may be viable in handling of chars, lime sludges from fluidized bed gasification, soluble salt residues from magnetohydrodynamics research, and ashes which result from coal conversion processes.

(b) Partial Pretreatment - Some mechanisms utilized to avoid heavy metal leaching include adjustment of the pH and alkalinity of the waste stream. For smaller quantities of sludges and solid wastes containing relatively large fractions of toxic heavy metals (selenium, cadmium, lead, chromium, nickel and zinc), dosing with lime or other alkaline materials may be an effective solution. Disposing of the residues on a bed of crushed limestone may further protect the water environment.

(c) Aeration of Organic Wastes - Temporary storage in a vessel which is equipped with mechanical aeration capability may be a cost-effective option in treating some organic wastes. The unit will act as an aerobic digester to biologically degrade organic fractions. This will be successful only where establishment of an efficient bacterial population is possible. Some problems may be inherent in this choice due to the wide range of organic substances (which in themselves may be toxic to biota) in the residues generated at the Center.

(d) Permanent Container Encapsulation - Disposal of highly soluble heavy metal residues and very toxic organic chemicals may be suitably accomplished by encapsulating the container (box, pail, or drum) in a non-degrading impervious material. This work has been extensively studied by the U.S. Environmental Protection Agency (20). The toxic and hazardous substances are containerized and the overall container is encapsulated in polyolefin plastics or fiberglass coats which are chemical, shock and heat resistant. Costs for this process were estimated to be \$6-15 per drum. As of this time, the encapsulation process is not available, but it does hold some promise for economic management of relatively small volumes of highly toxic substances.

(e) Encapsulation in-situ - Disposal of heavy metal residues (which may include the process waste streams at the Center) from coal conversion in a crushed limestone capsule has been one technique approved by environmental enforcement agencies in the past. The limestone is placed completely around (top, bottom and sides) the deposited waste in layers of one foot or more. Any water moving through the alkaline limestone will have a high pH and alkalinity, thus theoretically placing the leachate in a pH range in which most of the heavy metals are insoluble. Some calculations have indicated the limestone would provide sufficient alkalinity to neutralize a normally slightly acidic groundwater for almost 200 years. This technique is based on the premise that good operating conditions and faithful implementation of the design and construction will prevail.

2. Sanitary Landfill Disposal

The ability of a sanitary landfill to fulfill the necessary needs for preventing environmental impacts is based on three critical factors: (a) hydrogeological setting of the facility; (b) chemical and physical characteristics of the residues processed; and (c) design and operation of the site.

Optimal site selection is the one choice which exerts the greatest influence on environmental impacts and the cost of disposal. Unfortunately, from an operational perspective, the optimal site location is one in which there is the most competition with other uses for the land. Consequently, most land disposal operations are located by other criteria i.e. political and social pressures, land costs and availability (usually marginal for most uses including land disposal of residuals).

Hydrogeological setting relevant to land disposal includes the topographical features (steep hills and ravines introduce drainage and stability problems), depth to bedrock and soil characteristics (such as renovation potential i.e. ability of the soils to attenuate organics and heavy metals), bedrock character (fractured bedrock or limestone formations will preclude isolation from ground water at any depth), and depth to ground water (to avoid deposition and subsequent migration of toxic elements in the ground water system). Adequate quantities of suitable soils which must be used for cover is another parameter of concern.

The chemical and physical nature of the wastes are critical with respect to potential and actual environmental impacts. A residual which exhibits a lack of hazard characteristics as defined by RCRA regulations would appear to have few if any possible impacts on the water system. Only a few of the reported laboratory waste chemicals would be considered non-hazardous (statutory definition). However, due to the small volumes (approximately a half ton per year) it may be possible to utilize the sanitary landfill concept for disposal. One hundred pounds of chemical wastes combined with some eight hundred tons of municipal refuse in a codisposal arrangement will offer very little potential for environmental contamination.

Daily operations and the basic design of the disposal facility can prevent environmental impacts or keep them minimal. Properly designed surface run-off diversion systems (to divert water away from the wastes) can prevent the residuals from reaching field capacity (saturation). In this situation, leachate will not be generated. Effective revegetation programs combined with a suitably designed soil erosion and sedimentation

scheme will minimize or prevent siltation with degradation of water quality as a consequence. Efficient operating procedures used in the placement, compaction and containment of the deposited residuals will provide optimal conditions for avoiding settling and structural problems at some future time.

3. "Secure" Chemical Landfill

Proposed federal regulations outline the design requirements for chemical disposal sites. Table 2-5 lists the restrictions and design criteria which must be met to be classified (and permitted) as a chemical waste landfill. Interpretation of the statutes imply disposal of any chemical wastes (if they are safe from dangerous reactions, fire and explosion by reacting with other residuals) in a facility which follows the proposed design.

At the present time, the only disposal facilities now in operation which comply with the necessary criteria are located in western Ohio, Indiana, and Illinois. They are facilities with the necessary natural clay deposits (and required permeability) having depths ranging from 45-90 feet. However, they are not in total compliance due to the lack of leachate treatment facilities. The possibility of discovering sites with deep natural clays (with 1×10^{-7} cm/sec permeability) in southwestern Pennsylvania and northern West Virginia is remote, but it is possible.

There is some opportunity for taking advantage of some fortuitous circumstances that will yield the necessary design features at disposal facilities in this locale. Disposal of fixed FGD sludges, which are reported to attain the necessary low permeability with time,

CLASSIFICATION	CRITERIA	CONDITIONS
Natural Conditions	10 ft. thick minimum of natural in-place clay with permeability of $< 1 \times 10^{-7}$ cm/sec	If evaporation rate exceeds precipitation by at least 20 inches per year and No over-flow is expected to occur.
Designed Site - I	Leachate collection system on top of a minimum soil or clay barrier with a min. thickness of 5 ft. with permeability not greater than 1×10^{-7} cm/sec	Leachate Collection and Treatment will be required.
Designed Site - II	<p>Soil Liner-3 ft. thick min. with $< 1 \times 10^{-7}$ cm/sec over a synthetic membrane > 20 mil. thick with $< 1 \times 10^{-7}$ cm/sec permeability.</p> <p>Leachate Collection & Removal on top of soil mantle. Leachate detection and removal beneath the synthetic membrane</p>	<p>Leachate Collection and Treatment will be required.</p> <p>Leachate Detection & Removal System needed.</p> <p>Water Quality Monitor System not required due to detection system.</p>
<p><u>General Requirements</u> (All Classifications unless specifically deleted):</p> <ol style="list-style-type: none"> 1. Liquids must be treated to non-flowing consistency. 2. Water Quality Monitoring System is required. 3. Five foot separation from bottom of liner and high ground water table. 500 feet from nearest functioning public or private water supply. 		

Table 2-5 Secure Chemical Landfill Design Criteria, Proposed by EPA (4)

after their disposal may artificially create the necessary barrier. IUCS (International Utility Conversion Systems), Stabatrol, Inc, and Environmental Technology, Inc. are three corporations that are in the process of developing chemical landfills in the Tri-state area using the above described concept. An assessment of the feasibility of this disposal route for the undeterminate waste streams generated at the Pittsburgh and Morgantown Energy Technology Centers should be implemented. In addition, the above concept may be needed to manage the expected large volume wasted streams from full-scale coal conversion processing units.

Some potential exists for the construction of disposal sites which may not required compliance with the stringent design criteria outlined in Table 2-5. For the present time, some waste streams (lime kiln dust, power plant flyash, flue gas desulfurization sludge, and mining wastes) will be exempt from the standards being proposed until more data can be accumulated regarding the hazardous characteristics of these materials. Some coal conversion wastes would be very similar in nature to the special wastes. Development of hazard characteristics of typical solid and semi-solid residuals resulting from coal conversion processing becomes especially critical in light of the above described situation.

Concepts and proposals for safe and impact-free processing and disposal of coal conversion residues must be formulated and assessed as soon as possible due to the institutional regulatory climate. Statutes have a tendency to become set in stone and regulators will interpret them in the narrowest possible sense. Because of the potential economies inherent in land disposal of huge masses of residuals, a safe, viable and economic concept must be proven and accepted by the long line of regulatory bodies from local up to federal level.

CHAPTER III

EXISTING SYSTEM & RESOURCES

3.0 Introduction

In order to develop a residuals management plan for the Pittsburgh Energy Technology Center it is necessary to examine the existing management mechanism, rearrange the criteria for ordering of selected waste streams, determine the available resources available and establish departmental policies and constraints which must be considered.

Existing in-place practices implemented at the Center appear to be highly dependent on contractor availability (coupled with the Center's expressed desire to comply with all prevailing regulations). Laboratory chemical wastes as well as other residuals (other than refuse) are consigned to a single contractor with the expectation of regulatory compliance. Passage of the Resource Conservation and Recovery Act (P.L. 94-580) has introduced pressures for radical changes in the waste management system. Expectation of compliance with proposed statutes by the enforcement agencies may be high, but actual implementation in accordance with the regulations will be spotty. Contractor reliability in this respect will depend on his (the contractor's) entrepreneurial ability to find an ultimate disposal facility that is in compliance with the new regulations. In addition, the situation will change from day to day with no guarantee of any long term stability.

Area resources do not appear to exert any great influence on the chosen mechanisms for managing wastes of the type generated at the Center. An explanation of this phenomena may be due to two aspects of solid and

hazardous wastes resulting from energy research, namely the relatively small volumes of the waste streams and the absence of environmental enforcement (with low assigned priorities by the agencies) on the larger quantities of solid wastes with undetermined characteristics. Implementation of the regulations being promulgated under RCRA will place greater emphasis on the available area resources (in an economic sense) due to the expected uniformity of environmental protection requirements on a national scale, thus eliminating regional differences. Movement of hazardous wastes over large distances in search of acceptable disposal locations will only make sense on a cost basis. Uniformity of environmental protection regulations will eliminate enforcement level cost differences in waste disposal. Available area resources for processing of the Center's wastes must be an essential component in developing an environmentally acceptable and economically feasible management plan. Approximately seven sanitary landfills are presently in operation in Allegheny County at the present time. Some facilities are processing wastes similar to those originating at the Pittsburgh Energy Technology Center on an approved basis (under existing regulations).

3.1 Existing Solid Waste Management System

The first report of this project (21) described the mechanisms employed in the management of laboratory waste chemicals by eight research laboratories in the Pittsburgh region. Accumulated mixed chemicals (spent solvents and cleaners) are also included in the laboratory waste category. Some recommended methodologies for treating and disposing

of various categories of organic and inorganic chemicals was also included in the report. Origin of the recommended treatments is the Manufacturing Chemists Association bulletins on proper waste disposal of chemicals. A compilation of the findings of the first phase document are listed in Table 3-1.

As illustrated in Table 3-1, all laboratory chemical wastes are consigned to industrial waste brokers or refuse disposal companies. It is safe to assume that the wastes processed by the refuse haulers were delivered to operating landfills in the area. Actual environmental impacts resulting from this activity are probably minimal due to the very small mass processed when compared to the overall tonnages of municipal refuse which make up the codisposal operation. There is some potential for releasing small quantities of extremely toxic substances to the water environment. In addition, the occupational exposure (with complete ignorance of the hazards) of the landfill personnel increases the likelihood of accidental injury.

Brokers providing services to the Center are knowledgeable, to a certain degree, of the hazards associated with the materials they are processing. Consequently, their management methodology includes careful handling of the residues by their own personnel, compliance with packaging and transportation regulations (and the statutes built-in safeguards with respect to occupational hazards) and consignment to an ultimate disposal facility which has some technical capability. It is in the ultimate disposal phase that the state-of-the-art has not kept pace with the regulatory requirements.

A. Laboratory Waste Chemicals (PETC): Waste chemicals are periodically picked up by a hazardous waste broker (Ecology Chemicals and Refining)

A. Laboratory & Plant Wastes	(1) Clean Combustible Liquids Chlorinate & non-chlorinated	DOT Container	Off-site Incineration
	(2) Toxic Wastes-Heavy Metals	Consign to Broker or Hauler	Sanitary Landfilling
	(3) Reactive Chemicals & known carcinogens.	Standard Drums-Broker hauling	
	(4) Radioactive Wastes	On-Site Processing	On-Site Processing
	(5) Plant Refuse	Transfer to Parent Co. facility	NRC approved disposal
	(6) Waste Oil	Refuse Hauler	Sanitary Landfilling
		Drums-Consign to Reprocessor	Reprocessed
B. Laboratory Wastes	(1) Outdated Chemicals & lab. chemical wastes	DOT Containerization-Consign to Broker-Trans-shipment	Permitted Landfill
	SAME METHODOLOGY AS PRESENTLY USED AT PETC		
C. Laboratory Wastes	(A) Flammable Liquids (70%)	DOT Containerization-Consign to Broker	Incineration @ Arco Polymer (Monaca)
	(B) Viscous Materials-plastics and coal tars	Refuse Hauler	Landfill
	(C) Acids & Alkalais	No neutralization	Landfill
	(D) Very Hazardous Wastes	Special Handling-Case by Case Basis	
D. Laboratory Wastes	(1) Flammable Solvents	55 Gal. Drums-Non DOT	Landfill
	(2) Hazardous Fraction	Consign to Waste Broker Packing	?
	(3) General Wastes-Glass, etc.	Refuse Hauler	Landfill
E. Laboratory & Process Wastes	(1) Refuse	Refuse Hauler	Landfill-Sanitary
	(2) Hazardous Waste & On-Site Treatment Residues	Waste Broker	Landfill (Cleveland)
F. Small Lab.	Paper		On-Site Incineration
	Scrap Metal	Recycling Broker	Recycled
	Chemical Wastes	On-site processing	Uncontrolled land disposal

Table 3-1 Present Residuals Management Practices by Six Surveyed Laboratories (21).

The contractor's personnel collect the residues at the generating points and pack them in appropriate containers (DOT Specification Units) with vermiculate used as a cushioning agent. The waste chemicals are selectively placed in the drums (using reactivity characteristics as criteria). Charges for the packing service is on an hourly basis and the price for transport and disposal of the chemical wastes is based on the size and number of containers. Intrinsic hazardous nature of the discarded substances is not usually a factor in the pricing structure.

Liability relationships are not clear from the data gathered. It is assumed the broker's personnel are covered by Workman's Compensation in the case of accidental injury or death due to explosions or exposure to hazardous substances. Responsibility of accidental damage to PETC facilities and personnel cannot be ascertained. This is dependant on the responsibility and liability clauses embedded in the purchase contract between the broker and PETC. The same holds true for accidental damage or injury to PETC personnel both inside the facility and during the movement phase of the pick-up operation within PETC grounds..

After the consignment of laboratory waste chemicals leaves the PETC property, liability and responsibility for damage caused by the residuals is not well-delineated unless the ownership of the wastes has been clarified. Usual practice is to consign ownership of the shipment to the carrier via a bill of lading or special assignment document. The broker (now the owner of the wastes) is covered by general liability insurance in case of any accidents or spills that cause harm or damage during the transport operation.

The methodology used by Ecology Chemicals & Refining to process the laboratory chemical wastes includes transporting the consignment to a

central transfer facility in Manor, Pennsylvania. The wastes are then held for consolidation with other streams (in the originally packed DOT containers) to make up optimal handling volumes for trans-shipment to a state licensed and permitted industrial waste processing site in Alabama. The license and permit are those issued by that state (under their specific regulations) to allow handling and disposal of this class of residuals.

B. Household and Miscellaneous Chemical and Industrial Wastes: From a volume perspective, this category is probably the largest handled by the waste disposal contractor. Drums of mixed flammables such as toluene, acetone and organic solvents make up the bulk of this group. The contractor will either provide the DOT specification containers or transfer the liquid fractions to a single bulk transport unit. Where feasible, this broker will sell the flammable liquids to a bulk processor of blended waste fuels.

All of the liability relationships described for the laboratory waste chemicals apply to this group of liquid flammable residuals. Questions of liability arising from temporary storage at the broker's transfer site (with respect to PETC) appear to be similar to that of the waste generator vis-a-vis the ultimate disposal site. Regulatory interest in this part of industrial waste management is manifested by the regulatory need of a state permit to operate a storage facility, fuels reprocessing operation and ultimate disposal site. Practical and legal considerations would indicate the impossible task of specifically identifying the damage contribution from the wastes generated at PETC in the case of an accident, deleterious health effects to on-site personnel or the public at large, or pollution episodes at the temporary storage location and the fuel

reprocessing plant.

C. Process Wastes (From Ongoing Research Projects): At the present time, operations at the Pittsburgh Energy Technology Center are producing some relatively small volumes of what has been described as indeterminate (with respect to potential hazardous classifications by RCRA standards) wastes. The scope of this report does not include a detailed assessment of the process residues presently generated and future residuals from proposed test and pilot plant evaluations. However, handling of some waste streams such as char from the now discontinued (at PETC) Synthene process, slags from fluidized bed combustion evaluation, coal dusts, coal catalyst residues does have a history at the facility.

The solid residuals (chars, slags and coal residuals) have been deposited on-site. It is not clear from the data already gathered whether the disposal area was engineered, prepared and constructed to some developed standards or specifications. A major goal of additional research should be to assess the regulatory and environmental impact implications of past practices at the Center.

Wastewater, accumulated as a consequence of operating the Synthene plant by an outside contractor (Lummis Co.), was consigned to a disposal company for offsite treatment and disposal. The procedures used in the management of this relatively high volume (as compared to liquid wastes from laboratory operations) have not been clearly reported in any detail. The only statement that can be made with some certainty is that the wastewater left the Energy Technology Center.

Presently the wastes resulting from the research projects are being managed in the same institutional framework. Outside contractors (in this case, the General Electric Company) are saddled with the responsibility

of managing the residuals from the magnetohydrodynamic research project. It has come to our attention that their proposed management scheme is to consign the residues to the most responsible waste broker available at the present time. Characteristics of the wastes may be known, however the broker has not been made aware of them in any great detail. It appears that the project contractor is depending on the broker to provide an approved (by regulatory agencies) methodology with a dearth of information. The case in point is the solid residuals, which may contain or be made up entirely of soluble salts, with some potential for environmental degradation. Possible health effects associated with the residuals streams are even more tenuous and may not be addressed in this management system.

Due to the greater quantities of this category of residues, there may be some important economic constraints that should be included in the transport and disposal elements of overall management. The wastes are indeterminate, with assessments ranging from innocuous (or inert) to extremely hazardous, depending on the vested interest of the group making the determination. It will be important, both from an economic and public health protection view, to come up with alternatives that are viable. Greatest difficulty will be in establishing the reliability of any chosen system in the rapidly changing regulatory climate.

3.2 Present Management Policies

A cursory examination of management policies which seem to be influencing present practices include the following factors: (1) internal policies at the Pittsburgh Energy Technology Center; (2) policies and procedures of the responsible environmental regulatory agencies; and (3)

the waste management industry procedures.

1. Internal Policies and Procedures at the Center: The perceived objectives of PETC with respect to management of residuals are: (a) handling and disposal of the wastes generated in compliance with all the governing statutes; (b) greatest possible separation (in a liability and legal sense) from pollution and accidental spill episodes; (c) adhering to administrative procedures that may be imposed by a higher central authority (DOE general policy-both stated and implied); and (d) minimal involvement in external management of the residues. Fiscal policies may act to constrain the selection of waste management alternatives with regard to restriction of capital expenditures and directing spending toward operational costs. There also may be an established policy covering use of consultants and contractors for on-site operations.

Where the proper management of residuals is considered, there is a conflict in objectives in almost any research endeavor. Primary objectives of any effort in a facility such as PETC is the achievement of research goals i.e. to provide new processes of coal conversion with more convenient and economical forms of energy to the ultimate consumer. Management of the residuals may be counterproductive due to the introduction of economic and environmental constraints into the overall assessment of the conversion processes. A more detailed analysis of prevailing policies should be undertaken by the Center to optimize the fulfillment of their primary mission with the least probability of major disturbances from the residual component of the processes under investigation.

2. Environmental Regulatory Procedures: Present policy covering the control of the classes of residuals generated at the Center are not

specifically delineated in any one regulation or statute. Practices in environmental pollution control have evolved over time and vary from one region to another. Individual administrative style, especially in managing hazardous wastes, has had more influence in determining acceptable handling methodologies than that of published regulations. The main explanation may be in the interpretation of the regulations as they are deliberately vague with respect to intrinsic characteristics of hazards. Most regulations include a catch-all phrase which can allow wide latitude of discretion on the part of the regional environmental enforcement administrator.

Historically, the leading enforcement activity has been taken by the Pennsylvania Department of Environmental Resources. The key administrator (at least in the initial phases of chemical waste processing and disposal) has been the regional solid waste director. He has set the judgmental tone for acceptable disposal techniques due to the absence of strictly delineated regulations and low level of guidance from the federal authorities.

Allegheny County involvement has increased in the last year but both the county and state look to the U.S. Environmental Protection Agency for directions since the development of the federal regulations. Although the apparent intent of policy and procedures practiced by all three levels of government is directed toward more federal involvement, the effect of their enforcement activity has been the movement of most chemical and industrial wastes to other states for ultimate disposal. It is not the present policy nor is it legally possible for the county or state to control or review the ultimate disposal mechanisms utilized outside their own jurisdiction. Actual disposition of the residuals outside their political

boundaries is of interest for informational purposes only.

A radical change in the above situation is expected as a result of promulgation of new federal regulations (with the goal of uniformity of enforcement) covering hazardous wastes. Most of the states, in our case the Commonwealth of Pennsylvania, have publicly stated their desire to accept primacy for enforcement of the federal statutes.

3. Waste Management Industry Procedures: Present operating strategies of the waste disposal industry, from the small waste broker to the national companies, is to process the residuals at minimum cost within the present regulations that are enforced. They will move the residues to a location, which complies with regional statutes as they are applied by local regulators, where disposal practices entail the least cost. An example of this strategy in action is the movement of industrial wastes (defined by present regulations or interpretation of the statutes)

from the Pittsburgh area to a disposal site near Youngstown, Ohio. The industry is very responsive to the everchanging levels of enforcement activity, economics being the prime mover in directing industrial waste streams to specific locations.

Long range goals (and policies now in the process of formulation) of the industry is to prepare new sites that will comply with the proposed RCRA regulations. The waste disposal industry does not expect radical alterations in the proposed regulations dictating the processing and disposal compliance standards before the regulations become law.

3.3 Regional Management Resources

In order to develop a realistic and feasible residuals management plan for the Pittsburgh Energy Technology Center, a determination of

present and future resources needed for implementation is necessary. External (from the Center) physical resources include a service industry with the necessary capabilities for pick-up and transport of the residuals, processing (where appropriate) plants and land disposal installations. Some resources for handling spent laboratory chemical and process wastes are now in place in the western Pennsylvania region. A chemical waste disposal industry is in the development phase in the Pittsburgh district. Large operations already exist in this area for the processing and treatment of acid and alkaline residuals. Some liquid waste incinerators are in operation, but none of them have any great capacity and are only available for processing on-site combustible liquids. Land disposal facilities running the gamut from sanitary landfills to specialized industrial waste operation are in existence. A number of newly proposed sites are in the process of obtaining permits for management of some residuals generated at the Center.

A. Handling and Transport

Almost all refuse disposal services offered in the region can provide pickup and removal of the laboratory waste chemicals and the larger waste streams. None of them can furnish the certification now required (approval by the responsible enforcement agency) by the Center. Two of the listed companies (RAD Services and Ecology Chemical & Refining Co.) do provide packing and containerization services which comply with DOT regulations. Chambers Development Company and Sabatini Disposal Service will offer similar help without the certification.

National disposal companies (Chem-Dyne, Browning Ferris Industries, Rollins-Perl) are processors of bulk waste streams. They will store and pickup wastes in 30 yard containers (roll-off containers and tanks) and

3000 gallon skid-mounted tanks) and stationary storage tanks for liquid wastes. Many of the local liquid waste handlers (A-M-O Pollution, Inc., Chambers Development Co., Kelly Run Sanitation, Browning Ferris Industries) have truck-mounted vacuum pumps for removing liquid wastes from stationary storage tanks located on-site. The vacuum tankers can also be used to remove sludges and liquid wastes from lagoons and ponds.

Bulk waste acids (3500 gallon lots) are collected at the generating location and processed by Mill Service Company and Industrial Waste Co. at their own regionally located neutralization plants. They also handle inorganic wastewater treatment plant sludges and liquids.

As can be surmised by the above and Table 3-2, there is no lack of resources available for management of the Center's waste streams. All of the activity described above is carried out under present day regulatory requirements.

B. Processing and Treatment

The only industrial waste processing facilities (for off site residuals) located in the PETC region are the two acid neutralization plants. Most wastewater treatment installations in the area are specially built units for on-site treatment of the manufacturing facility. Units are not available for treatment of off site residuals. Many regional sewage treatment plants are now in operation as part of a regional sewage system. In some special instances, they may treat delivered industrial wastewater. With the advent of RCRA regulation enforcement, the sewage treatment plants will no longer process small lots of organic wastes from industry. Regional waste processing (by the disposal industry) of organic residues by employing biological treatment is non-existent.

PICKUP & TRANSPORT SERVICE COMPANIES

Refuse Haulers Offering Industrial Waste Services (LOCAL)

Kelly Run Sanitation Co.	Sovereign Sanitation, Inc.
Chambers Development Co.	Sabatini Disposal Service
Sanitary Landfill, Inc.	Browning-Ferris Industries of PA.

Industrial Waste Disposal Services (LOCAL)

A-M-O Pollution Services, Inc.	Ecology Chemical & Refining Co.
Industrial Waste Division of Cenco	Browning-Ferris Industries
Mill Service, Inc.	W. D. May Industrial Services.

Waste Oil Handlers and Processors (LOCAL)

A-M-O Pollution Services, Inc.	Pitt Oil Company
Ecology Chemicals & Refining Co.	Wiseman Oil Corporation
Mill Service, Inc.	

Special Hazardous Wastes Processing Services (NATIONAL)

Rollins-Perl (Phillipsburg, New Jersey)
Chen-Dyne (Xenia, Ohio)
Chem-Trol, Division of SCA, Inc. (Model City, New York)
Erie Pollution Control, Inc. (Cleveland, Ohio)

Table 3-2 Disposal Industry Resources Available for PETC Residuals

Individual on-site industrial liquid waste incinerators are in operation in the region (Arco Polymers, Inc. in Monaca is one unit). There is one liquid waste incinerator processing a wide spectrum of liquid residuals from various industries. However, the unit can process approximately ten gallons per hour and consequently cannot be considered an available resource. The nearest industrial waste incinerator processing a wide spectrum of residuals is in the Cleveland area almost two hundred miles away. Plans have been announced by several groups of entrepreneurs, over the last five years, to erect and operate relatively large capacity units. None have come to fruition.

C. Land Disposal

There are six permitted sanitary landfills located in Allegheny County. Their locations with relation to PETC are shown in Figure 3-1. All of them, with the exception of Baillie's Landfill, have and still are processing some wastes similar to the PETC residuals. (15) Chamber's Landfill in Monroeville disposed of laboratory waste chemicals (approximately 500 pounds) every six to nine months. This operation was carried out with the knowledge of environmental enforcement authorities and did not have any apparent environmental impacts. In the present regulatory climate, activity of this type is no longer feasible. However, all of the sanitary landfills, except as noted, have the potential to develop a small portion of their facility to process the waste streams generated at the Technology Center and comply with all existing and proposed regulations. Armoni's and Kelly Run Landfills would present the most feasible choices, if the proper incentives were forthcoming. As of this date, the financial incentives to offer hazardous waste disposal services by these

companies has not exceeded the risks and liabilities involved in complying with existing statutes.

Figure 3-2 is also a map of ultimate disposal facilities (and their geographical orientation with PERC) which process industrial solid waste streams. Included are all of the flyash disposal sites in the county that are used by the Duquesne Light Company. Also shown is the site run by West Penn Power for the Mitchell Station because it is relatively close to Bruceton. Codisposal of flyash with the indeterminate waste streams may be practical from a technological standpoint, but some institutional factors must be altered. The power companies do not have any motivation to share their disposal resources with others (unless they own and operate the full scale coal conversion plants). From an environmental protection perspective, the scheme for codisposal makes some technical sense.

New disposal operations to process stabilized flue gas desulfurization sludges are about to go on-line. Of greatest interest to PERC is the Municipal and Industrial Disposal Company site in West Elizabeth. This facility will process stabilized FGD wastes which (in time) become an excellent base material for containment of biological sludges and hazardous wastes. This concept was developed to handle the biological sludges generated from wastewater treatment at the U.S. Steel coke works in Clairton. Another FGD sludge disposal site is in the construction stage in Ambridge to handle the waste stream from Duquesne Light's Phillips Station. Both installations are privately owned and do have a strong interest and incentive to accept residuals originating at the Energy Technology Center.

The Phillips disposal site in Stowe Township disposes of cement

dusts, steel mill slags and some indeterminate industrial solid wastes generated by the industrial complex on Neville Island. This location has the potential for development into an operation that could handle large tonnages of industrial solid wastes with regulatory compliance.

CHAPTER IV

RECOMMENDED RESIDUALS MANAGEMENT PLAN FOR PETC

4.0 Introduction

Any recommended waste management plan for the Pittsburgh Energy Technology Center must be capable of attaining the primary objectives of the Center by its implementation. We see the objective for the plan as management of all waste streams generated by the Center's activities in total compliance with statutes and in the safest manner possible with minimum cost. The goals (regulatory compliance, safety and low cost) are not arranged in any order of priority. In order to develop an implementable system, all of the constraints acting on the available choices must be taken into account. Some criteria for measurement of goal achievement is also necessary.

The recommended plan is structured to address the following elements: (a) management resources of the Center covering an administrative structure, communications network, and data requirements; (b) components to be covered in the on-site portion of the management plan; (c) short term measures for handling laboratory waste chemicals and indeterminate waste streams; (d) long term planning for future implementation needed to comply with proposed federal regulations; (e) on-site processing and disposal alternatives; (f) strategies for developing off-site processing and disposal resources; and (g) potential systems which could provide reliability and economy if institutional and political constraints are eased.

Protection of the environment from undesirable impacts (with reasonable costs) is the major objective of the plan. Present practices appear

to attain this objective when processing the laboratory waste chemicals. Present methodology utilizing single disposal contractor consignment of all small waste streams generated at the Center, with subsequent transport of some residuals 800 miles via common carrier for final disposition, engenders (what are now considered) reasonable costs. On-site disposal (in an uncontrolled manner) of the slags, chars and coal dusts have not resulted in any serious environmental impacts (of which we are aware of at the present time). This technique has been acceptable only due to a low assigned priority by responsible enforcement agencies. Both of the above practices will be in jeopardy and most likely will not be acceptable with strict enforcement of federal RCRA regulations.

Storage, transport, processing and disposal of solid waste streams is not the total content of the management plan. An administrative effort must be defined with regard to making the system function properly. Policies, administrative responsibilities, individual capabilities of the relevant personnel are all involved. A clear delineation of authority is essential in the relationships between the Center and headquarters operations (DOE), departments and divisions within the facility and external dealings with federal, state and local environmental enforcement authorities.

4.1 Recommended Management Plan

Major components of the internal portion of the residuals management plan proposed for the Pittsburgh Energy Technology Center are centered on a management organization with clear lines of authority and responsibility, detailed data base and communications network to transfer information to the users, and a central storage unit to provide

physical control of hazardous residues as long as they are at the Center.

A. (1) Management Structure

Figure 4-1 is a conceptualized organization chart designed specifically for management of all waste streams generated at the Center. It is a basic concept that can be modified to fit the circumstances and present operations policy of the Center. A description of the authority and responsibilities of the individual elements in the organizational structure are detailed as follows:

DUTIES AND RESPONSIBILITIES

DIRECTOR (TECH. CENTER): In the context of the proposed waste management system, the Director of the Pittsburgh Energy Technology Center must delegate the necessary authority (through the appropriate divisions and levels of management) eventually to the Administrator of the Residuals Management Plan.

DIVISION DIRECTOR (Environmental and Conservation Division): Same as above. Main function is to delineate the line of authority coming from the Director of the Technology Center.

ADMINISTRATOR-Residuals Management: Note: We envision this position as part time, which may create conflicts in objectives between this individual's major activity and those associated with the residuals management plan. Consequently, the person chosen to be responsible for the plan (this is the key operator who will influence the success or failure of the recommended system) must have minimal or no conflicting job requirements. The Branch Chief for Environmental Monitoring may be the logical choice

Figure 4-1 Organization Chart for Recommended Residuals Management System

for this position as his present duties have the least inherent conflicts.

Authority:

1. Can ban any toxic chemical (or dictate a substitute) from laboratory or research project use (also outside contractor's chemical usage), with concurrence of the professional science advisory committee.
2. Can ban any toxic chemical (or dictate a substitute) which is used for general household and processing operations. This includes solvents, cleaners, rodenticides, insecticides, etc.
3. Can cancel or alter any contractual arrangements with waste brokers and refuse haulers for good cause (within the legal limitations).
4. Can assign or remove Center personnel from the Residuals Management System for good cause (within union, legal and organizational limitations determined by overall Center policies and procedures).
5. Can determine policies and procedures in the operation of the Residuals Management System with the concurrence of the professional science advisory and facilities operations committees (within budgetary limitations set by the Center Director).

Responsibilities:

- A. Handle all liason with environmental enforcement agencies and OSHA where the Residuals Management System is involved. This refers to all site specific matters.
- B. Serve on the professional scientific advisory and plant operations committees to provide communications in both directions.
- C. Select and evaluate consulting specialists services (and in-house staff) providing support functions to the residuals management organization in a staff capacity.

- D. Supervise the implementation and operation of the Residuals Management System by in-house personnel (especially in the physical operation, design and safety procedures needed for the recommended chemical residues storage facility).
- E. Determine and develop long range goals and alternatives for the management of relatively non-hazardous wastes streams (present and future) originating from the Center's operations.
- F. Act as liason with other Technology Centers for information transfer in residuals management.

The above listing is not intended to be all inclusive.

PROFESSIONAL SCIENCE ADVISORY COMMITTEE (Staff Function):

Authority: None.

Responsibilities:

1. Advise the Administrator of the Residuals Management System on the feasibility of eliminating specific hazardous chemicals and substances from the Center's research activities.
2. Provide input into the detailed chemical waste data sheet system which must perform as the heart of the information system.
3. Furnish advance information on new chemicals and potential chemical residues from laboratory and project operations.
4. Give general scientific support to the Administrator as required.

FACILITY OPERATIONS COMMITTEE (Staff Function):

Authority: None

Responsibilities:

1. Provide advice on feasibility of toxic chemical substitution for general operations.
2. Give overall support to the Administrator with research contractor operations and liason with other Center personnel.
3. Give general operations support for facilities construction and equipment (and manpower) needs.

SPECIAL CONSULTANTS (INDUSTRIAL WASTE MANAGEMENT):

Outside consulting services can be utilized to establish and maintain the detailed chemical residues and indeterminate waste streams data sheets. Initial assistance in implementing the round-trip manifest system recommended can also be provided (this is a minimal task). Outside services should also be obtained in the following aspects: (a) assistance to the Administrator in his relations with the various environmental control and occupational safety enforcement agencies; (b) treatment and disposal concepts and systems specially tailored to the Center's operations. Vendors do provide this service, but in some instances it may not be in the best interests of the Center, it will always be in the vendor's best interests; (c) design and construction of the recommended storage area; and (d) studies relating to on-site processing and disposal alternatives for the indeterminate waste streams, as well as characterization of those residuals.

LEGAL SERVICES: Legal services (either in-house or as part of the general legal services employed by the Center) should be available to the Administrator as required.

The implementation and operations arm (operations and plant services) to actually run the day-to-day affairs of the residuals management organization is not conceived as full-time employment for the individuals involved, but as an adjunct duty of the qualified and trained personnel that are now performing some of the functions described.

(2) Information Network

The heart of the information network is the individual chemical waste data sheet which is illustrated in Figure 2-1 and 2-2. The purpose of this detailed information is to provide specific identification of the substance, possible health effects, its hazardous nature, safety and first aid procedures and recommended processing and disposal data. It is expected to be of great assistance to the Administrator and operating personnel in case of accidents and to aid in monitoring proper handling and disposal of the residues generated at the Center.

Another document which must be installed as part of the residuals management information system is the round-trip manifest for all wastes that leave the Center. This manifest can be modeled on the form used in California, Illinois, New York, or the sample document published in the proposed RCRA regulations. The routing and procedures for return of the form should be made mandatory on the part of the waste broker. The manifest system will provide the information needed to ascertain compliance with all existing environmental regulations.

It is only a matter of time before Pennsylvania required the manifest operation. Establishment of the manifest for the Center's residues will be in-place and operating for early compliance with the proposed federal regulations. A minimum effort (by the Center) will be needed

to close the loop on information flow. The returned manifest form will be checked off by the overall waste management foreman and be dispatched to central files. Policy and procedures should be set with respect to the length of time and form (microform) the records will be stored. Figure 4-2 depicts the information networks envisioned for the Residuals Management Plan.

B. Immediate On-Site Recommendations

Immediate implementation of the recommended residuals management system is initiated by establishing (or erection) an on-site storage area for the laboratory waste chemicals and household wastes with hazardous characteristics. Also, very detailed procedures must be developed to insure safe and systematic operation of the storage area. Space requirements should be determined and the storage operation installed.

(1) Storage Area Requirements:

As detailed in Section 2.2B of this report, a central storage facility should be established with the attributes listed on page 62 and 64. This may take the form of already existing storage space in one of the Center's buildings, but preferably it should be a small separate building located some distance from the main personnel concentrations. Detailed layouts should be conceived for proper temporary storage of the hazardous residues.

(2) Management Procedures

Detailed step-by-step procedures should be developed to detail the movement of all chemicals and household wastes to the above storage area. Authority and responsibility should be delegated as required and assigned

Figure 4-2 Information System Flow Network

to insure close supervision of this element of the Residuals Management Plan.

C. Short Term Management Recommendations

For the intermediate time (present to passage and enforcement of RCRA regulations), the following recommendations are offered for the management of laboratory waste chemicals and the indeterminate wastes:

- (1) The present set-up for consignment and handling of laboratory waste chemicals by an outside waste broker who certifies the disposal of the materials in a legally permitted facility is the best available choice. Due to the small volumes and relatively small total costs to maintain this option, the transport of the residuals to very distant locations is economically feasible. Continued use of Ecology Chemical and Recycling Co. (as long as their prices are competitive and they can provide certification) is recommended.
- (2) A manifest system complying with all of the new federally proposed regulations should be installed as soon as possible.
- (3) A study should be conducted of potential for resource recovery in the form of heat from the flammable residues. The pricing mechanism (with respect to consignment and off-site handling) should be included in the study. It may be feasible to install a bulk storage unit (tank), aggregate the flammable liquids, and enter into agreements with a waste oil recycling company for the sale of this liquid waste. This aspect must be within the institutional and policy constraints imposed by the Center's management.
- (4) Indeterminate waste streams should be characterized in the context

of proposed federal regulations. Based on the findings, a management plan must be developed for this residual category. Present alternatives to be considered include: (a) on-site disposal in accordance with acceptable present day methodology without going through a permitting procedure (with PennDER), but with their assistance; (b) if the volumes are not excessive (with concomitant high costs of off-site processing) and the physical nature of the residuals permit easy storage and transport, develop a mechanism for transport to a nearby disposal site. Municipal and Industrial Disposal operations in West Elizabeth appear to have the greatest feasibility if the details can be negotiated.

D. Management Plan Recommendations - Long Term

Some long term elements of the recommended management plan (after implementation of RCRA regulations) must be considered. Greatest impact of the regulations will be felt by the disposal component of management of the residuals from the Energy Technology Centers.

(1) Establish the waste category to be assigned in accordance with the final form of the RCRA regulations. This is especially critical in the case of the mixed wastes that may not end up in the "hazardous" category. The recommendation should be documented during the installation phase of the detailed chemical waste data sheets.

(2) Determine the feasibility of establishing an on-site disposal operation that will comply with RCRA regulations. This installation can be designed to process the residuals from two or more Energy Technology Centers. A joint venture with the Morgantown Center (with the disposal site at Bruceton) may be desirable because: (a) it will insure the

least disturbance or constraints on the Centers' primary research goals;

(b) share the costs of the operation; (c) avoid delays in mounting new research efforts due to lack of disposal options for expected residuals from that research; and (d) Bruceton possesses some very important attributes - remote location and available land - which will minimize social and political constraints. This recommendation is especially relevant to the large indeterminate waste streams.

(3) Determine the conditions which would make an on-site liquid or solid/liquid waste incinerator feasible. The unit can be installed in two or three phases. First, a liquid waste incinerator without the air pollution control auxiliaries (scrubber or baghouse) could be erected. This unit would be limited to processing the hydrocarbon liquids, toluene and solvents (acetone) that make up the major portion of liquid residuals generated at the Center. Some of the solid flammable materials could be dissolved (this must be determined) and processed as liquid residues. Potential for heat recovery should be assessed. Feasibility of later addition of air pollution control devices (if necessary) to expand the spectrum of residuals that can be processed should be analyzed. Joint venture arrangements with Morgantown and other Technology Centers should be explored. There will be very strong incentives to implement this recommendation at some future date. They include: (a) easier compliance with RCRA regulations and the EPA avowed goal of encouraging incineration as a disposal alternative; (b) removal of impediments in fulfilling the primary mission of the Energy Technology Center; (c) reduction in costs with increase in utilization of the incinerator, (d) use of existing technology thereby avoiding risk of failure of the chosen system if it is not a proven technology.

(4) Development of an acceptable land disposal methodology by installing an on-site experimental disposal area which possesses the necessary hydrogeological and physical design features for compliance with RCRA rules. The size (or capacity) of the experimental land operation can be adjusted for joint venture opportunities mentioned above, or for PETC use only. Residuals to be processed will cover the entire range of residuals generated at the Center.

(5) Encapsulation, solidification (and stabilization of project waste streams) and pre-processing of some residues should be explored and assessed to derive a least cost solution to residuals management.

4.2 Summary of the Plan

A. Establish a management organization at the Energy Technology Center which can be designed to administer the whole spectrum (size, volume, and class of residual) of wastes generated at the present time (under present regulatory conditions) and in the future (with new federal statutes).

B. Develop and create an information (and data) network which includes a detailed waste chemical characteristic data sheet for use by operations, management, safety and disposal personnel. A round-trip manifest system should be installed as soon as possible.

C. Install a hazardous waste chemicals holding area at the Center for close supervision and safe storage of the residuals prior to consignment and transport off the facility.

D. Continue the present methodology (waste broker consignment) for management of residuals generated at the Center, at least for the short term.

Establish requirements for a reliable system to comply with expected federal regulations.

E. Check the feasibility of acquiring and utilizing a liquid waste incinerator (on-site) to process the flammable liquid residuals produced at the Center.

F. Assess the economic and institutional feasibility of a joint venture with other Technology Centers for processing residuals from both installations at the Pittsburgh Energy Technology Center.

G. Determine the viability of constructing an experimental land disposal operation at PETC to handle all residuals in accordance with the federal statutes.

H. Explore the feasibility of off-site disposal of the wide spectrum of residuals by land disposal techniques.

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APPENDIX-I

Other Project Activities

As envisioned by the technical project officer, this final report was developed to be utilized as a "working document" by PETC personnel engaged in the problem of solid waste disposal from a complex industrial research site. This document could also be utilized by other energy technology centers and as a starting point for larger scale coal conversion facility operating and design personnel.

During the course of this research activity, University of Pittsburgh personnel conducted rapid leaching tests in accord with RCRA guidelines and other self-designed leaching tests on samples of Synthane gasification and Synthoil liquefaction solid waste residuals. Leachates were analyzed for key heavy metal and organic pollutional parameters. Data from this phase of testing is presented in reference 23 of this report. The entire paper will be published as part of the ASCE-EPRI Conference Proceedings in fall, 1979 by the American Society of Civil Engineers, New York City.

Also, during the course of this research activity, the University of Pittsburgh was requested to participate with DOE/FE and ASTM in a "round-robin" testing evaluation of the EPA-"Toxicant Extraction Procedure" in conjunction with the ASTM methods "A" and "B" on several samples of coal related and industrial derives sludges. Results of this participation and results from other participants may be found in:

Phase I Progress Report: ASTM D-19.12 Collaborative Test Program prepared for ASTM, Subcommittee D-19.12 Philadelphia, PA

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