A COMMERCIAL REGIONAL INCINERATOR FACILITY FOR TREATMENT OF LOW-LEVEL RADIOACTIVE WASTE

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ABSTRACT

In 1981, US Ecology, Inc. began studies on the feasibility of constructing and operating a regional radioactive waste incinerator facility. In December, 1982, US Ecology requested turnkey quotations from several vendors for engineering, procurement, and construction of the new facility. After technical and commercial evaluations, a contract was awarded to Associated Technologies, Inc., of Charlotte, North Carolina, in June, 1983. In June, 1984, US Ecology made a public announcement that they were studying two sites in North Carolina for location of the facility. This same month, they submitted their permit application for a radioactive material license to the North Carolina Department of Human Resources. The facility will accept wastes from power reactors, medical and research institutions and other industrial users, and will incinerate dry solid waste, pathological waste, scintillation fluids, and turbine oils. The incinerator will be a dual chamber controlled air design, rated at 600 lbs/hr, with a venturi scrubber, packed column, HEPA, and charcoal filters for pollution control. The stack will have a continuous monitor.

INTRODUCTION

Incineration is a proven method of reducing the volume of waste products and is a well established technology in non-nuclear industrial applications. In 1981, US Ecology, Inc. began a study to determine the feasibility of applying available incinerator technology to the disposal of commercially generated low-level radioactive waste (LLRW) materials. The intent of this feasibility study was to determine whether a properly designed and stringently regulated incinerator could be a safe and efficient means for volume reduction of certain types of LLRW. As envisioned by the company, the incinerator facility would be a permanent regional incinerator located in an appropriate market intensive location.

It was decided that the facility should be designed to handle a combination of waste from power reactors, medical and research institutions and other industrial generators. The facility would process dry active waste (DAW), scintillation fluids, biomedical waste and turbine oils. Low activity dried resins, filter cartridges and filter media were also considered but eliminated at a later date because of their higher activity.

Typical waste streams were developed through a detailed analysis of the waste received at US Ecology's Richland, Washington facility. This information was used to develop the source term for the facility dose model, and to provide physical data in designing the feed system, incinerator, and pollution control equipment. The information analyzed included waste characteristics, radiation readings at the container surface, shipping container size, density of the waste, and, finally, the activity of the waste (including an analysis of each isotope present). Waste streams developed showed the projected radionuclides present, the total activity of each radionuclide and the percent of the total waste volume that contained each radionuclide.

Various combustion technologies were investigated along with different combinations of off-gas treatment and filtration subsystems. Primary consideration was given to three types of incineration technologies: controlled air, fluidized-bed, and excess air. Both dry, wet or a combination of both flue gas filtration systems were considered.

Published information which discusses the viability and reliability associated with LLRW incineration indicates that the technology was available.

Based upon an internal evaluation, supplemented by information from several equipment manufacturers, an economic study was completed. This study showed that a regional incinerator processing from 140,000 to 190,000 ft^3 of LLRW per year would be competitive with shallow land burial facilities. The incinerator process volume will be dependent upon waste type, density, BTU rating, and volume of non-combustibles.

Licensing of the radioactive waste incinerator was considered the most critical controlling factor in the development of the facility. The basic incinerator technology was considered sufficiently developed to answer all technical questions. It was the negative public perception associated with radioactive waste and hazardous waste that was considered the biggest obstacle to the location of the facility. Public reaction can have a direct influence on local and state officials and state officials and regulators. This fact has been the single most influential obstacle in our efforts to build the incinerator. This will be covered in more detail later in the paper.

The initial schedule was projected to show an 18-month time frame from start of engineering through facility start-up. This was based upon a six-month initial engineering time frame for permit preparation. A six-month period was scheduled for review, public hearings and issuance of the permit. This was considered optimistic but attainable. Finally the facility could be constructed within six months from issuance of the radioactive materials license. As we highlight the present schedule later in the paper, we will show how optimistic this schedule actually was.

CONTRACT AWARD

In December, 1982, US Ecology requested turnkey quotations from several vendors for engineering, procurement and construction of the incinerator facility. The vendors represented the three types of combustion process evaluated earlier: controlled air, fluidized bed and excess air. Air pollution control systems bid were both of the dry-and-wet-type designs. The specifications were written based upon a performance-type contract allowing each vendor to propose his specific type equipment. For this reason, equipment, pricing and scheduling varied.

After completion of the technical and commercial evaluations, a two-phase contract was awarded to Associated Technologies, Inc., (ATI) of Charlotte, North Carolina, in June, 1983. The incinerator system selected is a dual chamber controlled-air design, with a venturi scrubber, packed column, High Efficiency Particulate Air (HEPA), and charcoal filters for pollution control. The controlled-air system allows for combustion to take place without excessive turbulence, thus minimizing carry-over of fly ash particles. However, because the waste will be bulk-loaded into the primary chamber, proper mixing of the fuel, air and waste would be enhanced by the addition of a shredder located prior to the incinerator ram feed.

A wet system for off-gas primary filtration was selected in lieu of a dry system because of the projected higher decontamination factor that could be achieved. The scrub solution can absorb gases such as radioactive iodine and can achieve acid gas neutralization. The disadvantage is that the scrub solution must be handled as a liquid, requiring evaporation by means of radiant heat.

The contract that was awarded ATI divided the project into two phases. The first phase included engineering up through design and equipment selection. This information would be used for inclusion in US Ecology's permit application which would be submitted to the state of North Carolina's Radiation Protection Section. The initial project schedule reflected a December 31, 1984 facility start-up.

FACILITY TECHNICAL DESCRIPTION

Facility Layout

The facility will include office space, site laboratory, storage area, feed preparation area, and process area. It will be located on approximately 20 acres of land, with the stack at the center of the acreage (see Fig. 1).

Process Building

The incinerator and the off gas scrubbing equipment and ash storage will be contained in a separate process building. The building will be constructed of 12-inch-thick concrete block and the interior of the building will be maintained at a negative pressure of a minimum of one inch of water column with respect to atmospheric conditions. This will minimize fugitive emissions from the facility. (See Fig. 2).

The process building will have forced-air ventilation using a combination of outside and recirculated air. The ventilated air will be filtered through a dry filter system consisting of a prefilter, HEPA filter, two carbon filters and a final HEPA filter. The filtered air will then be returned to the building or exhausted up the stack.

Operations Area

The operations area will include the drum storage areas, the receiving and shipping area, control room and feed preparation area. These areas will be housed in a pre-engineered building with the exception of a portion of the feed preparation area which is housed in an extension of the process blockhouse to provide sufficient overhead space for maintenance of the shredder and feed system. The feed preparation room houses the DAW conveyor feed system, shredder, a decant room for processing drummed shipments of scintillation fluid and turbine oil, and a room to house the vial breaker used to remove liquid from the scintillation vials (see Fig. 3).

There will be a dedicated area for storage of drums of DAW for incineration. There will not be an area allocated for storage of scintillation fluids or turbine oil. Due to their flammable nature, they will be processed as received by decanting into the facility storage tanks.

There will be a freezer building attached to the pre-engineered building for storage of pathological waste. Also, a portion of the building will be dedicated to short-term temporary storage of waste in transit to an out of state licensed shallow land burial facility.

A hood will be placed over the DAW shredder to contain particulate emissions. The decant and vial breaker room will be ventilated to remove both flammable organic vapors and radioactive particulates. The ventilated air will be passed through a dry filter assembly consisting of a prefilter, HEPA filter, dual activated carbon filter and a HEPA filter prior to discharge to the stack or into the return air system.

Office Area

The office portion of the facility will include offices, a reception area, lunch room, laboratory, decontamination room and locker room facilities. This section of the building will be separated from the operations area by a 12-inch-thick concrete block wall. The block will be filled

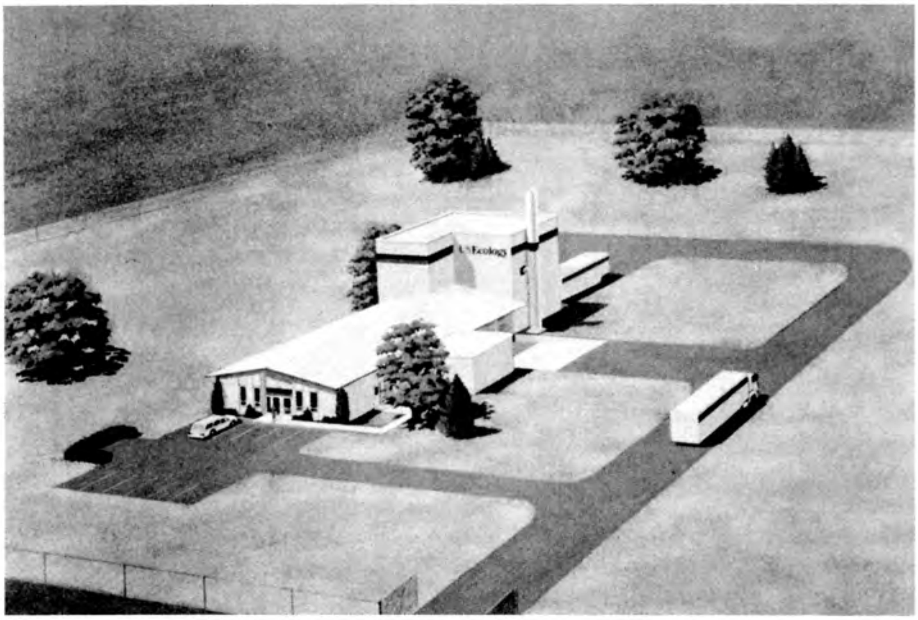

Fig. 1. Facility Layout

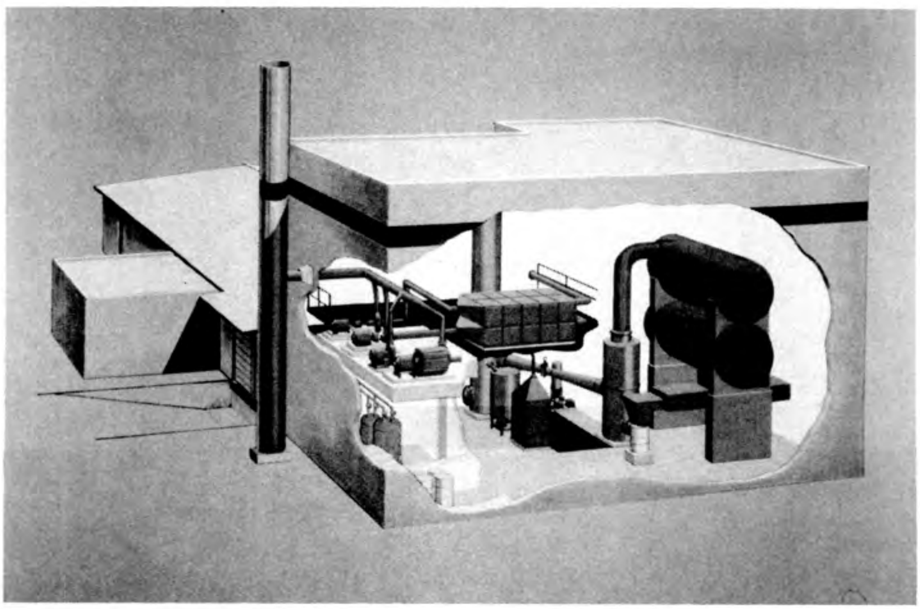

Fig. 2. Process Building

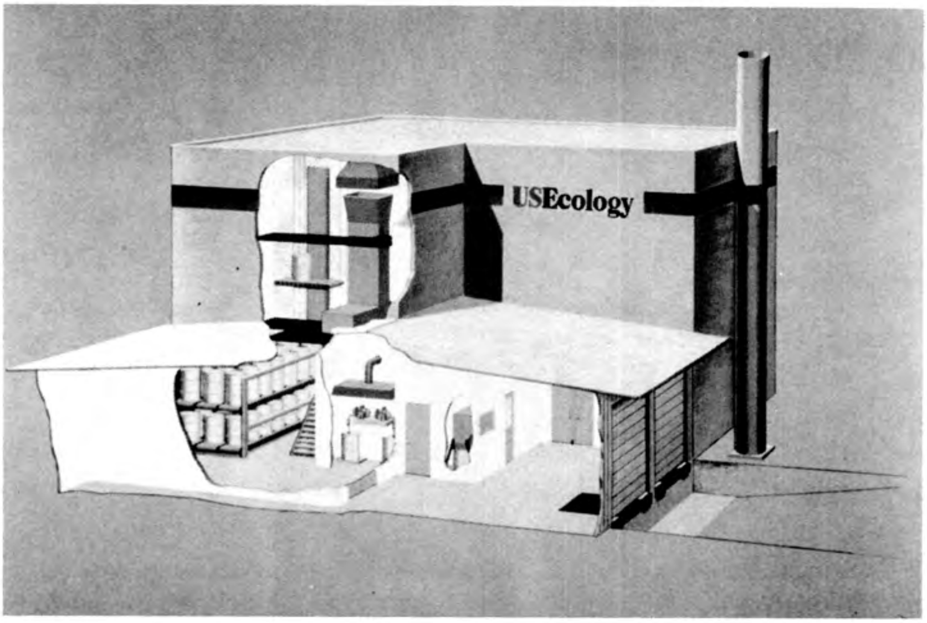

Fig. 3. Operations Area

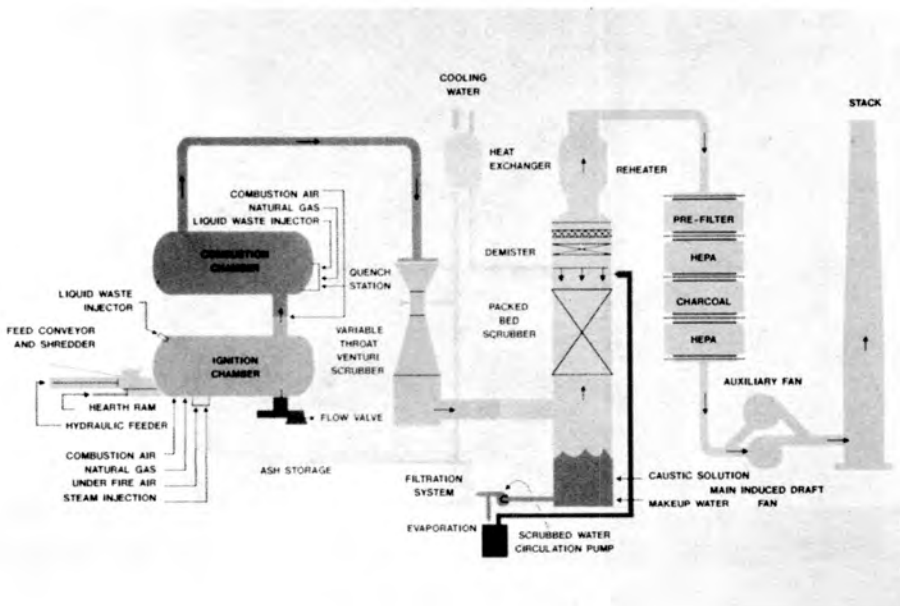

Fig. 4. The System Flow Diagram

with grout to increase its shielding capacity. The wall will also be sealed at the roof to minimize air from the operations area from infiltrating into the office area. Also, due to the nature of the operations performed in the decontamination room (i.e., emergency shower, etc.) and the laboratory, these rooms will have separate heating, ventilation and air conditioning (HVAC) units from the rest of the office areas.

Fire Protection

The entire facility, with the exception of the control room, and office space, will be protected by a Halon Fire Suppression System. The control room will be protected by manually operated portable units.

Sewers and Drains

The emergency decontamination shower and sink, the laboratory sink, and all floor drains in the storage facility will drain to the storage tank located in the process building.

The aqueous storage tank will be located below grade in a concrete vault in the process building. The vault will have access for inspection of the holding tank. The aqueous waste will be processed through the incinerator by injection into the primary chamber. Also, all external drains to the holding tank will be double-lined pipe with a telltale drain for leak protection.

Incinerator Capacity

The incinerator will be designed to efficiently incinerate the below listed waste forms. The incinerator will be capable of operating at the following incineration rates when at full capacity and processing a single waste type.

a. Dry active waste - 600 pounds per hour
b. Pathological waste - 600 pounds per hour
c. Scintillation fluids - 40 gallons per hour
d. Turbine oil - 34 gallons per hour

The facility can simultaneously incinerate all waste types in any combination as long as the total heat released, including auxiliary heat, does not exceed 4.9 million BTU per hour.

Feed System

Waste received for incineration will be unloaded from the transport vehicle onto a conveyor for logging into the facility computer tracking system. The drums will be numbered and all manifest information will be logged into the computer. The drums will pass through a drum scanner; they will be X-rayed and then weighed. This information will also be input into the computer for comparison with the manifested information and to be used by the operator for drum processing sequencing.

The drums will be either stored or loaded by forktruck onto a drum conveyor with a total capacity to hold 60 drums. The conveyors will be located on two levels with three lanes on each level. When a drum is loaded, the controller will advance the conveyor to provide adequate space for the next drum. As required, the vertical conveyor will stop at the appropriate level. A drum will be fed from one of the six lanes onto the vertical conveyor. The drum will then be transported to the shredder where it will be automatically fed into the shredder receiving hopper. The waste is shredded prior to charging to increase burning efficiency and minimize temperature fluctuations. (see Fig. 4 for the system flow diagram).

Pathological Waste

The containers of pathological waste will be loaded directly onto the vertical conveyor and elevated to the ram feeder intermediate opening. The container will be automatically loaded into the ram feeder. The charging operation will then be automatically completed using the same sequence and safety controls as for the DAW.

Scintillation Fluids and Turbine Oil

Scintillation fluids and turbine oil received in bulk form will be taken to the decant room where they will be pumped out. The scintillation fluids and oils will be transferred to separate storage tanks. Scintillation vials received will be placed in a vial breaker. Once the vials are broken, the liquid will be discharged into a small tank and the glass particles will be collected on a screen and discharged into a 55-gallon drum. The collected liquid will then be pumped to the storage tank using a decant pump.

The scintillation fluids and turbine oil will be incinerated in the secondary combustion chamber. Flow of the liquids to the incinerator will be temperature controlled. These fluids will be incinerated with other waste types to minimize supplemental fuel consumption.

Aqueous Waste

Aqueous waste will be collected from three major sources: 1) floor drains in the process building and operation areas; 2) the safety shower drains in the decontamination room; and 3) the contaminated wash sink in the laboratory. The waste water will be collected in the floor drain tank.

The contents of the tank will be pumped to the incinerator and injected into the ignition chamber where the liquid will be evaporated.

Ignition Chamber

The DAW and pathological waste charged into the ignition chamber is burned at less than stoichiometric conditions for a sufficient time to reduce it to mixture of ash and non-combustible materials. The underfire air system provides combustion air to the primary combustion chamber. It consists of a fan, a control valve, and air distribution to underfire air ports located along both sides of the hearth. This air entering at the base of the burning bed promotes complete and reliable incineration.

The flow rate is controlled based on the temperature in the ignition chamber in order to promote the most efficient burning with the temperature limitations of the incinerator. The ignition burner is also controlled based on the temperature in the ignition chamber. After the chamber has been preheated and the first waste has been charged and ignited, the ignition burner shuts down and comes back on only when the waste burning in the ignition chamber has insufficient BTU value to maintain the temperature.

The ash will be removed from the incinerator with a hearth ram. The hearth ram is placed in the floor of the primary chamber below the ram feeder and it has the capacity to stroke the full length of the hearth. The hearth ram is actuated to push the ash into the ash drop-out opening at the far end of the chamber. The ash ejector ram will push the ash into an ash drop-out opening that will discharge into a mixer where it will be densified using liquid from the scrubber blow-down. The ash should be Class A type material per 10 CFR 61 requirements.

Secondary or Combustion Chamber

The volatile gases produced in the primary combustion chamber pass into the secondary combustion chamber where they are completely oxidized. Secondary air equivalent to 100% excess air is introduced through ports in the throat between the primary and secondary chambers. The main burner, located at the discharge of this throat, provides additional heat to maintain the required temperature. Both secondary air and the main burner are controlled to maintain a stable temperature in the secondary chamber.

Wet Scrubbing System

Immediately downstream of the incinerator, the combustion gases wil be lowered from 1800°F to 172°F in the quench section of the venturi scrubber. The off-gas will then pass through the variable throat venturi scrubber where extremely fine particulate matter will be removed. (see Fig. 4, the system flow diagram).

The off-gas from the venturi scrubber will then pass through a packed column to remove mineral acids, particularly hydrochloric acid (HCL) produced by the combustion of polyvinly chloride. The HCL removal efficiency will be a minimum of 99% down to one part per million by volume. The packed column will be equipped with a demister to minimize liquid carryover.

The salt concentration level in the scrubbing solution will be controlled with a density meter. The turbidity of the solution will also be monitored to minimize particulate buildup.

The scrubbing solution pH will be maintained by the addition of sodium hydroxide. The addition will be automatically controlled by a pH meter. The sodium chloride generated by the reaction between the HCl and sodium hydroxide will be maintained by blowdown of the scrubber solution. The same scrubbing solution will be used in the quench, venturi scrubber, and the packed column. Ash particles, larger than 100 micron, in the scrubbing solution will be removed by cartridge filters. The heat will be removed from the scrubbing solution with a tube and shell heat exchanger and by makeup water.

The blowdown will be pumped to a 55 gallon 17H drum. The liquid portion of the blowdown will be evaporated using 35 kW drum heaters. The evaporated water will be discharged to the scrubbing system.

Final Filtration

The off-gas from the packed column will pass through a final dry filter system prior to discharge. The temperature of the saturated off-gas will be raised by 30°F to prevent condensation inside the filter assembly. The filter assembly will consist of a prefilter, HEPA filter, two stage carbon filters and a HEPA filter. Each HEPA filter has a 99.97% particulate removal efficiency for particulate larger than .3 microns.

Stack

The exhaust from the main and auxiliary induced draft fans passes to and up the 55 foot metal stack. The stack will have a velocity meter and probes for the continuous radioactivity monitoring system.

Programmable Logic Controller

The programmable logic controller (PLC) will monitor the incinerator process by receiving input from instruments shown on the P&ID's. The PLC will continually check the process parameter and compare these readings against predetermined set points. If these set points are exceeded, the PLC will issue an alarm and take a course of action to correct the process deviation or to automatically bring the system off-stream in a safe and controlled manner.

Stack Monitor

The facility will have a continuous stack monitoring system for simultaneous measuring of gross beta/gamma particulates and iodine. This system will be continuous duty, high capacity, with both remote and local alarms. The incinerator operator will have full readout in the control room to allow monitoring of the stack discharge. The stack monitoring data will be fed into a recorder to log the daily outputs.

A gas sampler will be installed downstream of the continuous sampler to allow facility to batch the stack. This will be done on a routine basis.

REVIEW PROCESS

In June 1984, US Ecology made a public announcement that it was proposing to site a LLRW incinerator in North Carolina. Although extensive conversations had been held on both the state and local level, this was the first public announcement. This same month, US Ecology submitted its permit application for a radioactive materials license to the North Carolina Department of Human Resources. The site identified is in rural Bladen County, off I-95 just south of Fayetteville, North Carolina.

Public and political responses to nuclear waste disposal are often emotional and reflect a lack of understanding relative to the issues involved. This is especially true in our case and the following scenario will show the overall confusion created when several regulatory bodies are involved.

As stated above, in June 1984 the company submitted its application to the North Carolina Department of Human Resources for a radioactive materials license for the installation of a LLRW incinerator. In July, we received a letter from the Department stating that this application would be reviewed by the Radiation Protection Section, the NRC and several other state agencies. We were told, also at this time, that final action on our application would take six months. This should have meant that the company would have been issued a license in January 1985.

In October 1984, we received our first set of 150 questions based upon a "preliminary" review of our application.

Because of the magnitude and scope of the questions, our response was not submitted until December 1984. Also in December 1984, we submitted our application for an air quality permit to the North Carolina Department of Natural Resources and Community Development. We had waited until December to submit the air quality application because of the extensive pollution control devices integrated into the incinerator. The North Carolina Administrative Code for incinerators requires that a grain loading of .08 GR/DSCF corrected to 12% CO_2 be achieved. Our proposed incinerator could meet this without the scrubber and HEPA filters. We had not seriously considered the applicability of the Resource Conservation and Recovery Act (RCRA) to the proposed incinerator. We had been told by the State Solid Waste Section prior to our submittal of the Air Permit Application that our facility would not require a RCRA permit.

In January 1985, we received additional questions on our application based upon an outside agency review (NRC). The document contained 10 questions, and our response was submitted in February 1985.

In March 1985, we received our first set of questions from the Department of Natural Resources pertaining to our air permit. We submitted our response in April 1985.

In April, we submitted information to the USEPA, Region IV, in Atlanta, addressing the Standards for Radionuclides - National Emission Standards for Hazardous Air Pollutants. We were told that our submission seemed to satisfy the regulations.

In May, we received a response from Marvin Resnikoff, Co-Director Sierra Club Radioactive Waste Campaign headquartered in New York, based upon his review of our application. He raised the issue of the potential for dioxin emissions from our proposed incinerator. Simply because this issue along with several others were raised, we had to address each one individually, using facts rather than unfounded allegations. After extensive research including conversations with outside consultants, we concluded that the entire dioxin emission issue as raised by Mr. Resnikoff was not supported by a sound technical basis. However, such statements had the effect of fueling the fire of an already controversial issue. Our response to Mr. Resnikoff was submitted to the Department of Natural Resources in June 1985.

In June 1985, we received our second set of questions from the Department of Natural Resources, plus, a study was completed by an independent consultant on the "Social and Economic Impact" created by our proposed facility. This study had been commissioned by the Governor's Waste Board in conjunction with a local Citizens Advisory Committee.

In July, we submitted our response on our air permit to the Department of Natural Resources. This same month we received another set of questions from the Department of Human Resources concerning the radioactive materials license. This document contained 65 questions. Also, in conversations with the EPA we were told that because of the confusion with the regulations dealing with their "Standards for Radionuclides," there had been no movement in the EPA regional office concerning our original letter back in April.

Also, in August, the opponents to the facility submitted a petition for a Declaratory Ruling requiring the application of the North Carolina Solid Waste Management Act (RCRA) to this facility. This petition resulted in a ruling that US Ecology must obtain a RCRA permit if it accepts any hazardous wastes regulated under the Solid Waste Management Act and Rules, regardless of the quantity involved and whether the wastes are manifested. This ruling apparently meant that <u>all</u> scintillation vials containing solvent material must be disposed of in a RCRA-regulated facility. Because this ruling would delay our application even further, we withdrew our request to process scintillation materials. This ruling has made the mixed waste question even more confusing, especially for those individuals generating these type wastes. There are <u>no</u> commercial low-level shallow land disposal facilities which are now disposing of scintillation wastes.

To complicate the issuance of the required permits even further, in October 1985 the EPA, Region IV, sent a letter to the North Carolina Department of Natural Resources stating the following:

> "We are currently evaluating US Ecology's request for construction under 40 CFR 61 and this review has been somewhat tedious because of the special expertise required to determine compliance with the regulations and the fact that certain test procedures, recordkeeping, and reporting requirements have not been promulgated as part of 40 CFR 61, Subpart I. In all likelihood, our review will result in a request for additional information from US Ecology. Until EPA renders written approval to US Ecology to construct the proposed incinerator, they are specifically prohibited from commencing construction (40 CFR 61.05(a)."

This decision was rendered six months after we had been told that our original submittal seemed to satisfy the regulations.

It would seem that the project is slowly approaching regulatory "grid lock."

In January, we finally received our first set of questions from the EPA addressing our April submittal.

Also, in January the State of North Carolina held two public hearings to allow the public an opportunity to express their opinion concerning this facility.

Prior to these hearings, several government officials had made the statement that "the professionals, not the politicians, will make the permitting decisions." We would hope that this is true, because from a purely technical analysis, there is no reason to believe that this facility would not meet federal and state regulations and achieve volume reduction of LLRW in a safe and environmentally sound manner. However, the confusion with the regulations, which has lengthened the review process to in excess of 20 months with no end in sight, has allowed those opposed to the facility to increase the public's fears through uninformed allegations designed to create hysteria and cripple the project. The increase in public pronouncements, coupled with regulatory confusion, has made final decisions on the many permits (Radioactive Materials License, EPA Radionuclide Permit, State Air Quality Permit, and RCRA Permit, if we were to include scintillation vials) difficult at best. Presently, we are awaiting further questions from the many regulatory bodies reviewing the application.

For waste management facilities to be permitted in any reasonable length of time, it is mandatory that regulations be passed to simplify the permitting process and to ensure that decisions are made by professionals who understand the process involved.