UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1201 ELM STREET
DALLAS, TEXAS 75270

Mr. Pete Smith
800 North Lindbergh Ave.
St. Louis, Missouri 63166

Dear Mr. Smith:

Enclosed are copies of the summary reports for PCB incineration at the Ensco facility in El Dorado, Arkansas, and the Rollins facility in Deer Park, Texas. A technical report will be available through the National Technical Information Service (NTIS).

When the technical report is available, I will let you know how to order the report, as well as the cost.

Sincerely yours,

R. Stan Jorgensen, Chief
Solid Waste Branch

Enclosure

Incineration of PCBs

Summary of Approval Actions

Energy Systems Company (ENSCO)
El Dorado, Arkansas

February 6, 1981
EPA Region 6
Air & Hazardous Materials Division
Solid Waste Branch
1201 Elm Street
Dallas, Texas 75270
214/767-8941

MONS 208330

I. Background: What are PCBs?

PCBs (polychlorinated biphenyls) are a synthetic group of chlorinated organic compounds first synthesized in 1881. When commercial production began in 1929, PCBs were initially used as a dielectric fluid in electrical transformers and capacitors. Later, their use was expanded to hydraulic fluids, glues, varnishes, printing ink, and epoxy paints. The advantages of PCBs as an electrical insulator included their thermal stability and resistance to degradation.

Initially, PCBs were not considered toxic (low acute toxicity was demonstrated in animal studies), but PCBs were later found to be a high risk chronic toxicant. In 1966, PCBs were identified as widespread environmental contaminants. Through Congressional action, in 1976, the manufacture of PCBs was banned. Final regulations controlling PCB storage and disposal were published on May 31, 1979.

Studies estimate that 750 million pounds of PCBs are still in use in transformers and capacitors, 20 million pounds are in storage, and 440 million pounds have contaminated the environment. According to our current knowledge of PCBs as an environmental and health problem, PCBs accumulate in animal fatty organs and tissues (especially in fish and poultry) and can cause human liver and kidney damage through ingestion or direct contact.

II. The PCB Regulations: How do they control the problem?

The May 31, 1979, PCB regulations (40 CFR Part 761) banned the manufacture, distribution in commerce, and use of PCBs after July 2, 1979, and detailed specific storage and disposal requirements. All PCB concentrations greater than 500 parts per million (ppm) must be incinerated under EPA prescribed conditions. Much of the electrical industry's PCBs fall into this category. Other disposal methods for lower PCB concentrations (50-500 ppm) include landfilling and incineration in high efficiency boilers.

The requirements for PCB incineration approval allow the EPA Regional Administrator to conduct a trial burn to ensure that the operational requirements of the incinerator regulations are met. The regulations require stringent monitoring of the amount of PCBs stored, the amount fed to the incinerator, and the conditions under which the PCBs are incinerated.

III. The Energy Systems Company (ENSCO) and Rollins PCB Applications

EPA, Region 6 received applications for PCB incineration from ENSCO located at El Dorado, Arkansas, on March 8, 1978, and from Rollins, located at Deer Park, Texas, on April 6, 1978. The first PCB trial burns were conducted at ENSCO in October 1979 and at Rollins in November 1979. Test results revealed the possibility that very low levels of two toxic organic compounds, tetradibenzo-p-dioxin (dioxins) and tetradibenzo-p-furans (furans), were present in the samples.

In order to evaluate if dioxins and furans were being emitted from the stack, additional tests were conducted at ENSCO and Rollins in August 1980. A summary of the test findings, a description of dioxins and furans, and a discussion of the air dispersion and risk estimate from the emission of the dioxins and furans appear in the following sections.

IV. Sampling and Analysis for PCBs, Dioxins, and Furans

In order to determine the emission rates of the various air pollutants, EPA required the facilities to conduct stack emission tests. These tests were conducted by an independent testing firm using methods and procedures prescribed by EPA.

During all emission tests, EPA representatives were on-site observing the tests and recording information concerning the operation of the incinerator and the air pollution control equipment.

Sampling for PCBs, dioxins and furans was performed in the stack utilizing a modified EPA Method 5 sampling d train. The sampling train incorporated two (2) resin cartridges to adsorb the organic vapors. The resin cartridges contained XAD-2 resin and florisil resin. The sampling train is shown in Figure 1.

The resin cartridges were located downstream from the probe and between the third and fourth impingers. The sampling train was designed to collect both particulates and organic compounds in the stack gas. Both resins were used so that the second resin would absorb any residual organic compounds which may have passed through the first resin. For dioxin and furans, the cartridges which house the resins were water jacketed. Cold water from the ice bath surrounding the impingers was pumped into the jackets which maintained the resins at a temperature of less than 70°F. Because of the sensitivity of organic compounds to ultraviolet light, the resin cartridges, impingers, and interconnecting glassware were protected from the sunlight by aluminum foil and opaque plastic.

The stack gases were sampled isokinetically for a period of four hours using the sampling system described in Figure 1. At the completion of each sampling period, the stack samples were transported to the laboratory for analysis. The stack samples were extracted with an appropriate solvent and analyzed using capillary column gas chromatography and high resolution mass spectrometry. For dioxins and furans, an added quality control technique was used. The stack samples were spiked with a labeled dioxin and furan which allowed the analyst to determine the extraction efficiency of each sample.

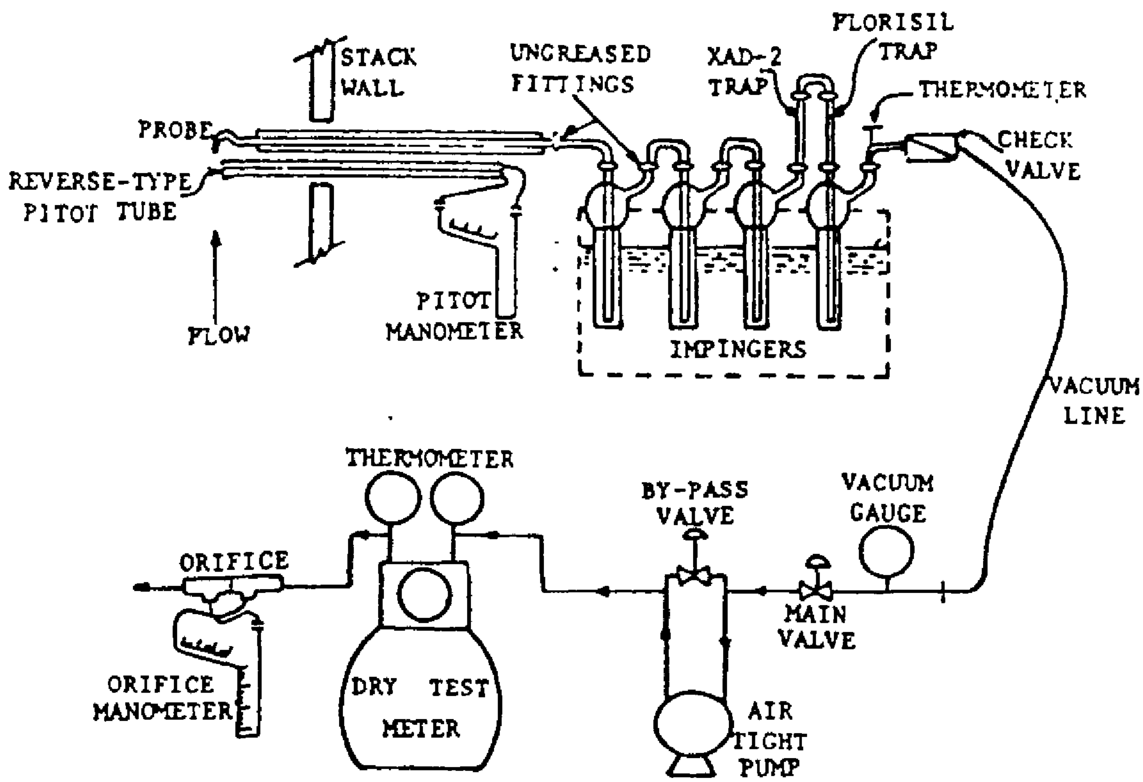

Figure 1 Sampling Train.

V. Summary of Results

Using the procedures discussed in Section IV, emission tests were conducted at the ENSCO facility in October 1979 and in August 1980. The tests conducted in 1979 were to determine the PCB destruction efficiency. Three tests were conducted and the data shown in Table 1 for the October 1979 test are averages of those tests.

Tests conducted in August 1980, were performed to determine the presence of dioxins and furans. The test results shown in Table 1 for August 1980 are based upon the incinerator operating under normal conditions (i.e. the disposal of PCBs and chlorinated organic waste).

ENSCO, El Dorado, Arkansas
Results of Trial Burn

	Oct 1979	Aug 1980
PCB feed rate, lb/hr	636	722
Temperature °F (avg)	2289	2236
CO, ppm (max)	10	7
Excess O_2, % (min)	13.4	9.5
CO_2, %	5.5	8
Particulates, lb/hr	149	23
HCl removal eff, %	98.9	99.8
PCB destruction eff, %	99.99998	no PCB analysis
Combustion eff, %	99.98	99.99
*Dioxin, ng/dscf	not analyzed	0.005
*Furan, ng/dscf	not detected	0.060

Note: the detection limit for the 1979 furan results was 1000 times greater than the 1980 furan results

Table 1

*ng/dscf = nanogram per dry standard cubic foot

VI. Additional Analyses

The results of the first test, showed the possible presence of dioxins and furans. EPA concluded that additional testing was necessary to determine if the operation of the incineration would present an unreasonable risk of injury to health or the environment from PCBs. EPA retested the incineration in August 1980 and verified the existence of extremely low levels of dioxin and furans in the exit gas stream. As discussed in the following sections, EPA used the emissions data to predict ambient concentrations which then became the input for an upper limit of risk estimate. EPA considered this risk estimate in making its final decision on approvability. These additional analyses were conducted because of the known toxicity of one of the dioxin isomers. Since the late 1960's, a series of events such as the industrial accident in Seveso, Italy, in 1976 which resulted in human exposure to 2, 3, 7, 8 TCDD has focused the concerns of scientific and public interest on the extreme toxicity of 2, 3, 7, 8 tetrachlorodibenzo-p-dioxin (2, 3, 7, 8 TCDD). These events have resulted in:

- The suspension of the use of Agent Orange herbicide (contaminated with 2, 3, 7, 8 TCDD) in Vietnam.

- The cancellation of the use of herbicide 2, 4, 5, -T (contaminated with 2, 3, 7, 8 TCDD) in Sweden.

- Suspension of certain uses of 2, 4, 5 -T in the United States.

This interest and concern has generated a large amount of information on the health effects of 2, 3, 7, 8 TCDD and the other isomeric forms of TCDD.

The analogous furan compound 2, 3, 7, 8 tetrachlorodibenzo-p-furan (2, 3, 7, 8 TCDF), has received limited study. The data which have been generated suggest comparable and parallel toxicities between related isomeric forms of TCDF and TCDD. This similarity in toxic properties is expected because of the similarity in chemical structures of the two compounds. At the same time, all evidence shows that there is a quantitative difference in the toxicities, with the TCDF compounds being less potent than the TCDD.

Likewise, the toxicities of isomers of TCDD and TCDF other than the 2, 3, 7, 8 isomer are found to be less potent. There are 22 isomeric forms of TCDD and 35 forms of TCDF.

The toxic effects of 2, 3, 7, 8 TCDD and 2, 3, 7, 8 TCDF reported in humans include:

- <u>Dermatological</u>
  Chloracne
  Hyperpigmentation and Hirsutism

- <u>Internal</u>
  Liver Damage
  Raised Serum and Enzyme Levels

Metabolic Disorders

Cardiovascular Disorders

Respiratory Tract Disorders

Pancreatic Disorders

- Neurological

  Sensory Impairment (Sight, Hearing, Smell, Taste)

  Central Nervous System Disorders (Lassitude, Weakness, Impotence)

VII. Predictions of Ambient Air Concentrations

The dioxin and furan emission data from the second test was used to predict maximum annual ground level concentrations. To predict these maximum ground level concentrations a computer-based dispersion model was used. A dispersion model simulates the plume's behavior as it travels downwind from the stack. The behavior of the plume depends upon a number of parameters including; temperature and velocity of the stack gases, stack height, wind speed and direction and mixing height. These data are entered into the dispersion model and the ambient concentrations that can occur are then predicted. There are various types of dispersion models available which are applicable to particular situations (e.g. rural or urban area, flat or mountainous terrain, high temperature stack, etc.). For the analysis of these facilities the proper model was selected and the maximum annual ambient concentrations were calculated. Maximum annual concentrations of the dioxins, predicted by the model, showed that values on the order of 10^{-14} to 10^{-15} grams/cubic meter could exist downwind of the stack.

VIII. THE UPPER LIMIT OF RISK ESTIMATE

1. Abstract

Many of the decisions faced by today's regulatory agencies require the evaluation of the risks to public health or the environment posed by a particular course of action. Such decisions include the setting of allowable levels of various materials in the environment, permitting or prohibiting the use of new chemicals for specific purposes, or developing ways to minimize the drawbacks of certain activities (such as nuclear power generation).

To assist decision makers, tools called "risk assessment techniques" have been developed. In general, these consist of methods for assembling the scientific research data relevant to the risks in question; guidelines for interpreting the data; criteria for determining the reliablity and scientific merit of each source of evidence; and mathematical models for extrapolating data. A "risk assessment" assembles the available scientific evidence and applies criteria and guidelines to reach conclusions about the kinds and degrees of risks posed by whatever action is contemplated.

The methods and criteria used in risk assessments have varied from agency to agency and even from program to program within an agency. In October of 1977, the newly formed Interagency Regulatory Liaison Group published an Interagency Agreement relating to the regulation of toxic substances. Part of that agreement established work groups to develop consistent and compatible practices in areas of common activity, including risk assessment. The Work Group on Risk Assessment published its report in the July 6, 1979 Federal Register. This is an invaluable source for anyone dealing in risk assessments.

2. The Design of the Assessment

The purpose of the study is to estimate the chance of adverse health effects in the areas of Rollins and Ensco resulting from incineration of PCB's at those facilities. The risks result from emission of two products of incomplete combustion of the incineration process: tetrachlorodibenzo-p-dioxin (TCDD) and tetrachlorodibenzo-p-furan (TCDF).

A risk assessment requires acceptable scientific evidance to build upon. Several important factors remain unknown in the Rollins/Ensco case. Acceptable evidence of toxicity and carcinogenicity exists only for the 2, 3, 7, 8 isomer of TCDD (there are 22 isomers in all), and does not exist for any of the 35 isomers of TCDF. Also, ambient concentrations of these materials have not been measured. As it has in similar situations in the past, EPA has generated what it believes to be an "upper limit of risk" assessment, obtained by making conservative, generally "worst case" assumptions in place of any missing data.

The idea is that if no unreasonable risk level is found under such worst case conditions, then one can have confidence that the risk which actually exists will be even less.

3. The Risk Elements

i. Assumptions: There are certain assumptions which underlie all the elements of the assessment. It is these which give it the character of an "upper limit of risk" estimate. The assumptions include:

1. The entire amount of TCDD found in any sample has the same toxicity and carcinogenicity as the 2, 3, 7, 8 isomer of TCDD. The same assumption is made for TCDF.

   In reality, the scientific data that do exist show the 2, 3, 7, 8 isomer to be the most toxic and the most carcinogenic, exceeding all others by a factor of from 5 to 35 times. This is indicated for both TCDD and TCDF. Also, the 2, 3, 7, 8 isomer would normally comprise only about 10% of any total sample of TCDD or TCDF.

   Thus, the assumption that all the TCDD and TCDF in any sample is equal in toxicity to the 2, 3, 7, 8 isomer is a worst case assumption.

2. The toxicity and carcinogenicity of 2, 3, 7, 8 TCDF equals that of 2, 3, 7, 8 TCDD. Again, for the reasons given above, this is a worst case assumption, leading to an estimate of the upper possible levels of risk.

3. The sensitivity of humans to the health effects of these materials equals that of the most sensitive species observed in lab tests.

4. For 2, 3, 7, 8 TCDD, there is no threshold level below which adverse health effects may not occur. That is, no matter how low the concentration of this material in the ambient environment may be, there will be some level of risk.

5. The duration of exposure to this material will be a 70 year average lifetime period. This is a worst case assumption since, if permitted, the incinerators could destroy the nation's inventory of PCB's in about 35 years.

6. The frequency of exposure is 24 hours per day, 7 days per week for 70 years. This is a worst case assumption since it does not allow for the normal 20 hour per day burn time and down time for repairs, etc.

7. The intensity of exposure is calculated from ambient concentrations of TCDD and TCDF which are predicted by a computerized air dispersion model from the actually measured stack emissions.

8. The total population within the affected area is exposed to the highest ambient concentration of TCDD and TCDF predicted by the model. This is a worst case assumption since most people would be exposed to lower concentrations.

9. All human exposure will be through inhaling tiny airborne particles to which TCDD and TCDF adhere.

10. The typical exposed person·

    a) Breathes at a rate of 20 cubic meters per day.

    b) Ingests and retains 100% of the particulate matter inhaled.

    c) The TCDD and TCDF are absorbed at a level of 100%.

    d) Average person weighs 60 kg. (132 pounds).

    Assumptions b) and c) are "worst case" assumptions. Not all particles breathed in are going to be retained in the lungs. Also, the analyzing laboratory used a hot solvent extraction method with agitation for several hours. Their extraction efficiency for recovering the TCDD and TCDF from the particulate matter was typically about 70%. To assume 100% efficiency for the human tissues is therefore extreme.

ii. Exposure Estimate:

The intensity of exposure is predicted by computer modeling of the measured stack emissions of TCDD and TCDF.

The population exposed was estimated in the following way:

For Ensco: The total metropolitan population of El Dorado, plus the suburban and rural population of most of the county were assumed to be exposed. These figures came from documents used by EPA for water quality planning in the El Dorado area. They are 1980 figures. The estimate is 50,000 people.

The total estimated exposed population is assumed to be located and subject to the highest predicted ambient concentration.

iii. Qualitative Risk Assessment

Table 4-2 in EPA's Office of Pesticides and Toxic Substances Risk Assessment document summarizes for each health effect the lowest dosage which has induced the health effect in question. The table also gives the highest combined dose of TCDD and TCDF predicted at Ensco.

The lowest dosage producing a health effect is seen to be 1,000,000 times higher than the highest dose predicted at Ensco. This is strong evidence that the health effects addressed in this qualitative risk assessment would not result from emissions of TCDD and TCDF.

iv. Quantitative Risk Assessment

The quantitative assessment for cancer was done with the help of EPA's Carcinogen Assessment Group (CAG). They provided a "risk factor" which, when multiplied by the ambient concentration of 2, 3, 7, 8 TCDD (plus all the materials assumed to be 2, 3, 7, 8 TCDD), gives the increased risk of cancer for an individual.

The "risk factor" is obtained by extrapolating the dose response of laboratory animals to the low dosages predicted to be in the environment.

The resulting individual risk for Ensco is 3.9×10^{-7}. This translates to less than 1 increased case of cancer in 2,500,000 exposed persons.

These numbers do not represent an estimate of the actual individual risk from operation of the incinerator. They are an estimate of the upper level of risk possible, and include many worst case assumptions which could not happen in reality.

IX. PCB Incineration Approval Conditions

The May 31, 1979, regulations regarding the incineration of PCBs and PCB items stipulate the requirements which must be met prior to the Regional Administrator granting approval (40 CFR Part 761) Additionally, the regulations allow the Regional Administrator to include any other requirements which are necessary to ensure that the operation of the incinerator does not present an unreasonable risk of injury to health or the environment from PCBs.

The following PCB incineration approval conditions outline specific conditions which must be met to remain an approved PCB disposal facility.

The approved facility must operate above 1100°C, with excess oxygen greater than 3% and carbon monoxide (CO) less than 10 times the CO_2 level to ensure combustion efficiency greater than 99.9%. If at any time during PCB incineration the combustion efficiency drops below 99.9%, or the temperature drops below the minimum specified, an automatic cutoff mechanism stops the flow of PCBs to the incinerator.

The incineration of chlorinated compounds produces chlorine in the combustion gases, which must be 99% removed by the wet scrubber to comply with the PCB approval conditions. Particulate emissions from the stack of the facility must meet the State's particulate emission permit limit. Annual retesting may be required by EPA to ensure continued compliance with particulate and chlorine limits.

Other approval conditions list requirements for handling, storage, marking, and records and data. All PCBs received at the facility must be recorded as to quantity, date received and from whom the PCBs were received. Also, the facility must record date and quantity of PCBs incinerated. These records and the incinerator operation will be monitored regularly by EPA and by an independent contractor who will inspect the facility at random times.

In addition to compliance with the PCB requirements, the incineration facilities must meet all applicable state, local, and federal regulations during PCB incineration.

X. The ENSCO Consent Decree

On January 28, 1981[1], a consent decree was entered in the U. S. District Court, Western District of Arkansas agreed to by EPA and Energy Systems Company. The consent decree does not prescribe or authorize the incineration of PCB material. It would eliminate any potential release of pollutants from the property at issue. The consent decree requires a plan and implementation of measures to correct all known or potential hazardous waste problems at the ENSCO facility.

The primary function of the consent decree is to generate an action plan in order to address and correct the various problem areas at the facility. The Action Plan contains requirements for the following actions:

A. <u>Non-PCB Waste Barrel Management</u>
B. <u>Scrubber Effluent Lagoons</u>
C. <u>Implementation of Fire Control and Emergency Capabilities</u>
D. <u>Bulk Waste Storage Facilities</u>
E. <u>On-site Lagoons and Basins</u>
F. <u>Transfer and Loading Areas</u>
G. <u>Stormwater Runoff Control</u>
H. <u>Tetraethyl Lead Residues</u>

Each major area of the Action Plan will now be discussed in more detail.

A. Non-PCB Waste Barrel Management - ENSCO shall commence implementation of a program to recontainerize or incinerate any leaking barrels of waste material and at the same time reduce the inventory of barrels to a maximum of 1,000.

Further ENSCO must construct a permanent waste barrel storage facility and cleanup the previously used barrel storage areas and incinerate or dispose of the material collected in cleanup. All of the remaining barrels will be placed in the new storage area that will be built in accordance with specifications approved by EPA.

B. Scrubber Effluent Lagoon - ENSCO shall commence implementation of a program to upgrade the scrubber effluent lagoons to prevent seepage, overflow or discharge of fluids from the lagoons. We will require the construction of a third new scrubber effluent lagoon. That will allow ENSCO to take the other existing lagoons out of service for repair or closure. ENSCO is also required to immediately install two new monitoring wells near the existing lagoons to monitor possible seepage.

C. Implementation of Fire Control and Emergency Capabilities - ENSCO is required to implement a program to establish and maintain an adequate fire prevention and response system. This is to be developed in consulation with appropriate local safety authorities and approved by the EPA. This part of the Action Plan requires that ENSCO have available within two months a fire fighting vehicle on-site. The fire fighting vehicle must have a water delivery system and a foam eductor system. ENSCO must also provide a water distribution system capable of delivering fire fighting water to the bulk storage tanks, barrel storage area and the processing area. ENSCO must also develop the plans and procedures for this part of fire control and emergency strategdy and submit these to EPA for review.

D. Bulk Waste Storage Facilities - ENSCO is required to commence a program to repair and upgrade or deactivate or remove from service all tanks associated with bulk hazardous waste storage. In summary, this requires that the dikes of all bulk storage tanks remaining in service and containing hazardous wastes, shall be raised to height capable of containing the capacity of the tank plus a designated quantity of stormwater and still having adequate freeboard. It also requires that all the area within the dikes of those tanks designated for hazardous waste storage be lined with six inches of material sufficient to be relatively imprevious.

Further, rain water falling within the tank diked areas shall be removed within 72 hours and treated in accordance with the EPA requirements. When contaminated, this stormwater must either be treated or incinerated.

E. On-site Lagoons and Basins - ENSCO shall commence a program to cleanup and/or secure all inactive lagoons and basins located within the property. The Action Plan identifies the specific lagoons some of which are from previous refinery operations. The Action Plan requires monitoring wells be placed near one treatment lagoon and the close out of a second lagoon on the plant site. Further, ENSCO must implement a groundwater monitoring program that will include periodic sampling and analysis of groundwater. All data obtained from such monitoring shall be forwarded to EPA.

F. Transfer and Loading Areas - This section of the Action Plan requires that ENSCO upgrade its permanent loading and unloading facilities to facilitate the collection and removal of any chemical spillage or any rain water falling in a contaminated area. ENSCO is also required to upgrade its non-permanent unloading facilities to prevent any seepage from seeping into the ground prior to cleanup.

G. Stormwater Runoff Control - This portion of the Action Plan requires ENSCO to establish a program to collect and treat all stormwater runoff in accordance with the EPA NPDES discharge permit.

H. Tetraethyl Lead Residues (TEL) - This section of the Action Plan requires that within nine months the identified TEL residues be removed, stabilized and placed in a permanent disposal area. This disposal area will be lined and capped to prevent the migration of the waste material. This portion of the plan, as with the other sections requires that ENSCO submit detailed plans and procedures for implementing the required actions within the time periods set by EPA.

This completes a review of the Action Plan and its specific parts. As previously discussed, the Action Plan addresses all non-PCB activities that may contribute to a hazardous waste problem at the facility. Obviously it works closely with the PCB incineration authorization in that it brings to focus those problems that ENSCO needs to correct in order to prevent any migration of non-PCB hazardous waste from the facility or eliminate any potential hazardous waste problems.

The Action Plan requires further study and design by ENSCO. All plans and specifications will be reviewed by EPA prior to construction. If EPA is not satisfied with any ENSCO submission it may issue directives which are then incorporated into the Action Plan. If EPA sees the need for additional requirements necessary to implement the Action Plan, EPA may issue additional directives which will also be incorporated into the Plan.

If ENSCO disagrees with any such changes or additional requirements, it must go to court and prove that EPA's directives are arbitary, capricious and unnecessary to accomplish the objectives of the Consent Decree. Any construction delays of a major subpart of the Action Plan will result in civil penalties of $1,000 per day for the first 60 days and $2,000 per day thereafter. The District Court will retain jurisdiction over this matter so that ENSCO will be subject to the Court's contempt power if it fails to carry out any portion of this decree.