INCINERATION OF LOW-LEVEL RADIOACTIVE WASTE AND SCINTILLATION VIALS UNDER RESOURCE CONSERVATION AND RECOVERY ACT

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Incineration is the most responsible disposal procedure for low-level radioactive waste and scintillation vials. Although scintillation vials containing C-14 and H-3 in amounts less than 0.05 μCi/gm. are not regarded by the Nuclear Regulatory Commission (NRC) as radioactive waste, the toluene and 1,4-dioxane, frequently used as the solvent base for scintillation media, are listed by the Environmental Protection Agency (EPA) as hazardous.

The incinerator was designed to be capable of handling low-level radioactive, pathological and hazardous waste. Ash demonstrated free from residual radioactivity and/or hazardous constituents (scintillation media) can be removed to a sanitary landfill. Incineration reduces the volume of waste and renders it non-radioactive and non-hazardous because the products of combustion are removed thru the stack and by chemical decomposition as defined by the EPA and confirmed by ash analysis. Proper incinerator design parameters achieved this result.

Responsibility for the proper design of the incinerator belonged to the Engineer working with calculations provided by the Health Physicist. Engineers chose the manufacturer, Environmental Control Products Inc. (ECP), based on personal contact with owners of incinerators and visits to several manufacturer's sites. Their final choice was based on capability to dispose of waste without exceeding regulatory limits. The manufacturer guaranteed that the incinerator would meet all Resource Conservation and Recovery Act (RCRA) requirements such as a two second residency time in the upper chamber to achieve 99.99% combustion. They would custom build an incinerator to specifications such as construction of the upper chamber four feet longer than the lower chamber to increase combustion efficiency by increasing the residency time. Before shipment, the manufacturer conducted a complete test of their product to verify that specifications had been met.

To determine the correct size incinerator, a comparison study on two previous years waste records was carried out. This provided an estimated growth in the use of radionuclides. A 10% yearly increase, extrapolated on a linear curve for twenty years was used. 2000°F was chosen for the upper chamber and 1850°F for the lower chamber as the specification temperatures. These higher temperatures with the longer residency time in the upper chamber met all RCRA requirements for complete destruction by incineration of hazardous material. Since plans for the future included applying for a Part B Permit for hazardous waste solvent disposal, a flange was incorporated in the side of the lower chamber so a liquid fuel injection system could be added.

Although the ECP 750T model (750 lbs/hour average burn rate) met all criteria, a larger model, the 1000T (1000 lbs/hour) was chosen and modified to specifications so radioactive waste disposal only required approximately one to two hours of burn time per week. On days when this type of waste was disposed of, the incinerator operated at least eight hours so the required dilution factor could be achieved and not exceed the maximum allowable regulatory release to an unrestricted area (top of the stack). The larger incinerator allowed use of pathological waste as

charging material during these hours of operation. Also, the larger size required only one work shift.

Choosing the 1000T instead of the 750T increased the cost payback by less than one month, from 10.5 months to 11.4 months. This cost payback was based solely on disposal of low-level radioactive waste and not on the significant saving associated with incineration of pathological waste.

The license application preparation began with an architect's drawing showing the location of the incinerator in the new toxicology building and its proximity to the main building and the surrounding area with general information on the incinerator. The decay calculations for short-lived radionuclides included the entire computation for remaining radioactivity at the time of removal from the laboratories, for ease of review by regulatory personnel. Amounts of less than 1.0 μCi either before or after decay were considered non-radioactive and incinerated. Calculations were made for maximum (up to 50 mCi) and minimum (0.25 mCi) amounts received as verified by Burroughs Wellcome Co.(BW Co.) inventory records of receipt of radioactive material. The information thus generated was put in a tabular format to expedite examination.

The following items were included in the license application: a summary of incineration calculations at 2000^{o}F showing maximum activity per burn vs. maximum regulatory limit with fraction of regulatory limit reached for 8, 10, 16 and 24 hour burns for C-14, H-3 and S-35; Pasquill Equation for ground level radiation to hypothetical man; the new radioactive waste management section of the corporate radiation safety handbook; the steady state environment inventory world wide, for Durham County and for the air above BW Co., calculated using surface area of the earth as $4\Pi r^2$ with $r = 3959$ miles and world wide production of H-3 equal to 1.9×10^6 Curies and for C-14 equal to 3.8×10^4 Curies.

There were three State regulatory agencies concerned with the adjudication of the license and permit process. 1) The North Carolina (NC) Dept. of Human Resources, Radiation Protection Branch (Agreement State-license), 2) NC Dept. of Human Resources, Division of Health Services, Solid and Hazardous Waste Management Branch (RCRA requirements) and 3) NC Dept. of Natural Resources and Community Development, Division of Environmental Management, Air Pollution Branch (Emission Control Standards-Air Permit).

Permission to incinerate pathological and low-level radioactive waste was requested, and the required engineering background data to the Air Pollution Branch to obtain a permit to construct and operate an incinerator was submitted. This authorization was received expeditiously. It permitted incineration of 800 lbs. per hour of Types 0, I, III, and IV waste as requested, provided a successful test burn for particulate emissions was passed within 90 days after the unit became operational.

During the interim between submission and receipt of the license and air permit, a significant regulatory change took place. The NRC published a change in 10 CFR Part 20 in which certain radioactive, biomedical wastes were deregulated. This deregulation included scintillation vials containing C-14 and H-3. As a result, the vials, due to their ignitability and for toluene and 1,4-dioxane, also their toxicity, now fell under RCRA as hazardous waste. Because of the uncertainty of what approach would be taken in incinerating the vials as a hazardous waste and the limited

time available to coordinate the process with state representatives, the original particulate test was scheduled with review of the burning of vials to be done at a later date.

The first test burn was conducted on December 4, 1981. To maintain the permitted burning rate of 800 pounds per hour, 200 pounds was charged every 15 minutes. The burn exceeded 1.60 pounds per hour of particulate emissions and was failed. On February 3, 1982, the second test burn was conducted. During this test, 80 pounds were charged every six minutes. At 1.16 pounds per hour of particulate emissions this test was passed. By charging waste every 15 minutes, a larger volume of waste was put into the ignition chamber which was allowed to burn for a longer period of time. The ash on top of the charged waste was burning to a finer particle size. When the next load was charged, the fine ash was entrained in the exhaust gas and a greater amount was vented out the stack.

The covering letter for the license submission stipulated that when complete combustion occurs, all C-14, H-3 and S-35 go up the stack as products of this activity as radioactive CO_2, H_2O and SO_2. The following procedure was outlined and executed to confirm this hypothesis.

For one month before any radioactive waste was incinerated, only pathological waste was burned. After each ash removal, an analyses for residual C-14, H-3 and S-35 was carried out to establish background numbers for this particular incinerator. It is a fact that animal carcasses have naturally occurring K-40 and Ra-226. In addition, the refractory material would also have background activity. After the background numbers were established, radioactive waste was burned and repeat ash analyses done. The results hopefully would show that there was no residual activity remaining and therefore the ash was non-radioactive. What had been hypothesized was confirmed and permission granted in writing for the ash to go to the county landfill. The approval came within twenty four hours after the findings were submitted to the regulators.

With an operating permit in hand and established, acceptable means of disposing of solid and NRC regulated wastes, it was time to look into the incineration of the scintillation vials as a hazardous waste. Because the incinerator was new, it came under the RCRA requirements. In order to incinerate the vials a Part B application would have to be initiated and a trial burn conducted. In addition, the operating permit had to be amended to allow the burning of flammable solvents (Type V wastes). The approach here was to gather all available data and bring representatives from both regulatory agencies (Solid and Hazardous Waste Mangement Branch and Air Pollution Branch) together for a meeting. This was done and, in addition, the person who normally reviews and writes permits was invited. The State reviewed what data had already been collected. It was determined that in as much as the average BTU/pound of the liquid in the vials was greater than 10,000, a request for authorization to burn the vials as an auxiliary fuel source should be submitted.

The meeting was followed up with a written request to the State to burn the vials as an auxiliary fuel. This request was approved. The required data was submitted to the State to amend our initial operating permit. In this letter authorization was requested to burn 80 pounds per hour of scintillation vials, not to exceed 320 pounds per day (2 hours to develop an ash bed, 4

hours of burn time). The solvents in the vials would consist of xylene, toluene and 1,4-dioxane.

The Air Pollution Branch advised us that another test burn was required. A meeting was scheduled with them to ascertain what would be required to be analyzed for during the burn. It was agreed that in as much as this was the first unit of its kind in the area, the test burn should be analyzed for: particulates, heavy metals, vinyl chloride, asbestos and PCB's.

Two test burns would be conducted. On July 20, 1982 only scintillation vials were incinerated, charging 8 pounds every six minutes. On July 21, 1982 the standard solid waste feed (720 pounds per hour) with 80 pounds per hour of vials was incinerated. The results of the test burns were submitted to the State for review. They developed a computer model of the stack based on local meterological data compiled by the U.S. Weather Bureau at the local airport to determine the maximum ground level impact. They compared these data against established ambient air standards, or where these were not available, established OSHA standards.

In accordance with the RCRA regulations, the ash was handled as a hazardous waste until it had been analyzed and delisted. Since there was no on-site capability to conduct an extraction procedure toxicity analysis of the ash, the State Solid and Hazardous Waste Management Branch performed this test. The only test that remained to be done and pass was to analyze the ash for residual xylene, toluene and 1,4-dioxane.

For three consecutive weeks a homogeneous representation of ash was removed after burning vials, pathological and low-level radioactive waste at 1600°F in the lower chamber and 2000°F in the upper chamber. Each sample was thoroughly mixed, then raked smooth on a grid system and an equal sample removed from each grid square, for each weeks burn. On the fourth week, no vials were burned and two samples taken. One as a control and the other was spiked with a known amount of toluene, xylene and 1,4-dioxane. On the following four weeks the same procedure was repeated for burns at 1850°F in the lower chamber and 2000°F in the upper chamber.

Ten GC analyses of each of the five samples for each temperature burns were done by BW Co. analytical laboratories, and two independent outside laboratories, each serving as a verification of the others' work.

The ash from the 1600°F burns contained residual toluene, xylene and 1,4-dioxane. The ash from the 1850°F burns contained no residual solvents.

This laborious process provided the data to prepare a statistical protocol showing that the initial assumptions of efficiency and long residency time with the correct temperature in the lower and upper chamber did in fact result in complete combustion, meeting the stringent 99.99% standard in the RCRA regulations.