THE BYPRODUCTS UTILIZATION PROGRAM

SEWAGE SLUDGE IRRADIATION PROJECT

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ABSTRACT

The use of the Department of Energy (DOE) defense byproduct cesium-137 to irradiate municipal sewage sludge and destroy harmful pathogenic organisms is a major thrust of DOE's Byproduct Utilization Program. Research, pilot demonstration and activities to transfer the technology to the commercial wastewater treatment sector constitute DOE's strategy for this byproduct use. Recent efforts are directed at successful technology transfer with DOE support of a full-scale cesium sludge irradiator in Albuquerque, New Mexico.

BACKGROUND

The concept of using radiation for the benefit of man was born in the Atoms for Peace Program during the 1950's. For a variety of political and institutional reasons, this concept was never fully pursued and implemented on a widespread scale. One of the promising uses for radiation developed in the early 1950's was to destroy harmful microorganisms in municipal sewage sludge[1]. During the 1950's and 1960's, however, energy was cheap, environmental concerns for clean water were minor, and the treatment of municipal sewage was not a significant problem.

During the 1970's, concern about water pollution led to the enactment of laws and regulations which resulted in increased quantities of municipal sludge[2]. In addition, high energy costs mitigated against utilization of the traditional means of sludge disposal. Therefore, recycling of sludge became an actively pursued disposal method. Safe recycling, however, raised concerns about the levels of pathogenic microorganisms in the sludge. The concept of gamma radiation of sludge was thus reborn and was studied extensively by Sandia National Laboratories (SNL) in the early 1970's using cesium-137 as the radiation source[3]. That work successfully demonstrated the effectiveness of destroying harmful bacteria, parasites, viruses and fungi with radiation as part of a normal system of sludge treatment[4], and contributed to Environmental Protection Agency (EPA) regulations establishing the proper role of radiation and the prescribed absorbed dose of 1 Mrad necessary for subsequent unrestricted reuse of the irradiated sludge[5].

Concurrent research at New Mexico State University (NMSU) supported by the Department of Energy (DOE) and EPA investigated the agronomic potential of using sludge in the calcareous soils of the southwestern United States. Related research into the feeding of irradiated sludge to animals was conducted to determine any potential harmful effects. To date, as summarized by NMSU[6,7,8], significant agronomic benefits have been realized from sludge land application involving increased micronutrients available for plants and improved soil characteristics. In addition, no detrimental effects with animal feeding and subsequent reproduction have been seen which would indicate that a significant quantity of sludge produced in the United States could not be properly managed and used as an animal feed supplement.

DOE BYPRODUCTS UTILIZATION PROGRAM (BUP)

The goal of the DOE BUP is to develop and encourage widespread use of defense nuclear byproducts in solving unique societal problems[9]. Recognizing that cesium-137, as a byproduct, had potential as a gamma source for sludge irradiation, DOE supported the research mentioned above undertaken by SNL and NMSU. This research was verified at SNL with the construction and operation, beginning in 1978, of the pilot plant, Sandia Irradiator for Dried Sewage Solids (SIDSS) (Fig. 1). Successful SIDSS operation led to consideration of widespread commercial use. As a result, DOE efforts have shifted to technology transfer.

Early on it was concluded that the strategy for technology transfer in an industry as conservative as the wastewater treatment community had to include the full-scale utilization of gamma irradiation at several municipal sewage treatment plants under joint DOE/city projects[10]. As Fig. 2 shows, these engineering prototypes constitute the vital link between pilot demonstration and commercialization of sludge irradiation technology.

A detailed process of identification, screening and evaluation of candidate municipal sites for these engineering prototypes was undertaken. Sites were evaluated according to specific criteria such as sludge quality, disposal options, sludge production, municipal interest and capability and national prominence[11]. A computer model, OPTIMA, was also developed to allow quick, easy, initial evaluation of the technology for specific locations[12]. Sites evaluated according to these criteria have included St. Petersburg, Florida; Seattle, Washington; Albuquerque, New Mexico; San Antonio, Texas; Provo, Utah; Idaho Falls, Idaho; Howard County, Maryland; and Stockton, California[13-18]. Currently, Albuquerque has been selected as the initial site for a full-scale, cesium-137 sludge irradiator. DOE has entered into a Cooperative Agreement with the city to support the design, construction and initial operation of this sludge irradiator.

ALBUQUERQUE SEWAGE SLUDGE IRRADIATOR PROJECT

The city of Albuquerque with a 20-year history of using sewage sludges on city parks recognized in the mid-1970's the likely promulgation of EPA regulations requiring additional treatment to destroy pathogens if this sludge reuse option were

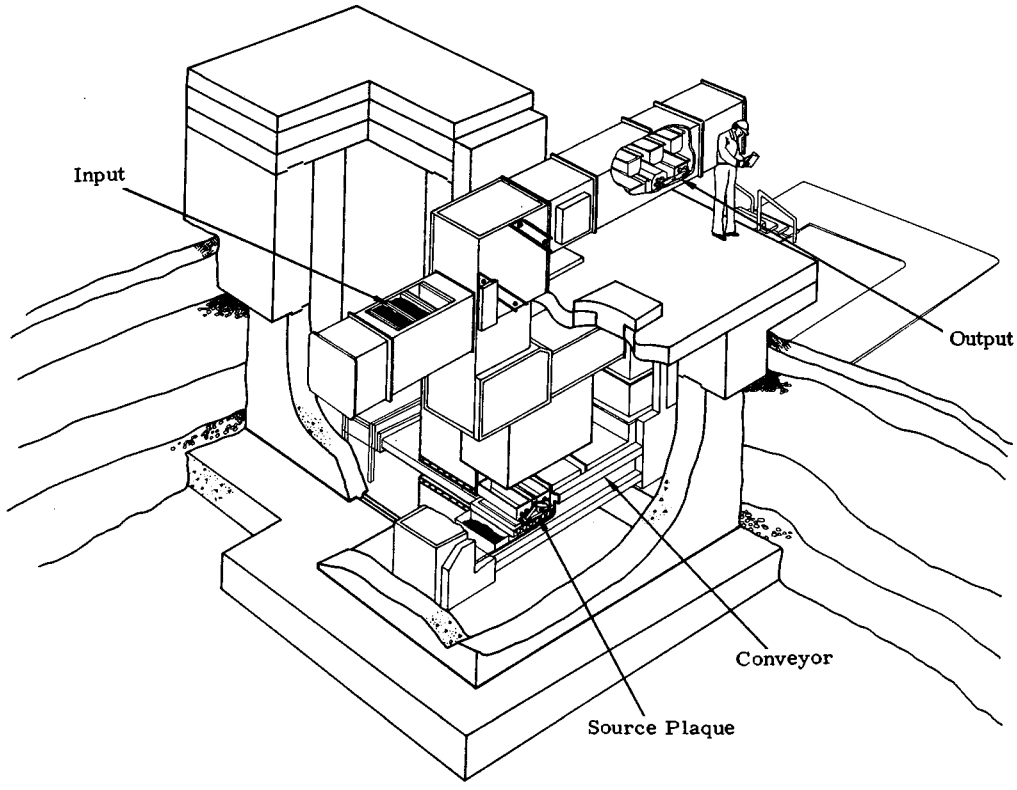

Fig. 1. Sandia Irradiator for Dried Sewage Solids (SIDSS)

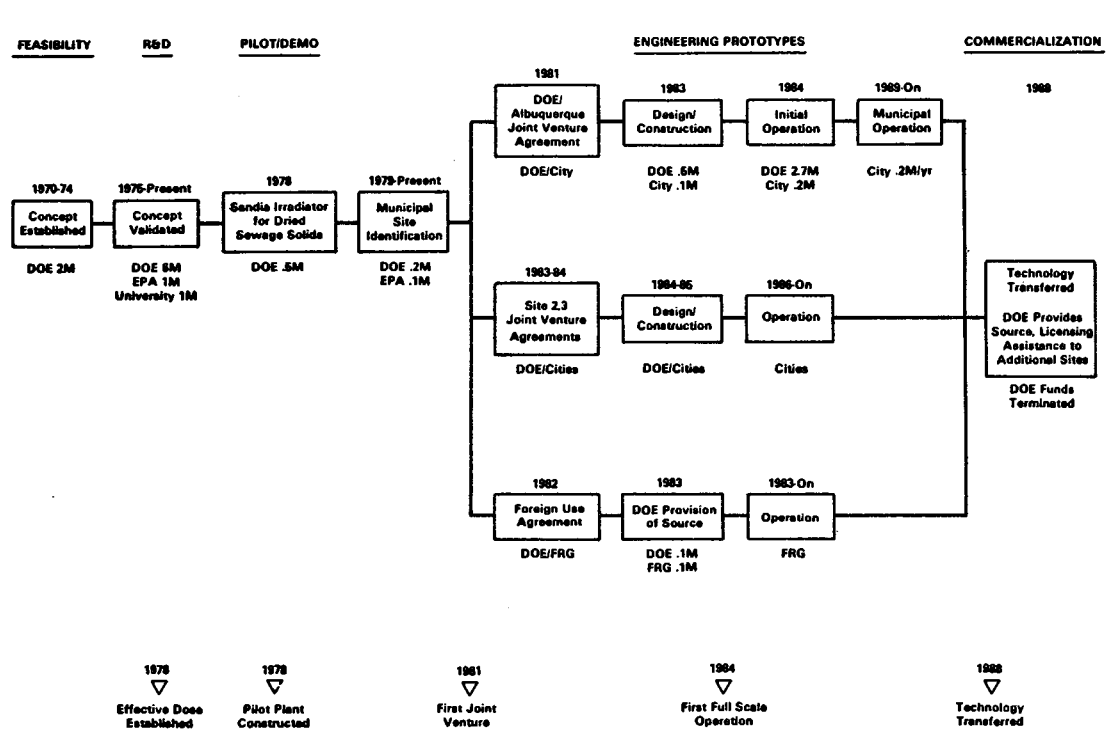

Fig. 2. DOE Sludge Irradiation Technology Transfer Strategy

to remain viable. Studies conducted by the city indicated that irradiation, as part of a major treatment plant upgrade, might provide the most compatible and inexpensive treatment meeting these anticipated EPA regulations, so that the city could continue their sludge disposal practice[19]. The city expressed their interest to DOE, and, as mentioned above, a detailed evaluation was conducted of the potential for sludge irradiation in Albuquerque.

A Cooperative Agreement was signed in 1981 which envisioned DOE technical support to the city project and EPA Construction Grants funding of the facility itself. Concurrently, EPA sponsored an Environmental Impact Statement (EIS) process to assess the proposed treatment plant upgrade including the irradiator. Recent uncertainty regarding EPA Construction Grants funding, a DOE desire to have the Albuquerque irradiator operational as soon as possible, and appropriation of construction funds for the BUP have changed this arrangement. Currently, DOE and the city are negotiating a modification to the Agreement to provide for DOE funding of the design and construction of the irradiator portion of the city's planned upgrade. The EPA has completed the EIS process[20] and on December 20, 1982, issued a Record of Decision approving the proposed upgrade project and validating sludge irradiation as the optimal pathogen destruction method. Remaining approvals for the project are at the local county and city levels.

The structure of the DOE/city irradiator project and respective participant responsiblities are shown in Fig. 3. The Albuquerque irradiator design is based on the design and experience gained with the SIDSS[21]. A similar bucket conveyor system will be used as will movable source plaques which can shuttle between a loading pool area and the conveyor area. Normal operation will be in a dry environment with ventiliation provided for cooling and radiation monitoring. Unlike SIDSS where buckets of sludge pass over and under one source plaque, the Albuquerque facility will have three source plaques stacked vertically. Sludge in buckets will pass over, between and under this source plaque arrangement. The Albuquerque irradiator will be capable of irradiating up to 30 dry tons per day of sludge to an absorbed dose of 1 Mrad using approximately 15 MCi of cesium-137 chloride packaged in standard WESF capsules. Approximately 275 WESF capsules will be distributed throughout the three source plaques to provide the required 15 MCi.

Assuming approval by local political bodies, detailed design will commence in mid-1983 with construction beginning in early 1984. Routine operation will begin in mid-1985. The projected cost for design and construction to be supported by DOE is approximately $3 million.

OTHER RELATED ACTIVITIES

To support the Albuquerque irradiator project as well as other DOE BUP initiatives involving cesium, several additional activities have been undertaken. SNL has compiled and prepared a document outlining the capability of cesium WESF capsules to meet required ANSI N 542 tests for sealed sources. This document, after final review, will be submitted to the Nuclear Regulatory Commission (NRC) for registration of these capsules[22].

Oak Ridge National Laboratory (ORNL) and SNL have cooperated in the destructive analysis of one capsule removed from the SIDSS. This analysis is ongoing and was intended to verify the compatibility of the cesium chloride with the capsule materials under actual use conditions. Preliminary results indicate no causes for concern with regard to utilization of the capsules for radiation sources[23].

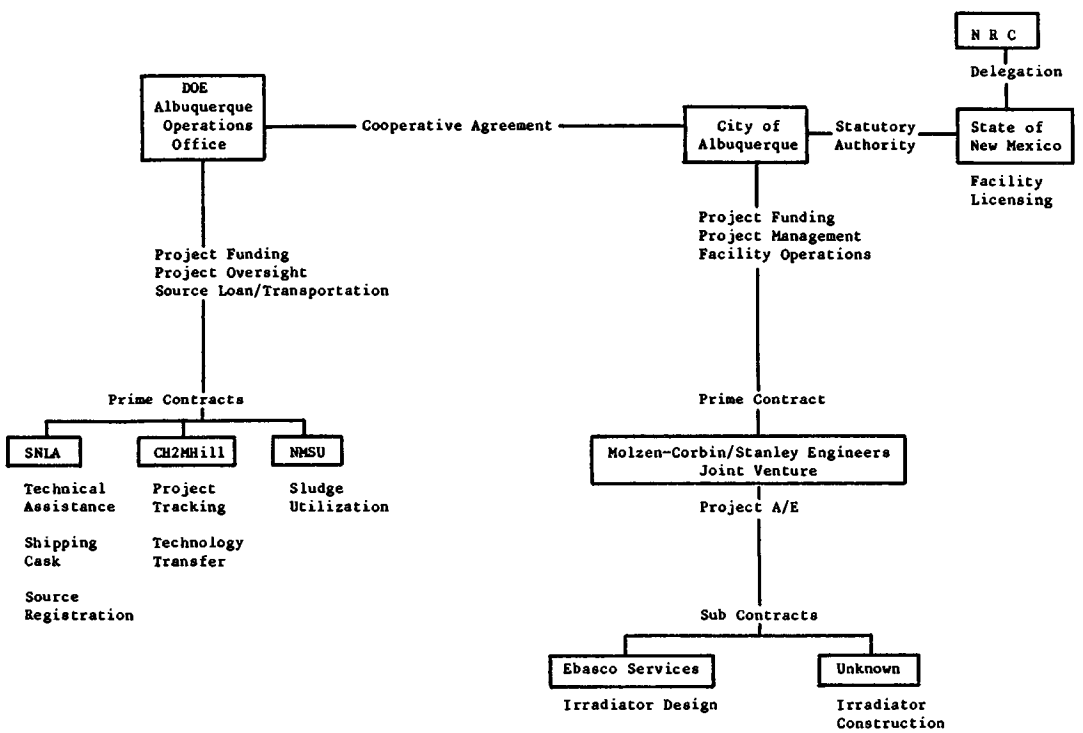

Fig. 3. Albuquerque Sludge Irradiator Project Participants and Responsibilities

SNL, through the Transportation Technology Center, has undertaken the design and procurement of a shipping cask able to transport up to 16 WESF cesium capsules at a time. The cask, which will weigh approximately 30 tons, will be compatible with the limitations of the WESF and the Albuquerque irradiator, and will be licensed by the NRC and Department of Transportation (DOT) for use. The cask body is currently being fabricated by Japan Steel, analyses at SNL are being completed, and a Safety Analysis Report should be prepared by the spring of this year.

Pacific National Laboratory (PNL) has been tasked by the BUP to reencapsulate nine 1-inch-diameter cesium sources for eventual shipment to the Federal Republic of Germany. These sources will be used in the liquid sludge irradiator plant at Geiselbullach to demonstrate the effectiveness of cesium as a gamma source. Such demonstration could lead to increased demand for cesium as a substitute for cobalt-60, the major isotope used in irradiation technology throughout the world.

FUTURE OF SLUDGE IRRADIATION

Although the regulatory climate in general has recently been relaxed somewhat, the concern for pathogens in sludge which is recycled exists and continues to warrant some form of treatment to insure public health and safety. For many cities eager to reuse their sludge, radiation with the DOE defense byproduct, cesium-137, may provide the best option for this treatment. The DOE Byproducts Utilization Program will continue to actively encourage the successful transfer of this technology to the commercial sector as a means of meeting program goals and commitments to provide society maximum benefit from the byproduct materials DOE has produced.

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