VOLUME II
GENERIC DEREGULATION OF
BELOW REGULATORY CONCERN
RADIOACTIVE WASTES
SOLICITATION NUMBER RS-RES-89-052

TECHNICAL AND MANAGEMENT
PROPOSAL

SC&A Inc.

GENERIC DEREGULATION OF BELOW REGULATORY CONCERN RADIOACTIVE WASTES

SOLICITATION NUMBER RS-RES-89-052

TECHNICAL AND MANAGEMENT PROPOSAL

Submitted to:

U.S. Nuclear Regulatory Commission
Division of Contracts and Property Management
Mail Stop P-1020
Washington, D.C. 20555

Submitted by:

S. Cohen & Associates
8200 Riding Ridge Placo
McLean, Virginia 22102
(703) 893 - 6592

VOLUME II
GENERIC DEREGULATION OF
BELOW REGULATORY CONCERN
RADIOACTIVE WASTES
SOLICITATION NUMBER RS-RES-89-052

TECHNICAL AND MANAGEMENT
PROPOSAL

Submitted to:

U.S. Nuclear Regulatory Commission
Division of Contracts and Property Management
Mail Stop P-1020
Washington, D.C. 20555

Submitted by:

J. J. Mauro — 3/25/89

John J. Mauro — Date
Vice President

S. Cohen & Associates
8200 Riding Ridge Place
McLean, Virginia 22102
(703) 893 - 6592

TABLE OF CONTENTS

APPENDIX C - SC&A Selected Project Summaries and Letters of Commendation

Appendix D - Overview of the Methods Used to Characterize Radionuclides in Low-level Waste in Nuclear Power Plants

TABLES

FIGURES

1.0 INTRODUCTION

1.1 BACKGROUND

The discussion which follows summarizes our understanding of the history and current status of BRC. This understanding establishes the basis for the approach we have developed for each of the four project tasks. It is convenient to discuss the background of BRC from both a regulatory/policy perspective and a technical perspective. The former helps to establish the possible scope of issues that may need to be addressed in Tasks 3 and 4, and the latter establishes the nature and extent of data and computer models currently available for use in Tasks 1 and 2.

1.1.1 Regulatory History and Current Status

Section 10 of The Low-level Radioactive Waste Policy Amendments Act of 1985 (Radioactive Waste Below Regulatory Concern) requires that the NRC establish standards and procedures, and develop the technical capability, for considering and acting upon petitions to exempt specific radioactive waste streams from regulation by the Commission. The basis for such exemption is the presence of radionuclides in such waste streams in sufficiently low concentrations or quantities to be below regulatory concern.

Prior to the Amendments Act, the concept of regulatory exemption was addressed in several contexts. Most notably is the exemption guidance provided in the proposed revisions of the NRC's Standards for Protection Against Radiation (NRC 85). However, a broader definition of exemption could derive from (1) residual radioactivity guidance in Regulatory Guide 1.86 (NRC 74), (2) exemptions granted for the sale of specific consumer products, (3) the routine effluent guidelines provided in Appendix I to 10 CFR 50, and (4) mill tailings regulations. In each case, licensed radionuclides are released from direct regulatory control because the potential consequences of releasing these materials from direct regulatory control are extremely small.

In accordance with Section 10 of the Amendments Act, in August 1986 the NRC published a Policy Statement on Radioactive Waste Below Regulatory Concern (51 FR 30839), which was encoded as Appendix B to 10 CFR 2. The policy statement establishes standards and procedures that will permit the Commission to act upon rulemaking petitions filed under 10 CFR 2.802 to exempt specific waste streams from NRC regulatory control. Fourteen criteria are established for use by petitioners. In addition, the Commission Policy Statement provides guidance and procedures which cover:

(1) Information petitioners should file in support of petitions to enable expedited processing,

(2) a discussion of each of the decision criteria, and

(3) administrative procedures to be followed.

Generic rules issued in response to such petitions have the potential to significantly reduce the volumes of low-level wastes and the costs of its disposal.

Prior to the issuance of this policy statement, individual waste generators obtained exemption from NRC regulations for waste disposal on a case-by-case basis via use of 10 CFR 20.302 (a). In February 1983, the NRC issued an I&E Information Notice (No. 83-05) to encourage waste generators to make use of this regulatory alternative, and a number of licensees have applied for and received exemptions for specific waste streams. The types of wastes consisted primarily of large volumes of soil, scrap wood, and oil contaminated with very low-levels of radioactivity. However, the volume of waste granted exemption, relative to the total volume of waste, has been extremely small. This means of obtaining regulatory exemption for unique waste streams is still available to waste generators.

In 1986, the NRC issued NUREG-1101 (NRC 86) as additional guidance primarily for academic, medical, and industrial licensees seeking authorization to dispose of small quantities of radioactive materials by onsite subsurface disposal under 10 CFR

20.302. In evaluating each application, the NRC considers the radiological impact on public health and the environment. These analyses consider direct gamma exposure from the buried wastes, drinking water from a nearby well, ingesting agricultural products from radionuclide-contaminated soil, and inhaling resuspended radionuclides. Applications are submitted on a case-by-case basis, and are therefore of limited effectiveness in reducing the volumes of waste disposed at licensed facilities and reducing waste disposal costs for waste generators.

In January 1987, in response to the 1986 Policy Statement and Implementation Plan, EPRI initiated a major research program in the low-level waste area to develop the necessary technical information for inclusion in rulemaking petitions to exempt very low activity nuclear plant wastes from NRC licensed disposal facilities. The BRC research program addresses the following PWR and BWR waste streams:

PWRs	BWRs
Compacted DAW	Compacted DAW
Contaminated Oil	Contaminated Oil
Secondary Side Ion Exchange	Sandblasting Grit
Soil	Soil

The utility petition is presently being prepared by EPRI and its contractors, and is scheduled for submittal to the NRC (possibly through NUMARC) in April. The petition will be supported by a number of technical documents which address each of the 14 Decision Criteria.

The upcoming petition has the potential to markedly reduce the current and projected volumes of utility low-level radioactive waste shipped for disposal at current and planned low-level radioactive waste disposal facilities. For example, EPRI has estimated that the nuclear utility industry generates the following volumes of potential BRC wastes (EPRI 88):

WASTE STREAM	PROJECTED BRC VOLUMES	
	INDUSTRY TOTAL*	AVERAGE PLANT**
Compacted DAW	195,580	2,540
NonCompacted DAW	113,960	1,480
Waste Oils	19,400	340
PWR Sec. Side Resins	35,730	770
Evap. Concentrates	4,500	160
Contaminated Soil	30,940	770
Sandblasting Grit	2,310	90
Water Treat. Sludges	17,710	1,770
Tank and Sump Sludges	1,930	50
Sewage Sludge	2,310	230
Sec. Side Large Comp.	3,850	220
BWR Condenser Tubes	N/A	N/A
TOTAL	428,220	8,420

*Industry Volumes in Cubic Feet Per Year
**Average Plant Volumes in Cubic Feet Per Unit-Year

In 1987, $9.39X10^5$ ft^3[1] of low-level waste was disposed at commercial licensed low-level waste disposal facilities. Accordingly, based on these relatively recent estimates prepared by the nuclear utility industry, about 45% of the current volume of utility waste is potentially BRC.

An earlier report prepared by the National Environmental Studies Project of the Atomic Industrial Forum (AIF 86) found that 65 to 90 percent of compactable DAW generated by LWRs could be classified as BRC. Given an exemption dose rate of 1 mrem/yr to the maximum exposed individual, the report estimates a 35 percent reduction in the volume of regulated utility waste.

---

[1]Data obtained from Paul Smith of EG&G, Idaho Inc. The data are contained in the "State By State Assessment of Low-Level Radioactive Waste Received at Commercial Disposal Sites." These are annual reports prepared by the DOE in support of the national low-level waste program. The most recent published report is DOE/LLW-09T for 1987.

In support of proposed 40 CFR 193, the EPA performed a risk assessment of 16 waste streams and a variety of siting and deregulated disposal methods. The results revealed that, depending on the dose criterion selected, the volume of regulated waste could be reduced by as much as 28 percent to 68 percent. If a 1 mrem/yr criterion is selected, there would be a 35 percent reduction in the volume of regulated waste (Ho 88; Gru 88).

The Texas Low-Level Radioactive Waste Authority (TLLRWA) has also evaluated the BRC issue and has established concentrations and annual activity limits of short-lived radionuclides for disposal in permitted landfills. This method of waste disposal is estimated to result in a 50 percent reduction in the Texas institutional low-level waste volur Po 87).

It would appear that based on these studies, a BRC rule (whether established at 1 or 10 mrem/yr or greater ; or a rule that includes person-rem criteria) could significantly reduce the volume of waste requiring disposal at licensed low-level waste facilities for both utility and institutional waste generators.

In December 1988, the Commission announced that the 1986 Policy Statement will be expanded (53 FR 49887). This announcement, along with the transcripts of the International Workshop on BRC held in October 17-19, 1988 in Washington, D.C., and the public meeting held on January 12, 1989 in Bethesda, MD., broadens the BRC issues and possible range of BRC criteria that may need to be considered in developing a more comprehensive BRC policy or rule, or in granting license amendments under current rules. Some of the key issues discussed at the workshop and public meeting include:

(1) Definition of a Practice - The definition of what a practice is and how a given practice is defined is critical to the effective implementation of a BRC rule, whether generic or developed in response to a specific petition.

(2) Justification of Practice - Notwithstanding the individual or cumulative dose limit established as BRC criteria, a key issue is the need to develop policies or standards which require that a given practice be justified. This concept is summarized in ICRP 46 (ICRP 85) and is part of the ICRP system of dose limitation described in ICRP 26 (ICRP 77).

(3) Individual Dose Limit - Possible BRC individual dose limits up to 100 mrem/yr were discussed. A number of Federal agencies, advisory committees and industrial groups have addressed this issue and there is widespread consensus that a BRC limit of 1 to 10 mrem/yr or, under some circumstances, exposures up to 100 mrem/yr to the critical population group or maximum individual may be considered BRC.

(4) Cumulative Dose Limit - The IAEA and the EPA have recommended that, in addition to a BRC limit or guideline for the dose to the maximally exposed individual, a cumulative (i.e., person-rem) limit is appropriate. Others, such as the Health Physics Society and several industry groups, believe that a cumulative dose limit for BRC is unnecessary. Should such criteria be developed, questions regarding spacial and time integration may also need to be addressed.

(5) The Relationship Between BRC and ALARA - BRC has been described as the "floor" to ALARA (AIF-035). At the January 12 meeting, Richard Guimond of the EPA defined BRC in a slightly different way, stating that a waste stream or product may be exempted if it can be shown that active regulation of the waste stream or product is not cost-effective; i.e., demonstrate that exemption is ALARA. It is clear that optimization of protection (cost-benefit and value-impact analyses) will be required in support of a BRC rule. The cost-benefit analytical techniques described in ICRP 37 (ICRP 83)

will be useful in supporting this aspect of the BRC rulemaking.

(6) Multiple Sources of Exposures - A major issue at these meetings was how to deal with the possibility that a population or an individual may be exposed to multiple sources of exempt practices. This issue is primarily concerned with consumer products rather than waste disposal. However, a BRC rule for low-level waste will need to be cognizant of its implications with respect to BRC as it may apply to consumer products and routine liquid and gaseous effluents from licensed facilities.

(7) The Transition to BRC - The form of the licensing, monitoring, reporting and inspection programs needed to ensure that exemptions proceed in an approved and verifiable manner is a key issue and has relevance to the cost-benefit analyses performed in support of a BRC rule.

(8) Different BRC Strategies for Consumer Products, Recyclable Material, Routine Effluents, and Low-Level Waste Disposal - Each of these fundamentally different activities poses unique challenges to the development and implementation of a BRC policy, and may need to be addressed differently.

(9) International Programs - The IAEA (IAEA 88) has recently published international guidance on BRC that explicitly addresses most of these issues. The degree to which an NRC policy, rule or regulatory guide needs to be compatible with international guidance is an important issue which will affect the types of analyses required to support the rule.

(10) Accident/Probabilistic Considerations - Though a given practice can be shown to pose minuscule risks to individuals and population during routine and anticipated conditions, the degree to which highly

remote occurrences need to be postulated as part of a generic BRC rulemaking, or in response to a specific petition, is an important issue.

In addition to NRC policy statements, EPA proposed rules, and the recommendations of the IAEA, ICRP, NCRP, and the Health Physics Society, the proposed project will also need to consider state and local requirements regarding the disposal of solid wastes. For a BRC policy to be effective, it must take into consideration the needs and requirements of the state and local authorities that license solid waste management practices in each state. Insight on how the requirements of local authorities may influence the type of analyses required on the project may be gained by a review of the Texas BRC program. Texas Department of Health Code 20.300 permits incineration and onsite disposal only following Agency approval. Disposal into septic tanks is precluded. Disposal at municipal landfills is limited to specified concentrations and quantities of short-lived radionuclides at state-designated landfills. Though each state or compact may develop its own BRC rules, the Texas experience has established a precedent that provides insight into the alternative regulatory strategies, technical analyses and conversion to BRC procedures that local authorities may require.

1.1.2 Technical Background

The project will require access to, or the development of, electronic databases which characterize waste streams, the range of possible BRC waste handling and disposal practices, and a range of possible disposal site characteristics. In addition, computerized models will be needed which accept these data files and perform the necessary pathways modeling in a realistic fashion. Over the past five years, these databases and pathway models have matured.

1.1.2.1 Waste Characterization Databases

The discussion in Section 1.1.1 above refers to BRC studies performed by the NRC and by the AIF and EPA. Each of these studies independently concluded that the volumes of waste that may be ca[illegible]es for BRC consideration are large. Though there is little doubt as to the validity of this conclusion, close inspection of the data used in these studies reveals that they are based on a similar database, which has its origin in the 1981 database report (Oz 81).

The database used in support of the 10 CFR 61 rulemaking, provided in Appendix D to NUREG-0782 (NRC 81), is based on disposal site data available through 1981. As indicated in that report, though a considerable amount of information was available at that time, the data were limited and a number of simplifying assumptions were necessary. In addition, it was recognized at that time that waste management practices were evolving. These files, with some modifications made in the 1986 update (Oz 86), are the computerized files currently contained in the IMPACTS BRC, PRESTO-EPA-BRC and PATHRAE codes. These files were created <u>prior to</u> the 1985 Amendments Act which required a significant refinement of the record keeping practices of the disposal site operations. In addition, the files are aggregate values which may not be representative of a given waste generator at a given time.

Because of the age of the data, the files do not reflect the reductions in waste volumes which have occurred in the past few years. For example, Table 1-1 presents the change in nuclear utility waste volumes from 1981 to 1987. The volumes of waste per unit have on the <u>average</u> declined at least two-fold, but the total activity has remained fairly constant. These volume reductions reflect efforts made on the part of waste generators in response to the rising costs of waste disposal and, for utilities, the waste allocation system established by the Amendments Act. Waste management programs, such as those described in EPRI 1984, and more widespread use of supercompaction are in large part responsible for the volume reduction. The effects of these changes on the volumes of potential BRC wastes should be evaluated.

Since the 1985 Amendments Act, the level of detail and the accessibility of disposal site records has improved. Our understanding of the history and current status of these records is as follows. In 1982 and in 1984, the DOE funded the Conference of Radiation Control Program Directors to perform a survey of waste generators in each state. Each state provided a list of licensees to CRCPD which then initiated the survey in close cooperation with each state agency. The data contained in the completed questionnaires were loaded onto a national database maintained by EG&G for DOE. The DOE computerized database available from the EG&G network includes waste shipment data from individual nuclear plants, as obtained from the plant Regulatory Guide 1.21 semiannual reports, and aggregated data for industrial and institutional waste generators for each state based on the CRCPD surveys and shipping manifests (extrapolation was used for years when CRCPD surveys were not performed).

In 1982, the NRC contracted EG&G to develop the Disposal Site Information Management System (DSIMS) to collect manifest data maintained by the disposal site operators. In 1986, in accordance with the 1985 Amendments Acts, the disposal site operators were required to maintain more complete records. In addition, the NRC and DOE are currently jointly working on guidance for record keeping which will further improve the waste disposal site records and their accessibility through electronic media. The upgraded database system is called Manifest Information Management System (MIMS) and is a spin off of DSIMS. In addition, the manifest magnetic tapes for US Ecology are provided to the Utility Data Institute (UDI), which provides commercial access to the data. EG&G purchases these tapes from UDI and loads them onto their system.

[redacted]

[redacted]

1.1.2.2 Computer Codes

As part of the implementation plan for BRC set forth in the 1986 Policy Statement, a set of computer codes has been developed to aid in the identification of waste streams that are candidates for BRC consideration. One such code, IMPACTS BRC, is specifically referred to in the Policy Statement as an acceptable method for identifying candidate BRC waste streams.

IMPACTS BRC calculates the radiation exposure to individuals and populations for waste streams and disposal methods defined by the user. The disposal methods include:

- On-site incineration followed by disposal of ash in a sanitary landfill.

- Municipal incineration followed by disposal of ash in a sanitary landfill.

- On-site incineration followed by disposal of ash in a hazardous waste disposal facility.

- Hazardous waste incineration followed by disposal of waste in a hazardous waste landfill.

- Direct disposal in a sanitary landfill.

- Direct disposal on site.

The program allows a number of regional environments to be assumed and a broad range of radiological, chemical and physical waste characteristics and pre-processing assumptions. Through the use of "decision indices," IMPACTS BRC allows the user to manipulate specific waste form, packaging, disposal technology, sites, demography, and a number of other parameters which may need to be accommodated on a generic bases or in response to a specific petition.

The doses are calculated for workers, transporters, individual members of the public (including an inadvertent intruder) and the general public. Whole body and organ doses are calculated for a number of pathways including:

- Direct radiation
- Waterborne
- Groundwater
- Food pathways
- Resuspension

The IMPACTS BRC code is closely related to the IMPACTS code (NUREG/CP-4370) and, as such, may have some of the limitations of IMPACTS with regard to site-specific applications. As stated in the introduction to NUREG/CR-4370, "caution is advised in using the analysis methodology in a site-specific application, where site-specific models, radionuclide inventories, disposal methods, and environmental parameters would have to be considered." Accordingly, it may be necessary to supplement IMPACTS BRC with other pathways codes in order to perform sensitivity and uncertainty analyses, and to confirm the applicability of IMPACTS BRC for a broad range of site conditions.

In addition to IMPACTS BRC, other performance assessment codes have been modified for use in BRC applications and currently have widespread use. PATHRAE was developed by Rogers & Associates for use by EPRI and is the code used to support the upcoming utility petition. PRESTO-EPA-BRC is being used by the EPA in support of the 40 CFR 193 and 40 CFR 764 rulemakings[2], and COSMOS is being used by AECL in the Canadian programs and in support of the NYS low-level waste program. In addition to these codes, which have direct application to BRC, the EG&G Technical Coordinating Committee on Performance Assessment has compiled a list of computer codes which may have use in various aspects of performance assessment (including BRC) for low-level waste. (See Table 1-2)

[redacted]

---

[2] The Background Information Document prepared in support of proposed 40 CFR 193 (EPA 1988) includes an extensive matrix of BRC analyses using PATHRAE and PRESTO-EPA-BRC. The analysis matrix includes 7 disposal methods, 15 waste stream disposal scenarios and 3 climatological settings. In many respects, the analysis parallels the NRC BRC evaluations provided in NUREG/CR-3585.

1.1.2.3 Solid Waste Disposal Databases

There are over 6000 active private and municipal solid waste landfills in the U.S. Of these, 85% are owned by Federal, state or local governments and 15% are privately owned. Some of these facilities may become the recipients of BRC waste in the future. In 1986, the EPA Office of Solid Waste published a survey of sanitary landfills which was updated in 1988 (EPA 88; META 88). A database was assembled that identifies each of the landfills in the U.S. and provides a broad range of design and environmental data (Wes 86). Access to the database is through EPA's contractor, Westat, Inc., or through EPA directly. Data are available from the Office of Solid Waste on site characteristics, hydrology, and leachate chemical composition.

Electronic data identifying and characterizing municipal waste disposal facilities are also available through the permitting agencies in individual states. These data are maintained by local state offices, and, as is the case in Pennsylvania, to be useful to this project, the data from individual offices would have to be downloaded from each office and integrated. As a result, this source of data will likely have limited use on the project, with the possible exception of a verification role for the national database.

The data files used in IMPACTS BRC to represent municipal waste disposal in various regions of the U.S. were assembled before the 1986 solid waste database was assembled. Accordingly, it will be necessary to assess the degree to which the current files may need to be expanded or revised. In addition, the issue of sludge contaminated with low-levels of radioactivity is relatively recent, and the IMPACTS BRC files do not take this into account.

1.2 UNDERSTANDING OF THE PROJECT

The project is divided into four tasks, each with a specific objective. Task 1 is the only task initially authorized. Tasks 2 and 3 are options which may follow Task 1 in a sequential or overlapping fashion. The objective of the three tasks is to support a BRC rulemaking.

Task 4 is separate and distinct from Tasks 1, 2 and 3. Task 4 may be authorized on a task order basis, in accordance with Part G.5 of the RFP. One or more task orders may be authorized at any time during the course of the project, might vary in scope and duration, and might be initiated while Tasks 1, 2 or 3 are in progress.

Technical analyses performed as part of Tasks 1, 2 or 3 may be in varying stages of development when a specific Task 4 assignment is initiated. Accordingly, the contractor will need to provide simultaneous technical support to NRC on multiple assignments.

Each task requires a somewhat different mix of expertise. Task 1 will require expertise and experience in the following areas:

- o The methods used by waste generators (nuclear utilities, fuel cycle facilities, institutional waste generators, radionuclide and radiopharmaceutical manufacturers and suppliers, and other categories of waste generators) to record the radiological, chemical and physical characteristics of solid waste packages. Techniques used to determine and record the presence of difficult-to-measure radionuclides, and radionuclides which are below the limits of detection, must be understood in detail in order to properly interpret the manifest data.

- o The availability of electronic data. The data currently available from the EG&G network, DSIMS, MIMS and currently on state and compact database systems must be understood in terms of their usefulness to the project and how they may best be accessed and used to support a BRC rulemaking.

- o Familiarity with the structure, data files and input requirements of pathways codes, including IMPACTS BRC, PRESTO-EPA-BRC, PATHRAE and other codes which may be used to assess impacts on a generic or facility and site-specific basis. Although BRC rulemaking and petition reviews will be for generic practices and waste streams, it will be necessary to perform facility- and site-specific analyses to ensure that the distribution of possible site-specific impacts are properly understood. This understanding is obviously necessary to accomplish Task 2. However, it is also necessary for Task 1 since it defines the types of data needed to be gathered in Task 1.

- Data characterizing solid waste disposal practices, facilities and sites. It will be necessary to obtain data, preferably electronic data, identifying and characterizing the municipal disposal practices, facilities and sites throughout the U.S., including demographic, land use and hydrologic characteristics. Comparison of these data to the default files in IMPACTS BRC will be needed to ensure that the current files are applicable to the range of possible BRC waste handling and disposal practices.

In addition to the licensed sources of radioactive waste, a BRC rule will need to account for sludge from municipal wastewater treatment facilities found to be contaminated with low-levels of radioactive material released in the wastewater discharges, primarily from institutional waste generators. This is a technical area which will require expertise in sludge management.

Task 2 will require expertise and experience in the following areas:

- IMPACTS BRC. An in-depth understanding of the models, assumptions, decision indices and parameter files employed in IMPACTS BRC is needed so that the code can be used in an informed manner for generic and specific waste streams, and for BRC management and disposal practices at generic and specific sites.

- File Conversion and Management. Experience in accessing, downloading and interfacing files in diverse formats will be required so that electronic data from a variety of sources can be used in IMPACTS BRC and other application codes.

- o PRESTO-EPA-BRC, PATHRAE and Other Pathway Codes. Familiarity with the models used by the EPA, EPRI and others is needed to be able to independently assess the merits of a given application (Task 4). In addition, in order to be able to assess the need for alternative modeling techniques in support of Tasks 2 and 3, an understanding of a broad range of pathways models is needed.

- o Geohydrologic Modeling. Each of the models currently used for BRC and low-level waste performance assessment assume homogeneous media and incorporate several other simplifying assumptions. For the purpose of sensitivity and uncertainty analyses, and possibly for the purposes of modeling specific sites, more sophisticated modeling techniqes may be needed, including finite-difference models and models which are designed for fractured flow transport.

It is our understanding that the implementation of the IMPACT BRC code may be performed by Sandia and that our team will coordinate with Sandia in the performance of this task.

In addition to the technical expertise required in Tasks 1 and 2, Task 3 will require:

- o Experience in converting technical analyses and data into material suitable for the preparation of branch technical positions, regulatory guides, and the supporting documentation for proposed rules.

- o Experience in the performance of value-impact and cost-benefit analyses required in support of rulemaking.

- o Familiarity with current waste management practices for each category of waste generator. This experience will be needed to prepare cost-effective guidance pertaining to procedures for conversion of a waste stream from regulated to BRC (i.e., waste forms, processing and treatment, packaging and handling, storage and segregation, training, surveys, inspections, records, reporting requirements, QA/QC)

- Familiarity with current non-radwaste management practices and state and local codes.

In addition to the expertise required for Tasks 1, 2 and 3, Task 4 will require experience in performing technical assessments under a task order contract. Experience in providing the types of technical analyses and reviews described in 10 CFR 2, Appendix B, is needed in order to ensure a complete, consistent and defensible technical review of applications and petitions. In addition, it is considered essential that the contractor have no existing waste management contracts with EPRI, individual nuclear utilities or other major generators of low-level radioactive waste.

We recognize that the public health and safety goals and criteria that are inherent in numerous NRC and EPA regulations and guidelines (and also those of other Federal authorities, such as the DOE and FDA) are often quite different. In addition, there are diverse views among different agencies regarding the possible range of appropriate exemption criteria. Diverse views exist on acceptable levels of risk and also the procedures, models and assumptions that should be used to quantify risks. It is our understanding that part of our responsibilities on this project will be to gather data and perform technical analyses that will be useful in (1) exploring the merits of these diverse views and (2) helping to achieve a consensus on the issues. Other agencies with relevant activities are DOE, which is responsible for the safe operation of the DOE facilities and a broad range of remedial programs, and the EPA, which is responsible for the development of generally applicable environmental standards.

We recognize that a number of important benefits will be derived from a BRC rule, including (1) reduced waste disposal costs for waste generators, (2) preservation of the limited licensed waste disposal capacity for wastes with higher levels of radioactivity, (3) focusing resources where they are most needed and (4) enhanced overall stability of licensed waste disposal by removing BRC wastes that are typically low density, degradable waste forms which can reduce the structural stability of Class A disposal units.

1.3 OVERALL APPROACH

Based on our understanding of the project and the BRC background summarized above, we have assembled a project team with experience in each of the diverse disciplines required for the project. In addition, we have developed an approach to the project and a work breakdown structure which will efficiently accomplish the objectives of each task.

1.3.1 Task 1 - Source Term and Disposal Technology

Our approach to Task 1 is to divide the work into three technical working groups, each led by a Principal Investigator. The size of each group will vary, depending on the needs of the project at that time. However, a single designated Principal Investigator will be responsible for each working group throughout the duration of the project. The three working groups are:

(1) Waste generator and waste stream characterization.

(2) Solid waste management and disposal alternatives.

(3) Database management and integration.

[redacted]

[redacted]

The first working group will be responsible for compiling and reviewing waste characterization data for major waste and BRC generators. [redacted]

We have elected to structure this portion of Task 1 in this manner because each of the major categories of waste generators[3] is unique in terms of the types of radionuclides of concern and

---

[3]The major waste generators are often divided into the following categories: nuclear power, institutional, industrial, radiopharmaceutical, fuel fabrication facilities and government research facilities.

the types of waste management practices employed. We felt that insight into the reliability of waste characterization data can be best provided by professionals with <u>hands on</u> experience in each major category.

The second working group for Task 1 will be responsible for compiling and reviewing data characterizing current municipal waste management and disposal practices, accessing the electronic solid waste management database availab' from Westat and reviewing Federal, state and local solic waste management codes. [redacted]

The third working group for Task 1 will provide computer and database management support to the other two working groups. A specialist is this area is needed in order to efficiently access and integrate, as necessary, the waste manifest databases (available from the disposal site operators, on MIMS, from the Utility Data Institute WasteNet database, from each of the state and compact database management systems), solid waste management data available from the EPA and Westat, and site characterization data available from the Bureau of Census and the USGS. [redacted]

[redacted]

Our approach to Task 1 also includes reviewing the data input requirements for IMPACTS BRC (and possibly other codes) to ensure that the data required to perform Task 2 are gathered to the extent possible in Task 1. In addition, we believe that it would be prudent to identify the range of possible forms a BRC rule or regulatory guide may take, since this could affect the types of data that may be needed. By considering the possible needs of Tasks 2 and 3 as part of Task 1, we will minimize the degree to which Task 1 data acquisition efforts will need to be repeated in Tasks 2 and 3.

1.3.2 Optional Task 2 - Modeling Radiological Impacts

Our approach to Task 2 is to assemble two working groups; the IMPACTS BRC model execution group and the uncertainty analysis group. The model execution group will be responsible for working with Sandia in assembling and reviewing input data and running the IMPACTS BRC code to support rulemaking activities and the review of specific petitions.

The uncertainty analysis working group will be responsible for reviewing the appropriateness of the database and assumptions for any particular application.

[redacted]

1.3.3 Optional Task 3 - Support for the Preparation of a Draft Rule or Regulatory Guide

Optional Task 3 will commence following authorization by the NRC Contacting Officer, and its specific scope and budget will likely be defined at that time. For the purpose of this proposal, we have divided Task 3 into the following 4 subtasks:

- o Coordination and compilation of technical material from Tasks 1 and 2 required to support a rulemaking.
- o The performance of value-impact and cost-benefit analysis
- o The assessment of consistency with local regulations
- o Logistics support to notices and public meetings

[redacted]

1.3.4 Task 4 - Assessment of Petitions

Task orders to review petitions will be authorized in accordance with the task ordering procedures designated in Part G of the RFP. The specific scope, budget and schedule of any given task order will be defined at that time. For the purpose of describing our approach to Task 4, we have prepared an abbreviated Task Order Proposal in response to a hypothetical Task Request for Proposal. The hypothetical task order we selected for our example is to perform a minireview, followed by a detailed technical review, of an EPRI petition for BRC rulemaking on secondary side spent resin.

[redacted] In this way, multiple task orders may be accommodated simultaneously. Because the technical reviews required on any particular task order will mirror work performed on Tasks 1 and 2, task orders will be able to be completed in a highly cost-effective manner.

[redacted]

TABLE 1-1

NUCLEAR UTILITY SOLID WASTE VOLUME AND ACTIVITY DISPOSED AT LICENSED LOW-LEVEL WASTE DISPOSAL FACILITIES*

YEAR	NO. OF UNITS	TOTAL WASTE DISPOSED Ft³	Curies	WASTE DISPOSED PER UNIT Ft3	Curies
1981	73	1.67 E+6	9.40 E+4	2.3 E+4	1.3 E+3
1982	79	2.11 E+6	2.64 E+5	2.7 E+4	3.3 E+3
1983	80	1.90 E+6	4.85 E+5	2.4 E+4	6.1 E+3
1984	88	1.52 E+6	4.44 E+5	1.7 E+4	5.0 E+3
1985	93	1.52 E+6	5.82 E+5	1.6 E+4	6.3 E+3
1986	100	1.03 E+6	1.71 E+5	1.0 E+4	1.7 E+3
1987	106	9.39 E+5	2.20 E+5	8.9 E+3	2.1 E+3

*Data obtained from Paul Smith of EG&G, Idaho Inc. The data are contained in the "State By State Assessment of Low-Level Radioactive Waste Received at Commercial Disposal Sites." These are annual reports prepared by the DOE in support of the national low-level waste program. The most recent published report is DOE/LLW-69T for 1987.

TABLE 1-2

COMPUTER CODES FOR PERFORMANCE ASSESSMENTS

Shallow-land Burial

U. S. Environmental Protection Agency (EPA), "PRESTO-EPA: A Low-Level Radioactive Waste Environmental Transport and Risk Assessment Code - Methodology and User's Manual", U. S. EPA, April 1983.

U. S. Environmental Protection Agency (EPA), "PRESTO-EPA-POP: A Low-Level Radioactive Environmental Transport and Risk Assessment Code--Methodology Manual", EPA 520/1-85-001, 1985.

Fisher, J. E., N. D. Cox, and C. L. Atwood, "BURYIT/Analyze: A Computer Package for Assessment of Radiological Risk of Low Level Radioactive Waste Land Disposal", NUREG/CR-3994, November 1984.

Grant, M. W. et al., "PRESTO-CPG: Users Guide and Documentation for Critical Population Group Modifications to the PRESTO Code", RAE-47/2-2, Rogers and Associates, Salt Lake City, Utah, October 1984.

Merrell, G. B., V. C. Rogers, K. K. Nielson, and M. W. Grant, "The PATHRAE Performance Assessment Code for the Land Disposal of Radioactive Wastes, RAE-8469/3, Rogers and Associates, Salt Lake City, Utah, April 1985.

Napier et al., "Intruder Dose Pathway Analysis for the Onsite Disposal of Radioactive Wastes: The ONSITE/MAXI1 Computer Program", Pacific Northwest Laboratory, NUREG/CR-3620, October 1984.

Napier et al., "DITTY: A Computer Program for Calculating Population Dose Integrated Over Ten Thousand Years", (Draft Report), PNL-4456, Pacific Northwest Laboratory, April 1985.

Oztunali, O. I., W. D. Pon, R. Eng, and G. W. Roles, "Update of Part 61 Impacts Analysis Methodology - Codes and Example Problems", NUREG/CR-4370, Vol. 2, January 1986

Root, R. W. Jr., "Documentation and User's Guide for DOSTOMAN - A Pathways Computer Model of Radionuclide Movement", DPST-81-549, Savannah River Laboratory, 1981.

Atmospheric Transport

Baes III, C. F., and C. W. Miller, "CRRIS: A Computerized System to Assess Atmospheric Radionuclide Releases", Nuclear Safety, Vol. 25, No. 1, January-February 1984.

Bowers, J. F., J. B. Bjorklund, and C. S. Cheney, "Industrial Source Complex (ISC) Dispersion Model User's Guide", EPA-45014-79-030, 1979.

Fields, D. E., and C. W. Miller, "User's Manual for DWNWND-An Interactive Gaussian Plume Atmospheric Trasnport Model with Eight Dispersion Parameter Options", ORNL/TM-6874, Oak Ridge National Laboratory, 1980.

Fletcher, J. F., and W. L. Dotson, "HERMES-A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry", HEDL-TME-71-168, Hanford Engineering Dev. Lab., Richland, Washington, 1971.

Mackay, [. F., and R. F. Ely Jr., "Computation of Radiological Consequences Using INHEC Computer Program, GAI-TR-101P, Gilbert Associates, Reading, Pa., 1974.

Moore, R. E., C. F. Baes III, L. M. McDowell-Boyer, A. P. Watson, F. O. Hoffman, J. C. Pleasant, and C. W. Miller, "AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides", ORNL-5532, Union Carbide Corp., Oak Ridge National Laboratory, 1979.

Soldat, J. K., "Modeling of Environmental Pathways and Radiation Doses from Nuclear Facilities", BNWL-SA-3939, Batelle-Northwest, Richland, Washington, 1971.

<u>Surface Runoff and Surface Water</u>

Donigan, A. S. Jr., and H. H. Davis Jr., "User's Manual for Agricultural Runoff Management (ARM) Model", EPA-600/3-78-080, 1978.

Onishi, Y., G. Whelen, and R. L. Skaggs, "Development of Multimedia Radionuclide Exposure Assessment Methodology for Low-Level Waste Management", PNL-3370, Pacific Northwest Laboratory, 1982.

Fields, D. E., "CHNSED-Simulation of Sediment and Trace Contamination Transport with Sediment/Contamination Interaction", ORNL/NSF/EATC-19, Union Carbide Corp., Oak Ridge National Laboratory, 1976a.

Fields, D. E., "LINSED-A One Dimensional Multireach Sediment Transport Model", ORNL/CSD-15, Union Carbide Corp., Oak Ridge National Laboratory, 1976b.

Fletcher, J. F., and W. L. Dotson, "HERMES-A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry", HEDL-TME-71-168, Hanford Engineering Dev. Lab., Richland, Washington, 1971.

Knisel, W. G. Jr., Editor, "CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems", U. S. Department of Agriculture, Conservation Research Report No. 26, May 1980.

Simpson, D. B. and B. L. McGill, "User's Manual LADTAP II-A Computer Program for Calculating Radiation Exposure to Man from Routine Releases of Nuclear Reactor Liquid Effluents", NUREG/CR-1276, National Technical Information Center, Springfield, Va., 1980.

Shaeffer, D. L., and E. L. Etnier, "AQUAMAN-A Computer Code for Calculating Dose Committment to Man for Aqueous Releases of Radionuclides", ORNL/TM-6618, Union Carbide Corp., Nuclear Div., Oak Ridge National Laboratory, 1979.

Soldat, J. K., "Modeling of Environmental Pathways and Radiation Doses from Nuclear Facilities", BNWL-SA-3939, Batelle-Northwest, Richland, Washington, 1971.

Soldat, J. K., N. M. Robinson, and D. A. Baker, "Models and Computer Codes for Evaluating Environmental Radiation Doses", BNWL-1754, Batelle Northwest Laboratories, February 1974.

Unsaturated Subsurface Media and Groundwater

Bond, F. W., C. R. Cole, P. J. Gutknecht, and C. A. Newbill, "Unsaturated Flow Model (UNSAT1D): Computer Code Manual, CS-1355, Electric Power Research Institute, Palo Alto, California, 1982.

Cole, C. R., and S. K. Gupta, "A Brief Description of Three-Dimensional Finite Element Ground-Water Flow Model Adapted for Waste Isolation Safety Assessments", PNL-2652, Battelle Pacific Northwest Labs., Richland, Washington, 1979.

Duguid, J. O., and M. Reeves, "Material Transport through Porous Media: A Finite-Element Galerkin Model", ORNL-4928, Union Carbide Corp.,Oak Ridge National Laboratory, 1976.

Konikow, G. F. and J. D. Bredehoeft, "Computer Model of Two-Dimensional Solute Transport and Dispersion in Ground Water", U. S. Geological Survey Techniques of Water Resources Investigations 7, U.S.Geological Survey, 1978.

Lester, D., D. Buckley, and S. Donelson, "System Analysis of Shallow Land Burial", NUREG/CR-1963, Vol. 3, 1981.

Mangold, D. C., M. J. Lippman, and G. S. Bodvarsoon, "Draft CCC User's Manual", version 2, LBL-10909, Lawrence Berkely Laboratory, 1980.

Neumann, S. P., R. A. Feddes, and E. Bresler, "Finite Element Simulation of Flow in Saturated-Unsaturated Soils Considering Water Uptake by Plants", Third Annual Report, Project ALO-SWC-77, Hydrodynaimcs and Hydraulic Engineering Laboratory Technion, Haifa, Isreal, 1974.

Reisenauer, A. E., "Variable Thickness Transient Ground Water Flow Model, Volume 1, Formulation", PNL-3160-1, Pacific Northwest Laboratory, 1979.

Soldat, J. K., "Modeling of Environmental Pathways and Radiation Doses from Nuclear Facilities", BNWL-SA-3939, Batelle-Northwest, Richland, Washington, 1971.

Travis, B. J., "TRACR3D: A Model of Flow and Transport in Porous/Fractured Media", Report #LA-9667-MS, Los Alamos National Laboratory, 1984.

Washburn, J. F., F. E. Kaszeta, C. S. Simmons, and C. R. Cole, "Multicomponent Mass Transport Model: A Model for Simulating Migration of Radionuclides in Ground Water", PNL-3179, Pacific Northwest Laboratory, 1980.

Yeh, G. T., and D. S. Ward, "FEMWATER: A Finite-Element Model of Water Flow Through Saturated-Unsaturated Porous Media", Oak Ridge National Laboratory, ORNL-5567, 1980.

Yeh, G. T., and D. S. Ward, "FEMWASTE: A Finite-Element Model of Waste Transportthrough Saturated-Unsaturated Porous Media", Oak Ridge National Laboratory, ORNL-5601, 1981.

Biotic Transport

Gallegos, A. F. et al., "Documentation of TRU Biological Transport Model (BIOTRAN)", LA-8213-MS, Los Alamos National Laboratory, January 1980.

McKenzie, D. H., L. L. Caldwell, K. A. Gano, W. E. Kennedy Jr., B. A. Napier, R. A. Peloquin, L. A. Projhammer, and M. A. Simmons, "Relevance of Biotic Pathways to the Long-Term Regulation Of Nuclear Waste Disposal - Estimation of Radiation Dose to Man Resulting from Biotic Transport: The BIOPORT/MAXI1 Software Package", NUREG/CR-2675, Vol. 5, October 1985.

2.0 TECHNICAL APPROACH

Table 2-1 presents the preliminary work breakdown structure for the project. The following describes the technical scope of each task and subtask and the methods that will be used to accomplish the task objectives. At the project kickoff the preliminary WBS will be reviewed and revised as appropriate.

2.1 TASK 1 - SOURCE TERM AND DISPOSAL TECHNOLOGY

Objective: To acquire and establish the necessary database for developing a generic rule governing the disposal of radioactive waste determined to be BRC.

2.1.1 Subtask 1.1 - List of Major Generators of BRC Wastes

The starting point for identifying the major generators of potential BRC waste is to identify the major generators of low-level waste. Current lists of low-level waste generators are maintained by:

- o DOE/EG&G Idaho Falls
- o the disposal site operators
- o the individual states and compacts
- o the Utility Data Institute WasteNet database

A list of major waste generators will be obtained by using the manifest databases to select the coded waste generators that contribute to most of the waste. We will then request assistance of the NRC staff in translating the identification codes. An independent cross check on these results will be performed by randomly checking data through the states and compacts. The list will of course include all licensed nuclear power plants.

2.1.1.1 Preliminary Review of the Database

Appendix A presents a sample of the hard copy shipping manifests used by US Ecology and Chem-Nuclear. Though these manifests are periodically revised, they provide insight into the data available in hard copy and some of the differences that exist between Barnwell and Hanford. These hard copy manifests are the most complete and consistent set of data currently available in a readily accessible form. More detailed information is available from the individual waste generators. However, we believe that it will not be necessary to survey individual waste generators, except for a selected few in order to verify and supplement data provided in the manifests.

This subtask will have four objectives:

(1) identify the information available on hard copy from the manifests.

(2) identify the information available on electronic media, along with the differences between hard copy and electronic media.

(3) identify differences between Hanford and Barnwell hard copy and electronic data.

(4) compare the data available with the data input requirements of selected pathways codes.

Under the direction of the NRC Project Manager, the Task 1 Leader, supported by the database Principal Investigator, will contact representatives of EG&G, US Ecology, Chem-Nuclear and the Utility Data Institute to discuss the databases and how best to access the information needed for the project.

[redacted]

These databases contain the following information (note-not all the items listed below may be available for all waste shipments or from all databases):

1. A code identifying the shipment.

2. A code identifying the generator.

3. The classification of the generator (medical, utility, etc.).

4. Identification of the disposal site.

5. The date the shipment was received.

6. The total volume and weight of the shipment.

7. The total activity of all nuclides in the shipment.

8. The total mass of special nuclear material in the shipment.

9. The volume of each of Classes A, B, and C waste in the shipment.

10. Physical and chemical form of waste.

11. Radiation level of container (contact and 1 meter).

[redacted]

2.1.1.2 Initial Identification of Major Waste Generators

The electronic databases will be used to construct a list of the waste generators that have disposed of a given percentage of waste (i.e., 80, 85, 90, 95, 99 percent) over the past three years. Our previous experience in performing surveys for individual states and compacts reveals that over 90 percent of the volume of waste is generated by less than five percent of the potential waste generators. For planning purposes, it is assumed that the first cut list of potential BRC waste generators will include about 500 waste generator organizations, including the 108 operating commercial nuclear power plants.

2.1.2 Subtask 1.2 - Review of Data Input Requirements

In this subtask, the default data files and input requirements of IMPACTS BRC and other selected codes will be identified. This review will help to establish a "menu" of data against which to evaluate the completeness of the data available in hard copy and in electronic form (see subtask 1.3 below). For the purpose of planning we have assumed that, at a minimum, the following codes may need to be used on the project:

- o IMPACTS BRC
- o PRESTO-EPA-BRC
- o PATHRAE

IMPACTS BRC was developed by Oztunali and Roles specifically for this application and is cited in the 1986 Policy Statement as an appropriate BRC implementation code. PRESTO-EPA-BRC was developed by the EPA for its BRC program. As a result, it would be prudent to also use it on this project to identify and determine similarities and differences between the results of the two codes for specific applications. PATHRAE was developed by Rogers and Associates and is being used to support the EPRI petition. Other codes which may have application on the project include COSMOS and FEMWATER/FEMWASTE. COSMOS was developed by AECL to support the Canadian low-level waste program and has been used in the New York State low-level waste program. COSMOS is fundamentally different than IMPACTS, PRESTO and PATHRAE (which are structurally similar in many respects). Accordingly, COSMOS can help to provide insight into the effects of code structural differences on the results of specific analyses. FEMWATER and FEMWASTE (and other more recent refinements of these codes) represent a class of codes which apply finite difference methods to modeling transport. These classes of codes more accurately simulate specific hydrological regimes than the other models. As a result, they can be useful in cross checking the results of the other codes for site-specific applications. These more mechanistic codes will also be of use on the project to calculate or verify the values of aggregate parameters used as input to the simpler codes. These codes, however, require a great deal of site-specific hydrological input data which may be time consuming and costly to obtain. Accordingly, their use will need to be limited. Other specialized codes, such as those designed to model fractured media, may also have application on this project.

The list of relevant input data will also help to provide guidance to Subtask 1.7, which is concerned with reviewing and compiling data characterizing solid waste disposal practices and sites.

Though this subtask is not explicitly addressed in the RFP, we believe it is important to ensuring that upon completion of Task 1, the data needed to perform Tasks 2 and 3 are available.

2.1.3 Subtask 1.3 - Review of the Radioactive Waste Data Bases

Following completion of Subtasks 1.1 and 1.2, a clear picture will emerge on (1) the current data available in hard copy and electronic form, (2) the data needed to support rulemaking, and (3) the most cost-effective method to access these data.

In this subtask, the list of waste generators will be divided into major waste generator categories, including nuclear utilities, institutions, isotope producers and pharmaceutical manufacturers and nuclear fuel cycle facilities. A further refinement, especially of the institutional and industrial waste generators, may be appropriate. Each category will be assigned to a specialist who will review the data down to the container level (if need be) in terms of:

(1) accuracy
(2) completeness
(3) representatives
(4) verification

2.1.3.1 Accuracy Review

Accuracy will be based on knowledge of the methods used to sample and analyze the waste streams. Special attention will be given to indirect methods used to estimate radionuclide content, such as the scaling methods used by nuclear utilities for difficult-to-measure radionuclides, or when a given radionuclide is reported to be below the lower limit of detection. A brief summary of the procedures used by many nuclear utilities to estimate the concentration of difficult to measure radionuclides in waste packages, and its relevance to a BRC rulemaking, is provided in Appendix D.

2.1.3.2 Completeness Review

Completeness of information will be based on a review of the data against the information needed as input to run IMPACTS BRC or other codes [as defined in Subtask 1.2 (see 2.1.2 above)]. Additional data needs will be addressed as defined by our technical advisory committee and other review and advisory bodies that may be associated with the project.

2.1.3.3 Representativeness Review

Representativeness of the information provided for any given waste package or shipment will be evaluated by considering: (1) the variability among packages for specific waste streams and (2) the uniformity within the package. The former is concerned with possible outliers, and the latter is concerned primarily with components of a given potential BRC waste stream that are recyclable and which may need to be treated as a separate waste stream.

Using the data for individual waste packages comprising individual waste streams, cumulative probability distributions will be constructed for the waste streams in each waste generator category. For nuclear utilities, waste stream designations will include, at a minimum, compacted DAW, secondary side resins, evaporator bottoms, soil, and waste oil. These will be further broken down by PWR and BWR, as appropriate. This separation of waste streams is considered important to the project since a BRC rule or guideline, or the review of a petition (such as the EPRI/NUMARC petition), will need to be able to separately evaluate waste streams, categories and practices.

The level of detail to which such distributions will be developed may need to be limited to a degree due to the large number of possible combinations and permutations. For example, for nuclear utilities, the distributions developed for individual plants, waste streams and radionuclides could include the following numbers of combinations:

(1) 100 plants
(2) 10 critical radionuclides per plant
(3) 5 waste streams of interest per plant

This results in a total of 5,000 possible combinations, and therefore 5000 probability distributions for the utility industry alone. A more realistic approach may be to aggregate by region or by plant type, as opposed to generating distributions for each plant. The methods which will be used to aggregate data will be discussed with the NRC at the project kickoff meeting.

This level of analysis is needed because the actual management of the potential BRC waste streams will be disaggregated; that is, though petitions will be filed for waste streams which represent aggregate practice (e.g., all PWR secondary resin), the actual disposal of this waste via unregulated means will be by individual waste packages, generated by individual waste generators and disposed of by specific non-NRC regulated waste disposal practices. Because the actual disposal of potential BRC waste will be in a disaggregated fashion, the evaluation of the practice will need to be performed in a disaggregated manner before a judgement can be made regarding the exemption of the practice.

The product of this subtask will be a set of cumulative probability distributions presenting the distribution of radionuclide concentrations in each waste stream as a percentage of the total volume of waste in that stream. The distributions will be prepared in different aggregates, such as by BWR, PWR, and by region. In Subtask 1.5 (see Section 2.1.5), these distributions will be used to determine the volumes of potential BRC wastes by waste stream and category of waste generator.

2.1.3.4 Data Verification

Verification of electronic and hard copy data will be performed by contacting selected individual waste generators and accessing available state databases. Special attention will be given to outliers. States, such as New York, Pennsylvania, Illinois, Texas and California have at least one year of recent survey data on line and available for review. These data were gathered by independent state and compact surveys and therefore represent a useful method to cross check data provided in the manifest database. Participation by individual states and compact organizations throughout the project is also consistent with the December 1988 policy statement.

2.1.4 Subtask 1.4 - Data Downloading and Processing

The objectives of this subtask will be to develop and implement a plan to convert, as necessary, existing hard copy and electronic data into a form that may be (1) efficiently used as input to IMPACTS BRC and other pathway codes, and (2) download data to appropriate data processing programs. The former will be useful in Task 2 and the latter will be used to generate waste characterization output reports which may be used to support BRC rulemaking activities. In addition, the software which will be used to develop the probability distributions described above in Section 2.1.3.3 will be developed in this subtask.

In addition, there are a number of data processing packages which may be used to display the data in convenient form. The packages range from statistical packages, such as SAS, to Geographic Information Systems, which can display the data on high quality digitized maps.

In this subtask, a database management program, like DBASE, will be used to process the raw data, and create statistical distributions, to extract sub-sets of data. For example, the following information might be useful:

1. Statistical distrihution of waste generator categories (medical, utilities, etc).

2. Statistical distribution of waste generator by geographical region.

3. Statistical distribution of annual quantities generated (activity and volume).

4. Statistical distribution of specific activity by nuclide (Curies/gm).

5. Statistical distributions of chemical forms (e.g., ion exchange resin, metal oxides, etc.).

6. Statistical distribution of physical forms (solid, liquid, gas).

The information in items 1-6 will be compiled and put in the report. The information in items 4-6, in addition to being included in the report, will be written to data files for direct input into pathways models for assessment of risk.

2.1.5 Subtask 1.5 - Volumes of Potential BRC Wastes and Major BRC Waste Generators

In this subtask the major generators of potential BRC waste will be identified and the volumes of potential BRC waste will be estimated. This will be accomplished by comparing the distributions developed in Subtask 1.3 with the radionuclide concentrations estimated to cause a given dose to the maximally exposed individuals.

A number of generic analyses have been performed that estimate the concentration of radionuclides in individual waste streams that result in a unit exposure. For each radionuclide, generic site and pathway, doses have been normalized by expressing them in units of mrem/yr per pCi/g of waste. These normalized doses have been estimated using the family of IMPACTS and PRESTO codes. For example, NUREG/CR-3585 (Oz 84) presents output from the INVIMPS code which was used to calculate the maximum concentration limits for waste which will limit impacts to an individual to specified dose criteria. In addition, the INVERSE code, developed by Oztunali and Roles (NUREG/CR-4370), could also be useful in this application.

The example in NUREG/CR-3588 estimates the radionuclide concentrations in waste streams that result in 25 mrem/yr to the maximally exposed individual. In this subtask, the calculational assumptions will be varied in order to identify a range of radionuclide concentrations that can result in 1 mrem/yr.

Another convenient yardstick is the BRC doses calculated and published by EPA using the PRESTO-EPA-BRC code for population doses and the PATHRAE code for individual doses. The results of these analyses are published in the Background Information Document (EPA 88a) and other supporting documentation for proposed 40 CFR 193. The tabulated values of BRC doses cover a broad range of waste streams, disposal scenarios and sites. These results will also be converted to normalized doses.

Using these normalized doses, the data and distributions assembled in Subtask 1.3 will be processed to identify major generators and to estimate the volumes of potential BRC wastes. The results will be presented for a range of possible BRC criteria (1 to 100 mrem/yr; 10 to 1,000 person rem/yr). Sensitivity analyses will also be performed to assess how the results may change using alternative calculational assumptions to derive the normalized doses associated with different waste streams and disposal methods.

NUREG-1101 provides another method that may be used to estimate the potential volumes of BRC waste. NUREG-1101 provides guidance for academic, medical and industrial licensees for onsite disposal of radioactive waste. Waste disposal under these guidelines is not strictly BRC since the waste remains under the control of the NRC licensee. However, these waste disposal activities do not fall under 10 CFR 61 guidance. Accordingly, the waste disposal limits provided in Appendix A of NUREG-1101 may also serve as convenient "yardsticks" to estimate potential volumes of BRC wastes for non-utility waste generators.

2.1.6 Subtask 1.6 - List of Practical Disposal Options

In support of rulemaking activities, both the NRC and the EPA have defined a wide range of alternative potential options for BRC disposal. A list of these options is as follows:

<u>Options Addressed in NUREG/CR-3580</u>

- o On-site incineration followed by disposal of ash in a sanitary landfill.
- o Municipal incineration followed by disposal of ash in a sanitary landfill.
- o On-site incineration followed by disposal of ash in a hazardous waste disposal facility.
- o Hazardous waste incineration followed by disposal of waste in a hazardous waste landfill.
- o Direct disposal in a sanitary landfill.
- o Direct disposal on site.

Though the list itself doesn't distinguish between types of sites, the analyses performed in NUREG/CR-3585 does address different regions and demographic characteristics.

Options Addressed in EPA 520/1-87-012-1:

- Suburban sanitary landfill
- Suburban sanitary landfill with onsite incinerator
- Urban sanitary landfill
- Urban sanitary landfill with onsite incinerator
- Rural municipal dump
- Suburban landfill on the waste generator's property with pathological incinerator

The following presents a brief discussion of some of these options as they may apply to BRC, along with several additional disposal options not explicitly addressed in the above-cited references.

Municipal Landfills

Municipal solid waste landfill facilities (MSWLF) are allowed to accept industrial waste (proposed 40 CFR part 258). Nearly 50% of all MSWLFs accept some amount of industrial waste, although none accept industrial waste as a major portion of their total waste. Note that about 20% receive some portion of small-quantity generator hazardous waste. These facilities may be publicly or privately owned (15% are privately owned). This form of disposal is likely to be a practical disposal option for some generators of BRC waste.

Industrial Waste Landfills.

Approximately 28,000 industrial solid waste disposal facilities (i.e., facilities that accept no household wastes) are known to exist. These facilities, of which about 12% are landfills, are regulated under the existing and proposed 40 CFR Part 157.

Industrial landfills can be located either onsite or offsite. About 35% of the 390 million dry metric tons of nonhazardous industrial wastes generated annually is managed onsite (although not necessarily in landfills). Either offsite or onsite industrial waste landfills could be practical disposal options for some generators of BRC wastes. Note, however, that the pharmaceuticals industry, which is likely to be an important producer of BRC wastes, does not appear to handle a significant quantity of any of its wastes onsite at this time.

Land Application

Land application, or land treatment, is used as a disposal method for wastes from several industries, including oil and gas refineries and plastics and resins manufacturing. Land application is also used extensively to dispose/use municipal sewage sludge and in more limited ways, oil and gas well drilling wastes. Both onsite and offsite land application of all these waste types occurs. In all cases, the waste is mixed with soil and the soil microorganisms are used to break down the organics in the waste into their harmless component parts. In many cases, the use of the waste is considered to be marginally beneficial to the soil (for example, sludge is often marketed and sold as a soil conditioner to farmers). Outside of these waste types, however, land application is not a common practice. The industries expected to produce BRC wastes currently do not practice onsite land application of their wastes. However, since all wastes from this industry appear to be disposed at offsite land-based disposal facilities where the exact ultimate disposal method is not known and the industry does tend to produce some biodegradable organic wastes that could be conceivably land applied, the offsite land application of BRC waste cannot be completely ruled out.

Surface Impoundments

Surface impoundments are usually associated with wastes with low solids content (i.e., pumpable wastes). It is a very common onsite disposal method for industrial wastes (nearly 60% of all industrial waste facilities are surface impoundments). If the

BRC waste is a pumpable waste, onsite surface impoundment disposal should be considered a likely option for disposal of this waste where an onsite impoundment is already being used for nonhazardous industrial waste. Offsite impoundments are not as common as onsite impoundments and are typically chosen as an option if the facility has no land available or if siting or other restrictions prevent the construction of an onsite impoundment. Dewatering of the waste (usually to about 20% solids) for placement in an offsite landfill can be a less expensive option than shipping a low-solids waste to an offsite impoundment due to the expense of transporting liquid wastes. Thus offsite disposal in impoundments may be a less likely disposal option for BRC waste than some of the other options available such as onsite impoundment disposal or offsite landfilling.

Ocean Disposal

Congress recently enacted Public Law 100-688, known as the Ocean Dumping Ban Act, which prohibits the dumping of sewage sludge and any solids, semisolids or liquids associated with industrial manufacturing or processes (with very few exceptions) by December 31, 1991. EPA intends to apply the broadest interpretation of this law and will work to prohibit the disposal of any industrial waste in the ocean. For these reasons, it is considered that ocean disposal is not available as a disposal practice for BRC waste. However, at this time, EPA believes that only municipal sludge is being disposed in the ocean. Accordingly, ocean disposal of water treatment plant sludge contaminated with trace levels of radionuclides may still be a feasible option.

Incineration

Incineration, with or without energy recovery, is becoming a more common method of municipal waste reduction (it cannot truly be considered a disposal method, since the ash remaining must still be disposed). Because of the increasing numbers of municipal solid waste incinerators that may be available to industrial waste generators, this disposal method must be considered a practical disposal method for BRC generators. No significant amount of industrial waste appears to be incinerated onsite. Incineration is a costly waste disposal method unless the waste has a very high heat content and/or is produced in very large volumes. An example of an industry that does practice some onsite incineration of waste is the pulp and paper industry. Unless the BRC waste fits into this type of category of large volume/high heating value (for example, large volumes of very mildly contaminated oil), most industrial waste generators of BRC waste would tend to look for existing incinerators built on a very large scale, such as a municipal waste incinerator.

Waste Piles

Data on waste piles are very limited. A few industries such as the fertilizer industry use waste piles, and some publicly-owned wastewater treatment works processing municipal wastewater use onsite and offsite piles, but many of these piles are used for short- or long-term storage, rather than for ultimate disposal. It is not clear whether waste piles would be a practical disposal method for BRC wastes. It probably should not be ruled out as a possibility.

Injection Wells

Class V injection wells are used for the disposal of nonhazardous wastes that are not associated with oil and gas production or certain mining activities. Class V wells have been used for a variety of nonhazardous wastes including septage and municipal wastewater and are not necessarily deep wells, since they do not currently have any requirements as do Class I wells (hazardous waste injection wells) to underlie all known actual or potential sources of drinking water. If the BRC waste is liquid and is or can be made compatible with an injection zone, an onsite or offsite injection well may be a possibility as a disposal option.

Note that additional regulations governing these types of wells are planned to be proposed in the near future.

Recycling/Reuse

Recycling/reuse of BRC waste is not likely to be more significant than recycling/reuse of LLW. Generators of LLW have some pressure to recycle/reuse as much as economically practical. Deregulation would actually tend to reduce this incentive. It is more likely that recycling/reuse issues will be of concern as a pathway of exposure which must be precluded in order for a given practice to be considered for BRC.

Storage

With certain waste streams, LLW currently may be stored onsite until no longer considered a radioactive waste. This incentive would be eliminated by deregulation for those wastes defined as BRC. However, for certain short-lived radionuclides, increased use of storage for decay may be useful to institutional waste generators as a means of taking full advantage of a BRC rulemaking.

Discharge with Process Wastewater

This option would require the modification or issuing of NPDES permits to allow the discharge of a new or altered waste stream to a surface water body. Although this is theoretically possible with a mildly contaminated wastewater, its likelihood as a disposal option rests with the EPA. Current regulations, developed under the authority of the Clean Water Act, vary with the industry. Some industries already operate under "no discharge" conditions. The evaluation of this option, then, includes consideration of existing regulations upon the specific industry and the likelihood of permits to allow the discharge.

Licensed disposal Under 10CFR 61

This is the baseline option from which the impacts of BRC regulations will be assessed. It is possible that it may be expedient for BRC generators to continue using the same disposal method rather than shifting to another disposal method. This could occur if 1) they had a nearby facility for disposing of low-level radioactive waste, or 2) the volume of BRC waste is small and can be combined with the other waste.

In this subtask, these lists will be used as a starting point. The lists will be expanded to include additional options. In addition, some disposal options may need to be defined more explicitly, such as different classes of landfills, alternative incineration technologies, and a range of pretreatment strategies, including sorting of potentially recyclable materials. The sources of information that will be used to identify disposal options are summarized in Section 2.1.7, which follows.

2.1.7 Subtask 1.7 - Identification and Characterization of Disposal Options and Facilities

In order to expand the list of options, identify disposal facilities and gather data characterizing each facility, the following sources of electronic and published information will be reviewed.

Electronic Data

In support of proposed 40 CFR Part 258, the EPA undertook a survey of municipal solid waste landfills (MSWLFs). The survey encompassed 1,102 MSWLFs nationwide and it was upon this sample that the population characteristics of 6,034 estimated facilities is based. The sample contains information on the following parameters:

- Remaining capacity
- Ownership
- Size
- Age

o Proximity to (within one mile)

- Residences
- Drinking water
- Population

o Hydrogeology

- 100 yr floodplain
- wetlands
- karst terrain
- above seasonal high-water table
- primary soil type between bedrock and waste

The data are currently stored and maintained by an EPA contractor (Westat), but since the database was developed for a Federal agency, it is available for this effort. In addition, there has been a report on the survey, National Survey of Municipal Solid Waste Landfills, EPA 530-SW88-0034, draft final report, September 1988.

Published Information - Federal Sources

Much of the following information concerning the current disposition of nonhazardous, nonradioactive waste is from an EPA report entitled "Subtitle D Study, Phase I Report" and the preamble to proposed 40 CFR Part 258. The information these sources provide is summarized in four sources that will be useful for characterizing the types of disposal options currently used for nonhazardous waste disposal. These sources are:

Franklin Associates, Ltd, 1986, 1988 update, Characterization of Municipal Solid Waste in the United States, 1960 to 2000;

Science Applications International Corp., 1985, Summary of Data on Industrial Nonhazardous Waste Disposal Practices;

U.S. EPA, OSW, 1988, Survey of Solid Waste (Municipal)

Landfill Facilities;

U.S. EPA, OSW, 1986 Industrial Subtitle D Facility Study, Set of Questions in Telephone Survey.

Other sources likely to be of use in characterizing risks associated with disposal in municipal landfills are:

U.S. EPA, 1988, Draft Regulatory Impact Analysis of Proposed Revisions to Subtitle D Criteria for Municipal Solid Waste Landfills (40 CFR Part 258)--Subtitle D of the Resource Conservation and Recovery Act;

U.S. EPA, OSW, 1986, Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites;

U.S. EPA, OGWP, 1985, DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings;

U.S. EPA, OSW, 1986, Criteria for Identifying Areas of Vulnerable Hydrogeology Under the Resource Conservation and Recovery Act, Statutory Interpretive Guidance, Guidance Manual for Hazardous Waste Land Treatment, Storage and Disposal Facilities;

U.S. EPA, OSW, 1980, Guidance Document on Classifying Solid Waste Disposal Facilities;

ICF, Inc., 1986, The Liner Location Risk and Cost Analysis Model: Phase II.

Our project team, has worked extensively with EPA personnel on hazardous and nonhazardous waste disposal issues and are aware of current efforts in these areas, current regulatory thinking, and recent publications.

Published Information - Industry Sources

The National Solid Waste Management Association (NSWMA) has conducted several technical studies which are relevant to this project, such as a census of landfills and their capacities and a state-by-state study of tipping fees. The information in these reports is available in hard-copy form only, but can be readily transferred to electronic media if necessary.

Both NSWMA and the Association of State and Territorial Solid Waste Management Officials can provide contacts with appropriate personnel when specific petitions must be evaluated.

Our review of the above information will address the compatibility of different electronic databases. Most databases allow output to magnetic media in ASCII with fixed-length fields and records. Electronic transfers can be performed between computer systems via modem, tape, or diskette. Such information, when accompanied by appropriate dictionaries, can readily be transferred into other database languages. Our proposal subcontractor, Eastern Research Group, obtained the Platform Inspection System, Complex/Structure database from the Minerals Management Service in such a manner. The database contains over 4,000 observations with over 50 parameters per observation.

These data may be loaded onto a Geographic Information System (GIS), along with the locations and identities of each of the major potential BRC waste generators (i.e. the low-level waste generators). A number of GIS services are available to choose from. Alternatively, it may be most cost-effective to work through the ORNL Division of Health Siting and Waste Management and use the GIS employed in NUREG/CR-3056[4].

---

[4] We have been in contact with Richard Dunfee at ORNL to discuss their GIS hardware, software and data bases. ORNL has both the computer hardware and GIS software to establish a GIS for this project. They have assembled large GIS data bases and displays for the NRC in the past (see NUREG/CR-3056) and have the hardware and software to provide GIS support to this project in a highly cost-effective manner. ORNL currently has national demographic and hydrological data bases(down to the 1:24,000 scale) on line. In

During the course of the project, if it is determined that mounting the databases on a GIS is appropriate, we are prepared to work with ORNL, or bring aboard a GIS subcontractor, as needed. These systems will accept digitized site and environmental data and overlay the data graphically to facilitate data display and reviews. A great deal of the geographic data are available in digitized form primarily from USGS and the Bureau of Census.

Where only hard-copy records are available, an appropriate input screen can be designed for rapid data entry for programs such as PARADOX. (Eastern Research Group is currently creating a database of OSHA accident reports from over 5,000 firms for its project evaluating personal protective equipment.)

2.1.8 Subtask 1.8 - Disposal Facility Characterization for Pathway Modeling

Appendix C of NUREG/CR-3585 presents a description of the reference solid waste treatment and disposal facilities and site characteristics used as the bases for the files in IMPACTS BRC. The question that will be addressed in this subtask is the degree to which the set of generic assumptions used in IMPACTS BRC is representative of the full range of actual solid waste management practices and disposal sites. The approach that will be used is to:

(1) identify the additional disposal options which may need to be addressed as identified in Subtask 1.7 (see Section 2.1.7 above)

(2) identify the areas where IMPACTS BRC may need to be expanded, refined or revised.

---

addition, they have interagency agreements in place with USGS and the Bureau of Census to acquire additional digitized files as needed.

This subtask will be accomplished by constructing detailed waste handling flow diagrams using the data gathered in Subtask 1.7. These flow diagrams will be compared to the reference waste handling and disposal practices described in Appendix C of NUREG/CR-3585.

2.1.9 Subtask 1.9 - Critical Exposure Pathways

Subtask 1.5 will result in a preliminary identification of critical exposure pathways by comparing the normalized exposures for each waste stream and disposal option with the radionuclide concentrations and inventories in each waste stream. However, these findings will need to be revised when the list of disposal options is expanded and refined in Subtasks 1.6, 1.7 and 1.8. In this subtask, the results of Subtasks 1.5 and 1.8 will be reviewed together to revise and refine the critical exposure pathways identified in Subtask 1.5.

A hierarchy of exposure pathways will be developed for each disposal option and potential BRC practice. This hierarchy will be used in establishing BRC procedures or defining BRC practices. For example, a number of previous BRC studies have found that exposure to transportation workers is the limiting pathway. However, if this pathway can be eliminated by using radiation workers to transport BRC waste for disposal, the doses to the maximally exposed individual will be reduced, or, conversely, the radionuclide concentrations that may be considered BRC can be increased, thereby increasing the volumes of waste treated as BRC.

2.2 OPTIONAL TASK 2 - MODELING RADIOLOGICAL IMPACTS

Objective: Compute and analyze the impacts to public health and safety resulting from the disposal of various BRC waste.

Optional Task 2 will not begin until the NRC Contracting Officer issues a modification to the contract. Task 2 has been divided into 2 subtasks: Execution of IMPACTS BRC and sensitivity and uncertainty analysis.

2.2.1 Subtask 2.1 - Execution of IMPACTS BRC

Task 1 will have compiled a large database characterizing potential BRC waste streams and solid waste management and disposal practices. Using these data, IMPACTS BRC will be run for any of the waste streams and for a wide variety of possible disposal options.

Using the decision indices, IMPACTS BRC may be used for a variety of waste forms, packaging or disposal properties and sites. By selecting a given set of decision indices the user accesses a set of IMPACTS BRC files which are used to calculate individual and population dose by a number of possible exposure scenarios and pathways. In this subtask, decision indices will be selected which best represent the specific conditions which are being modeled.

In those cases where a disposal technology or site is being considered which is not modelled by IMPACTS BRC, or where the default files associated with the various decision indices are not appropriate for a particular application, the default files will be expanded to cover a broader range of conditions or additional calculational subroutines will be incorporated into IMPACTS BRC.

SC&A will evaluate, identify and document the most appropriate use of IMPACTS BRC for any particular application or conditions under which IMPACTS BRC may need to be supplemented by other models. The actual running of the code and expansion of files and subroutines can be performed by SC&A and its subcontractors, or by Sandia National Laboratories.

2.2.2 Subtask 2.2 - Uncertainty and Sensitivity Analysis

In this subtask, the day-to-day running of IMPACTS BRC will be supported by periodic sensitivity and uncertainty analysis which will document, quantitatively, the degree of uncertainty or conservatism inherent in the application of IMPACTS BRC.

As discussed in the Background section of this proposal, IMPACTS BRC is designed to account for all the significant factors affecting exposure and potential health risks, but remains simple enough to be easily useable and cost-effective. There are, however, some conditions for which IMPACTS BRC may be overly conservative or simply inappropriate. In these instances, it may be desirable to use a different submodel capable of accommodating the particular special circumstances.

In this subtask, alternative models will be run, as needed, to:

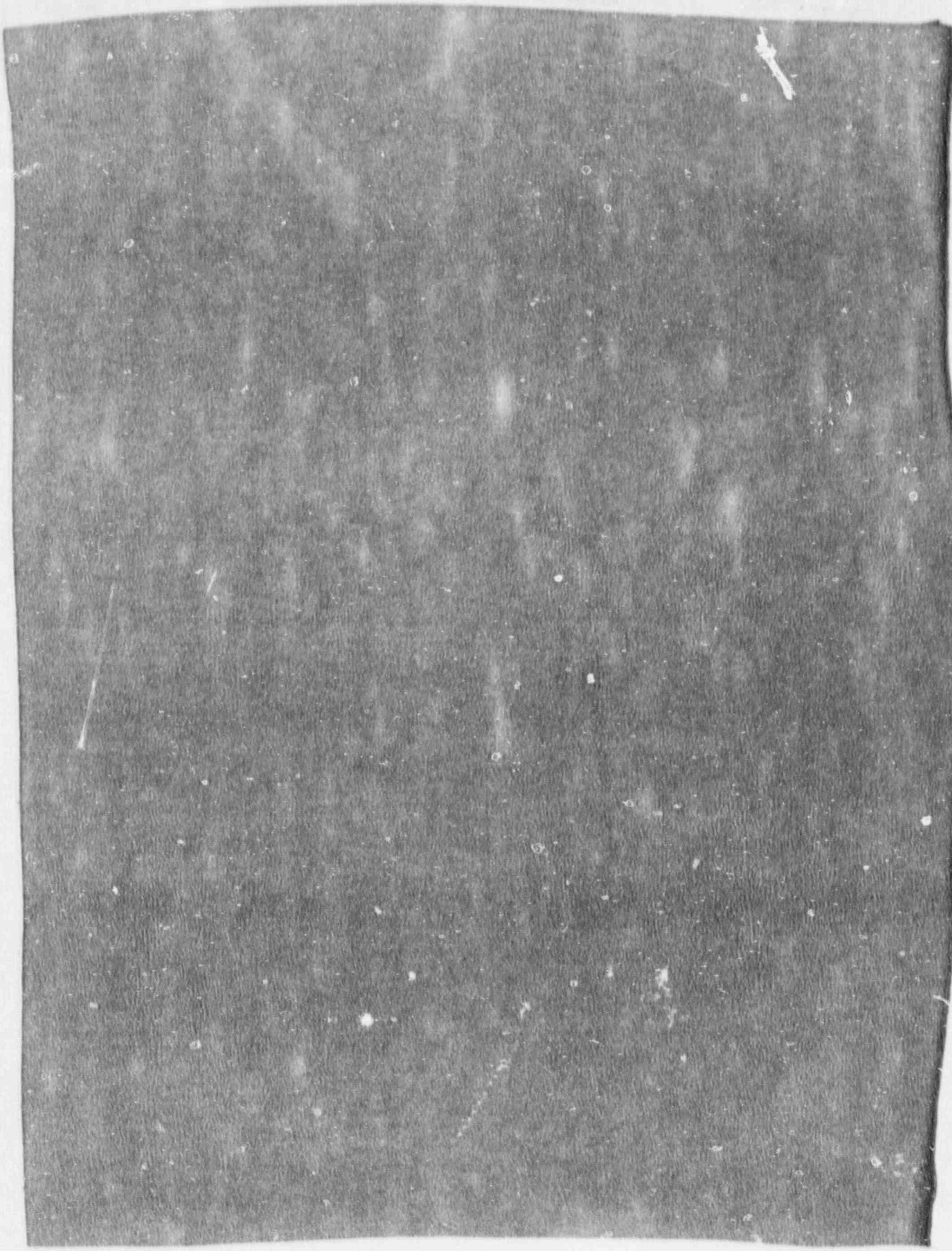
(1) assess the conservatism or uncertainty in a given IMPACTS BRC application

(2) evaluate impacts under circumstances where IMPACTS BRC is not appropriate.

(3) evaluate impacts using codes which have widespread application for lined and unlined sanitary landfills. The use of these codes, in addition to IMPACTS BRC, will help to characterize potential impacts using methods more familiar to sanitary landfill modelers.

Table 1-2 and 5-1 present lists of the codes available for these applications. A discussion of the capabilities of some of these codes follows.

[redacted]



[redacted]

Some of the groundwater flow and solute transport models which are adaptable for this purpose are briefly described below.

<u>EPACML and EPACMS</u>

These two codes were developed for EPA to assess contaminant migration from landfills and surface impoundments, respectively. EPA's principal intended use for these models is for determining when a substance can be delisted as hazardous or toxic, which is a very similar application to that of the NRC in determining BRC criteria. Some of the features of those codes include:

- one-dimensional finite element numerical solution for the unsaturated zone, which can be layered (heterogeneous)
- three-dimensional dispersion in uniform flowing aquifers (analytical solution)
- accounts for linear reversible sorption (K_d)
- set up for Monte Carlo analyses
- can account for chain decay daughter products
- EPACMS can handle nonuniform flow in the aquifer
- uses basic soil and aquifer properties as inputs, rather than specified velocities
- does not compute radiation exposure or dose rate but could easily be modified.

STAFF2D

This code was developed by HydroGeoLogic to simulate groundwater flow in fractured rock or dual porosity rocks, accounting for both uniformly distributed non-discrete fractures or individual discrete fractures and fracture zones. It is a finite-element numerical code which accounts for heterogeneous and anisotropic hydraulic properties. It includes effects of matrix diffusion, sorption (various types of isotherms), dispersion, chain decay and a variety of simple or complex boundary conditions. It can easily be adopted for Monte Carlo analyses and for computing radiological doses.

VAM2D and VAM3D

These codes are finite element models designed to compute transient or steady flow and solute transport in heterogeneous, anisotropic variably-saturated porous media. They are ideally suited for problems involving highly time-variant water table positions and transport systems dominated by heterogeneous unsaturated media. The codes account for flow and transport in two- and three-dimensions, respectively, soil moisture hysteresis, sorption, decay and decay chain daughters, multi-dimensional dispersion, and other significant processes. The original VAM2D code was developed by HydroGeoLogic, Inc. and a special, new enhanced version was recently developed under contract to the NRC for application to low-level and BRC-type waste dispcsal sites.

Other codes are also available from a variety of sources to address special problems and conditions. For example, the radiological impacts of disposal of certain waste streams in municipal sewerage systems may be evaluated by GENNI. GENNI is a system developed at Pacific Northwest that has been used to estimate the dose to a maximally exposed individual in both the worker population and the general public from the disposal of radioactive wastes in municipal sewerage systems.

Exposure scenarios investigated with GENNI include land application, sanitary landfills, and incineration, where the resultant ash is disposed in a landfill. The exposure of workers at the publicly-owned treatment works (POTW) and landfills are also examined. The results of preliminary pathway analyses using GENNI were presented at the annual meeting of the Health Physics Society in July 1988 (see Parkhurst, M.A., Herrington, W. N., Martin, J. B., Napier, B., and Neuder, S., "Evaluation of Exposure Pathways to Man from Disposal of Radioactive Material in Sanitary Sewer Systems", Health Physics Journal, volume 54, Supplement 1).

GENNI is public domain software and is readily available on a floppy disk with a user's guide. It runs on an IBM PC with a 40 megabyte hard disk and a coprocessor (personal communication, J. B. Martin, March 1989).

Though the ocean disposal of BRC wastes is not a highly probable disposal option, should the NRC wish to investigate the doses and risks from the ocean disposal of below regulatory concern radioactive wastes, our project team has in-depth experience in this area. Our subcontractor, ERG, has assisted in the development of MARINRAD (Marine Radionuclide Transport and Dose), a systems model developed for the Subseabed Disposal Program, Sandia National Laboratories. MARINRAD simulates the diffusion of waste through the ocean sediments, mixing within the water column, transport through aquatic food chains, and uptake by humans. Radioactive decay and decay chains are incorporated in the transport calculations as are sorption, concentrations in suspended sediments, removal by sedimentation. Both diffusion and advection are considered within the oceanographic transport model. The system is publicly available. ERG has developed compartment models for sites in the Atlantic and has performed sensitivity studies on the oceanographic and biological transport parameters.

2.3 TASK 3 - INFORMATION FOR DRAFT RULE AND REGULATORY GUIDE

Objective: Provide written, regulatory and administrative background information necessary for NRC staff to draft a generic rule and regulatory guide governing BRC wastes.

Task 3 is divided into the following four subtasks.

- o Coordination and compilation of technical material from Tasks 1 and 2 required to support a rulemaking.
- o The performance of value-impact and cost-benefit analysis
- o The assessment of compatibilities of proposed rules and guidelines with local regulations
- o Administrative and logistics support to notices and public meetings

[redacted]

2.3.1 Subtask 3.1 - Technical Support

Technical support to the rulemaking process will include the development of decision criteria and the compilation of technical material required to implement the criteria. Decisions will need to be made regarding (1) whether one or more rules or regulatory guides will be needed, (2) how practices will be defined, and (3) the types of restictions that are required for each practice. SC&A will compile the data needed (primarily from Tasks 1 and 2) to define the decision criteria, and perform technical analyses needed to support a BRC rule or regulatory guide.

We have designed Task 1 to be able to efficiently support the rule making process. Specifically, the manifest database, down to the container level, will be accessible to a variety of application codes, including statistical processing packages and geographic information systems. In this way, tables and figures which aggregate and disaggregate the data by any combination of parameters can be displayed. In addition, in Task 1 the database will be interfaced with a number of pathway codes so that dose assessments can be quickly performed as needed to support rulemaking.

Each of the members of the Task 1 and 2 teams will be available to support any technical analyses required during the rulemaking process.

2.3.2 Subtask 3.2 - Value-Impact Analysis

Task 3 will also require the performance of value-impact studies, including:

- development of an economic and financial database on the affected industry,
- economic and technical definition of model or reference facilities
- assessment of the impact of costs on the facilities,
- assessment of impacts on the industry,
- measurement of regulatory benefits.

- comparison of costs and benefits of alternative regulatory approaches,

- preparation of technical support documents and, where appropriate, the record of the rulemaking effort.

In this subtask, an analysis will be performed of the financial savings and sources of additional costs to the individual categories of waste generators and society as a whole that may be attributed to a BRC rule or regulatory guide. The financial analysis will compare BRC vs. LLW disposal, transport and generator costs. The BRC costs will include buying monitoring and sorting equipment, labor and equipment maintenance. The cost comparisons will be performed as a function of waste stream, disposal option and BRC criteria.

Non-dollar cost-benefit comparisons will also be evaluated, including: (1) vehicle miles traveled, (2) commitment of resources (steel, fuel oil, life of licensed facilities), (3) risk of injury and fatality from waste handling and transport, and (4) radiation doses to radiation workers, transporters and members of the public. The level of analysis and the type of documentation will be commensurate with the requirements of the rulemaking.

Cost-benefit issues associated with the deregulation of below regulatory concern radioactive wastes are highly complex. The volume of waste that is deregulated is shifted from LLW disposal sites to Subtitle D disposal facilities, with concommitant economic impacts on both sets of facilities. A brief overview of some of the considerations involved in the cost-benefit analysis are given for each set of facilities.

Subtitle D Facilities - Subtitle D facilities are for the disposal of non-hazardous wastes. A preliminary listing of disposal options is given in Section 2.1.6. Deregulated wastes would be sent to such a facility, possibly the local municipal solid waste landfill (MSWLF). In this subtask we will evaluate whether the increased waste volume associated with deregulation would adversely impact MSWLF capacity and facility lifetime. If the waste is processed by a publicly owned treatment works (POTW), we will evaluate whether the new waste streams render chemical make-up of the resultant sludge unacceptable.

LLW Disposal Facilities - Existing LLW facilities would lose the volume of deregulated wastes. Since there are fixed costs that a facility must recover to be economical, lower volumes can lead directly to higher unit costs for disposal. The volume/unit disposal cost relationship will be investigated to estimate the cost increase due to reduced volumes. The cost-effectiveness of the deregulation option will be evaluated in the context of estimated cost increases, where applicable.

In addition to the impacts on existing facilities, the impacts on future facilities will be considered. Under the Low-level Waste

Policy Act of 1980, states are responsible for the radioactive wastes generated within their borders. States are in the process of forming compacts and/or developing the criteria and regulations for hosting a disposal site. The economic viability of future/ potential disposal sites also depends on the ability to recover capital and operating expenses. This, in turn, depends on the projected volumes of waste that the facility will receive and the disposal cost per unit volume. Given the strong emphasis seen on volume reduction in the last few years, we need to investigate whether the additional reduction in waste volume due to deregulation will lead either to rendering potential sites uneconomical or lead to excessively high disposal fees.

[redacted]

2.3.3 Subtask 3.3 - Compatibility With Federal and Local Regulations

In terms of general regulatory support, there should be consistency with NRC regulations releasing wastes as BRC and regulations concerning those facilities to which deregulated wastes may be sent. For example, BRC wastes may be sent to municipal solid waste landfills (MSWLFs). These facilities are regulated by the U. S. Environmental Protection Agency under 40 CFR Parts 257 and 258 for which a proposed rule was published on 30 August 1988 (Federal Register, vol. 53, no. 168, pp. 33314 ff.). The proposed rule covers location restrictions (40 CFR Part 258 Subpart B), operating criteria (Subpart C), design criteria (Subpart D), and ground water monitoring and corrective action (Subpart E). The generic or regional facilities modeled in this effort should conform to the requirements placed on such facilities by the EPA.

The proposed 40 CFR Part 257 now adds Section 257.5, which requires notification and exposure information from industrial waste disposal facilities. Part 257 would affect industries that would consider the on-site disposal of BRC wastes. Siting and monitoring requirements set forth in 40 CFR Part 257 should be incorporated in any analysis of on-site disposal options for industrial wastes.

There are potentially two types of analyses within this effort for the NRC. The first effort is a generic or regional study, such as that proposed in Tasks 1 and 2. The second effort may be a more specific study, perhaps even a site-specific study, depending upon the nature of the petitions received under Task 4. For the latter type of study, State and municipal regulations need to be considered.

State regulations vary widely in specific design and operating standards for MSWLFs. The EPA has completed a detailed review of State regulations in 1984 and a supplemental review in 1987 (WESTAT, Inc. Census of State and Territorial Subtitle D Nonhazardous Waste Programs. Contract No. 68-01-7047. 1986; U.S. EPA, Office of Solid Waste, Updated Review of Selected Provisions of State Solid Waste Regulations - Criteria for Municipal Solid Waste Landfills (40 CFR Part 258) -Subtitle D of the Resource Conservation and Recovery Act (RCRA). August 1988). For example, 38 States and Territories require ground water monitoring, 24 States require liners, and 27 States and Territories require leachate collection systems. Prescribed distances from habitable residences vary from 200 feet to three-quarters of a mile, while the distances from community water supplies ranges from 400 feet to one mile. These publications and additional information from EPA Office of Solid Waste personnel can form the basis for site-specific studies, if such are needed.

The EPA reviews the State permit programs for MSWLFs in a process analogous to becoming an agreement State with the NRC with regard to radioactive wastes. If the EPA deems the State program adequate, the State may bring corrective action against a facility. The EPA may bring corrective actions directly against a facility if the State is not deemed to have an adequate program. With regard to corrective action, 21 States have requirements in their regulations, while 22 others have general authority to impose corrective action. When the generic and/or site-specific analyses are done, they should address the possibility of State or Federal site requirements.

Eastern Research Group, Inc., due to its long and close involvement in regulatory support for the EPA Office of Solid Waste and the Office of Water, will provide regulatory support to ensure the compatibility of NRC rulemaking efforts with other agency efforts to protect the environment. ERG is working closely with EPA personnel on municipal solid waste disposal, sludge disposal, and injection wells, and is therefore familiar with the regulations in place and in development for such disposal practices.

2.3.4 Subtask 3.4 - Administrative and Logistics Support

Under this subtask, SC&A will provide a broad range of logistics support to the NRC staff during the rulemaking process. As defined in Subpart H of 10 CFR Part 2, this support may include:

- Arranging public meetings
- Drafting input to Federal Register Notices
- Drafting responses to public comments
- Supporting ACRS meetings
- Drafting responses to petitions
- Arranging for workshops

[redacted]

2.4 TASK 4 - ASSESSMENT OF PETITIONS

Objective: Under a task order contract, provide technical assessments of petitions for rulemaking for the deregulation of waste streams.

Task 4 work assignments will be initiated following receipt of an executed, funded Task Order from the NRC Contracting Officer. In order to demonstrate our understanding of the task order procedures delineated in Section G.5 of the RFP and also describe the basic approach we will use on a given task order, the following presents an example Task Order Proposal prepared in response to a hypothetical Task Order Request For Proposal. It is assumed that the Task Order Request for Proposal is to assess an EPRI petition for BRC rulemaking for secondary side demineralizer disposal in municipal sanitary landfills.

A. Hypothetical Task Order Request For Proposal (Prepared by the NRC and submitted to SC&A by the NRC Contracting Officer.

A 1.1 Scope of Work/Meetings/Travel and Deliverables

Task A - Minireview

- Perform a minireview of the enclosed EPRI Petition for BRC Rulemaking to determine the degree to which the petition addresses the applicable regulations, including each of the 14 criteria set forth in Appendix B to Part 2 of Title 10 of the Code of Federal Regulations.

- Prepare a report of the review findings including questions to be transmitted to EPRI.

- Attending one meeting

Task B - Detailed Technical Review of Petition

- Perform a detailed review of the Petition

- o Prepare monthly progress reports, and technical reports in accord with Section F of the RFP

- o Attending two meetings

A.1.2 Estimated Level of Effort and Period of Performance

Task A	300 hours	1 month
Task B	1000 hours	4 months

A.1.3 Reporting Requirements (see Section L of RFP)

- o Monthly Progress Reports

- o Draft and Final Reports

B. Hypothetical Task Order Proposal (Prepared by SC&A and submitted to the NRC Contracting Officer)

B.1 Technical Proposal

B.1.1 Scope of Work

<u>Task A - Minireview</u>

SC&A will perform a minireview of the Petition to determine if the petition is substantially complete for docketting. The review will assess the degree to which the Petition addresses the following regulatory requirements and guidelines:

- o Information required for the Commission to prepare an Environmental Assessment as per Part 51.30, including need for the proposed action, and alternatives

- o The petition for rulemaking requirements set forth in 10 CFR 2.802(c)

- o Information required for the Commission to make a determination regarding no significant impact as per Part 51.32

o Information to aid the Commission in complying with Section 102(2) of NEPA

o An evaluation of economic impact on small entities as per 50 FR 50216

o Analyses explicitly addressing the 14 Decision Criteria of Appendix B to 10 CFR 2

o An assessment of impacts in accordance with IMPACT BRC methodologies

o A tabulation of the input data required for the staff to perform an IMPACTS BRC analysis

o A description of the non-radiological properties of the waste, especially any hazardous waste regulated under 40 CFR 260 to 265

o The bases for the waste stream characterization

o ALARA considerations

o Waste handling and transport

<u>Task B - Detailed Technical Review</u> (note that the scope of work assumes an complete submittal by the petitioner)

The following describes each of the technical reviews that will be performed to independently assess the Petition and provide technical support to an Environmental Assessment. (Note that many of the bulleted items are being addressed generically as part of Tasks 1, 2 and 3 of the main proposal and will be drawn upon to support the review of Task 4 petitions).

o Waste Characterization (Decision Criteria 8 and 9)

The manifest information management system for Barnwell and Hanford will be accessed and utility-specific waste package data on secondary side resins will be down loaded. Cumulative probability distributions will be prepared of the radionuclide concentrations (by critical radionuclide) vs. percent total volume of this waste stream. Separate distributions will be prepared for each of the most recent three years and aggregated over the three year period. These distributions will establish the variability of the radionuclide concentrations among secondary side resin waste packages and over time. If a bimodal distribution is found, similar distributions will be performed for selected individual PWRs.

- Comparison to Petition (Decision Criterion 9)

  The distribution compiled by SC&A will be compared to the data provided in the EPRI petition. If disparities exist, they will be resolved at meetings chaired by the cognizant NRC manager(s). The issue will be which database most accurately characterizes real waste.

- Recyclable Material (Decision Criterion 10)

  Since spent resin is a relatively homogeneous waste form (unlike DAW), the question which needs to be addressed is whether the resin is packaged and in a form which does not create incentives for recycling.

- Exposures to the maximum individual and critical population group from anticipated events (Decision Criterion 2)

  The database gathered in Task 1 of the main proposal characterizing municipal landfills throughout the U.S. will be used to (1) determine the applicability of the IMPACTS BRC hydrological models to the full range of hydrological characteristics and (2) select appropriate IMPACTS BRC decision indices. The default waste characterization files will be modified in accord with the radionuclide concentration distributions developed above (the 90 percentile level may be an appropriate bases for analyses). IMPACTS BRC will then be run to determine the dose to the maximum individual via all potential pathways of exposure and for the limiting sites and radionuclide concentrations. Based on the results, procedural constraints may need to be placed on the types of landfills that may receive the waste (e.g. Texas has established such constraints) and limits on the maximum radionuclide concentrations that may be disposed as BRC. These results will be compared to the doses calculated by the Petitioner.

- Collective Doses to the Population and Critical Population Group (Decision Criterion 3)

  The IMPACTS BRC runs described above will also yield population doses. The results will be compared to the population doses calculated by the Petitioner.

- Accidents (Decision Criterion 4)

  Based on the waste handling flow diagrams prepared in Task 1 of the main proposal, accident scenarios will be constructed for which waste handlers may come into direct contact with the waste material. External exposures and inhalation doses will be calculated for such incidents.

  Post-disposal impacts will also be evaluated including human intrusion (i.e., construction and agriculture), failure of the landfill containment, and fire. IMPACTS BRC will be used for this purpose after it is determined that the model structure and decision indices provide for an accurate representation of the full range of waste disposal sites.

  These results will be compared to those provided by the Petitioner.

- o Economic Analysis and Cost-Benefit Analysis (Decision Criteria 5 and 7)

  An economic analysis will be performed on the cost savings to the utilities (on a national level) due to the reduced waste volumes requiring licensed disposal, and the additional costs due to possible increases in unit cost for licensed low-level waste disposal due to volume reduction. The costs associated with establishing and implementing inspectable programs for conversion to BRC, in accord with a rule or regulatory guide developed in Task 3 of the main proposal will also be estimated. The full range of benefits will be reviewed, including non-quantitative benefits, and radiation exposure considerations, as delineated in Appendix B to Part 2.

- o Implementation Procedures for Conversion to BRC (Decision Criterion 11)

  The procedures provided in the petition for monitoring, inspection, and documenting, and reporting the conversion to BRC will be evaluated to assess compliance with the rule or regulatory guides developed in Task 3 of the main proposal.

- o Regulatory Compatibility (Decision Criterion 14)

  Federal, state and local regulations and codes will be reviewed to assess whether the petition is compatible with these requirements.

B.1.2 Task Order Team for Hypothetical Task Order

[redacted] The Task Order Manager will be supported by the technical personnel in the Task 1, 2 and 3 working groups. As indicated in Section 4, the project team includes sufficient qualified personnel to support their responsibilities in Tasks 1, 2 and 3, and also multiple Task Order Assignments. [redacted]

[redacted] Should multiple task order be authorized, additional task order managers will be identified either from the other task leaders or from the personnel identified in Figure 3-1. The Task Order Manager for a specific task order will be determined at the time of the task order and will depend on the technical scope of the petition and the availability of the personnel in light of their other commitments on this project. (resume provided in Appendix B).

B.2 Cost Proposal (abbreviated) for Hypothetical Task Order

[redacted]

Following submittal of the above Task Order Proposal to the NRC Contracting Officer, SC&A will meet with the NRC to discuss the proposal and make the necessary adjustments. Following written authorization, work will proceed. Alternatively, task orders can be implemented on an accelerated bases in accordance with Part G.6 of the RFP.

---

[6]These estimates assume work on Task 1 is completed or well underway, so that the results are available to support the review.

TABLE 2-1

PRELIMINARY WORK BREAKDOWN STRUCTURE

1.0 TASK 1 - SOURCE TERMS AND DISPOSAL TECHNOLOGIES

- 1.1 List of Potential BRC Waste Generators
- 1.2 Data Requirements
- 1.3 Radwaste Data Review
- 1.4 Data Downloading and Processing
- 1.5 Volumes and Generators of BRC Waste
- 1.6 List of Disposal Options
- 1.7 Identification and Characterization of Waste Disposal Options
- 1.8 Characterization of Options for Pathway Modeling
- 1.9 Critical Pathways
- 1.10 Report Preparation
- 1.11 Meetings

2.0 TASK 2 - MODELING RADIOLOGICAL IMPACTS

- 2.1 Execution of IMPACTS BRC
- 2.2 Uncertainty and Sensitivity Analysis

3.0 TASK 3 - INFORMATION FOR DRAFT RULE AND REGULATORY GUIDE

- 3.1 Technical Support
- 3.2 Value-Impact Analysis
- 3.3 Compatibility of Federal and Local Regulations
- 3.4 Administrative and Logistics Support

4.0 TASK 4 - ASSESSMENT OF PETITIONS

To be defined for each task order

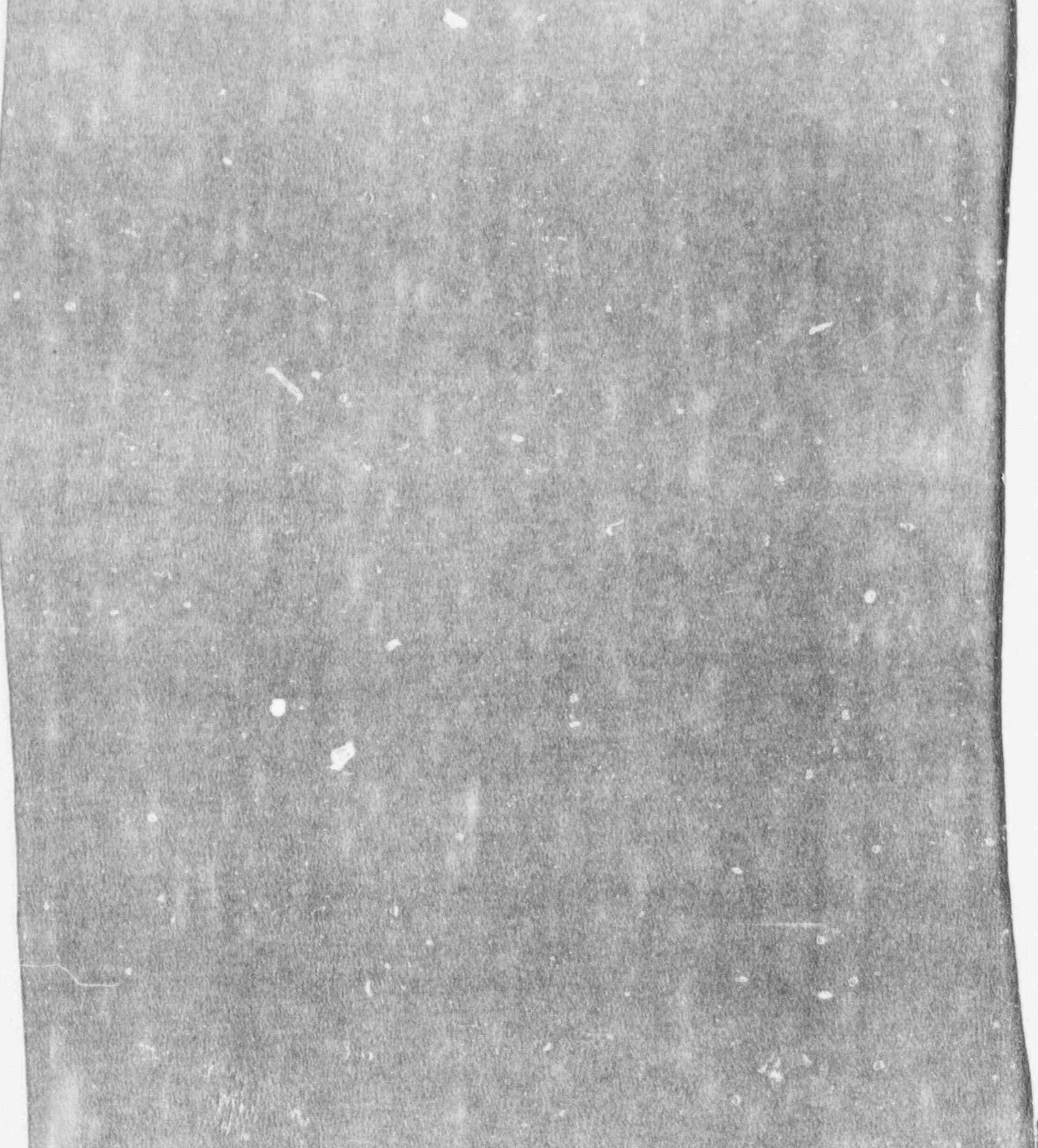
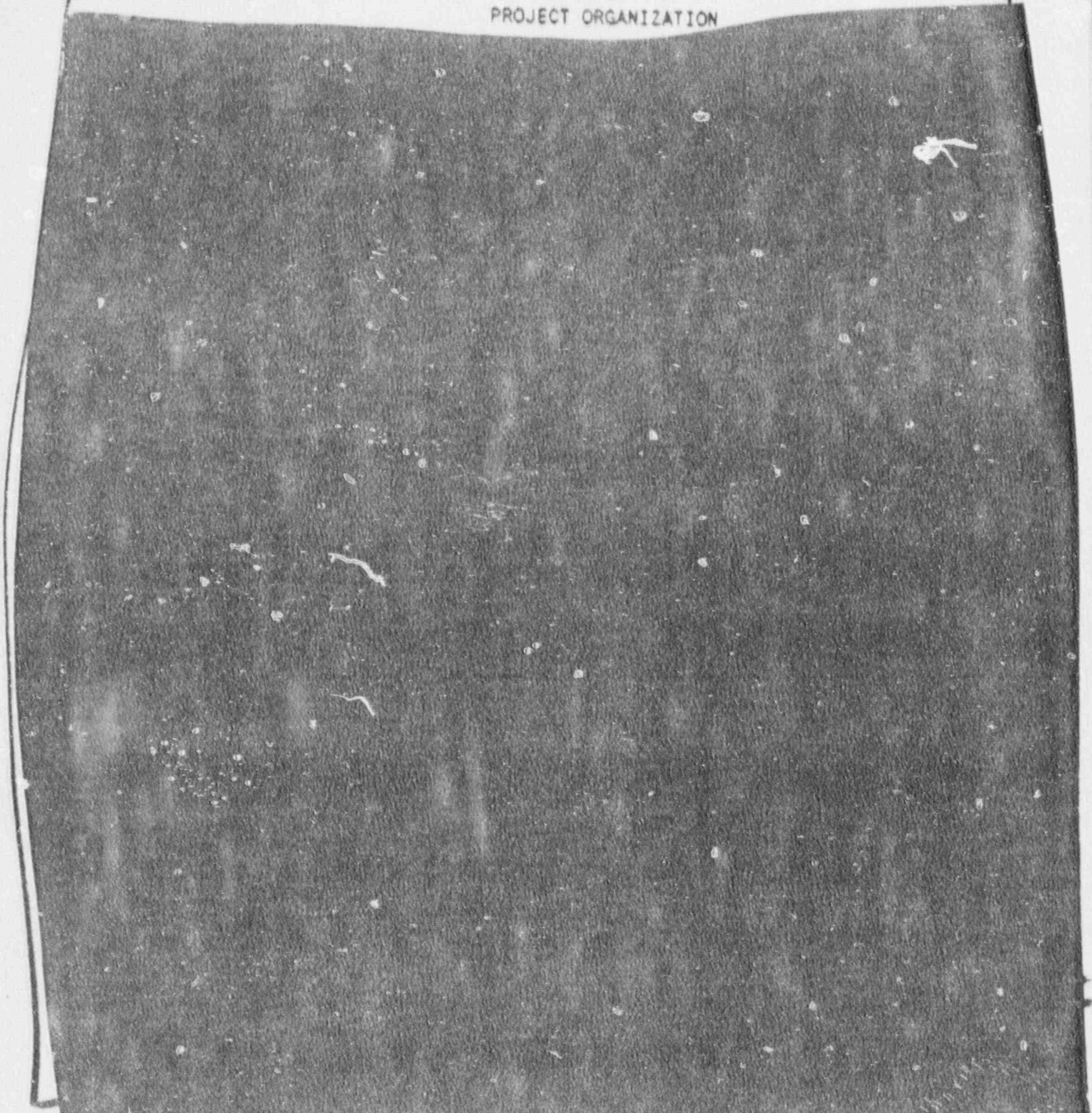


FIGURE 3-1

PROJECT ORGANIZATION



4.0 PROJECT MANAGEMENT PLAN

4.1 WORK BREAKDOWN STRUCTURE AND SCHEDULE

[redacted]

TABLE 4-1

WORKHOUR DISTRIBUTION

TASK 1

[redacted]

TABLE 4-1 CONT'D

TASK 2

[redacted]

TABLE 4-1 (CONT'D)

TASK 3

[redacted]

TABLE 4-1 CONT'D

TASK 4 (PER TASK ORDER)*

[redacted]

FIGURE 4-1

WORK BREAKDOWN STRUCTURE AND SCHEDULE

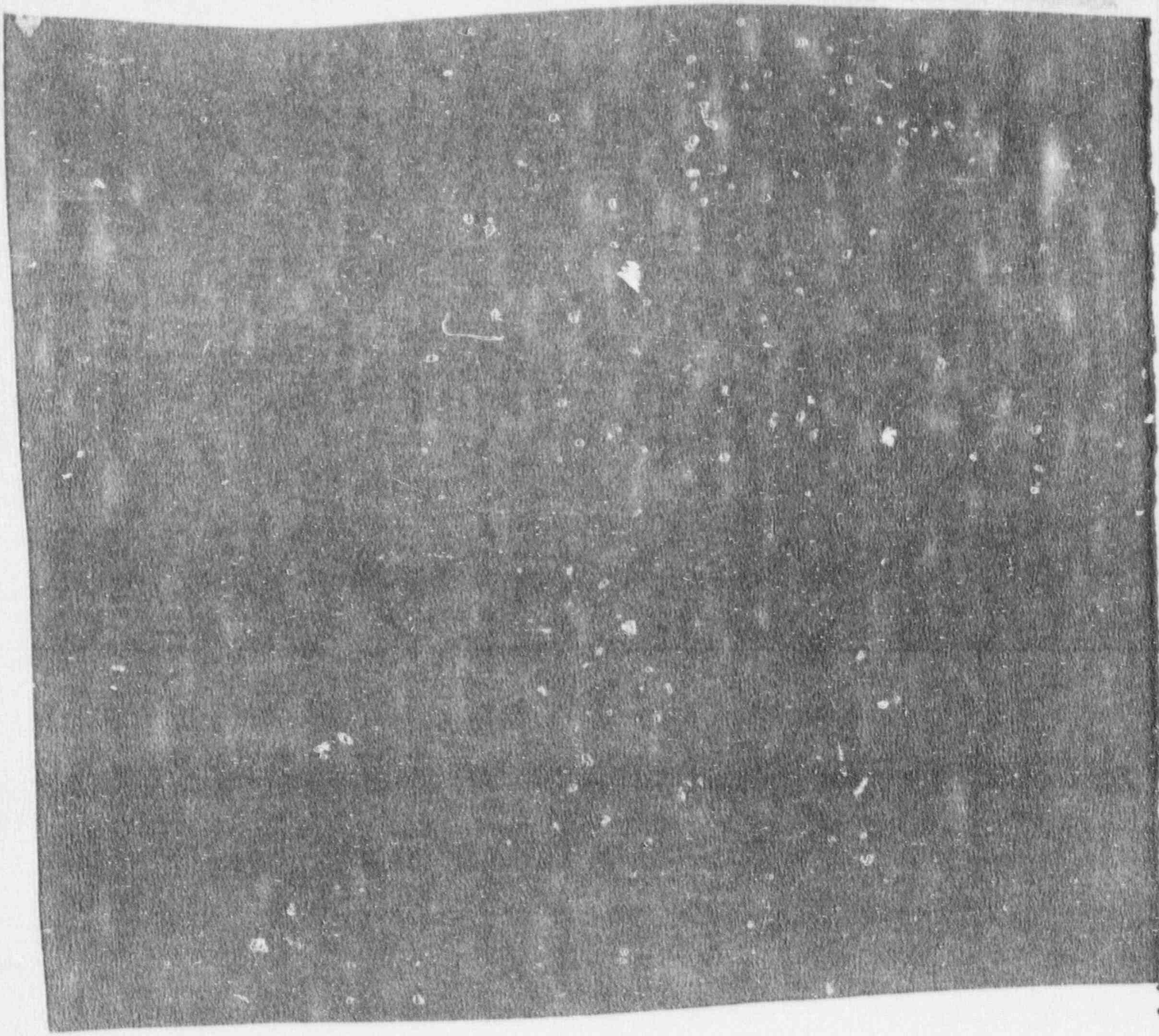


FIGURE 4-1 CONT'D

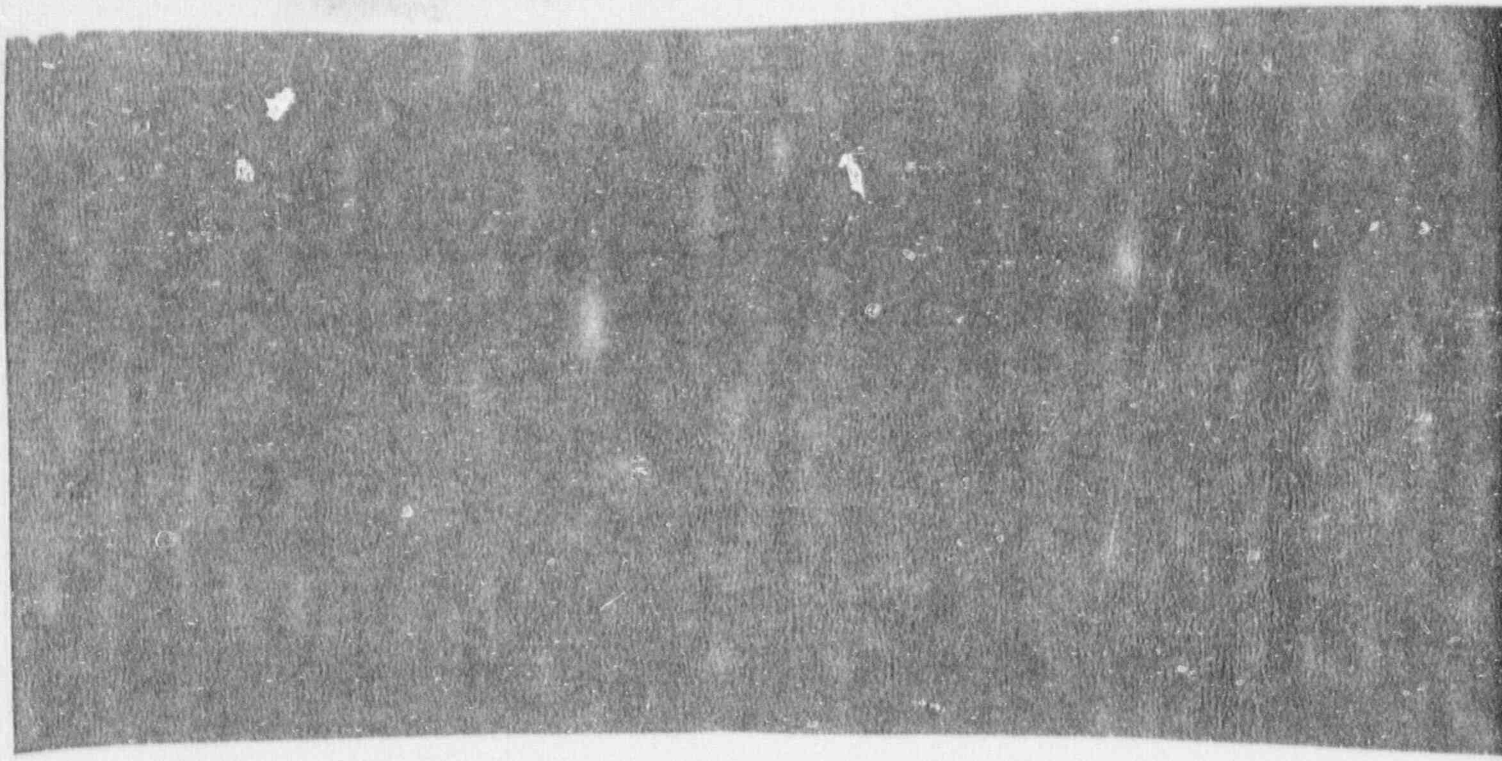
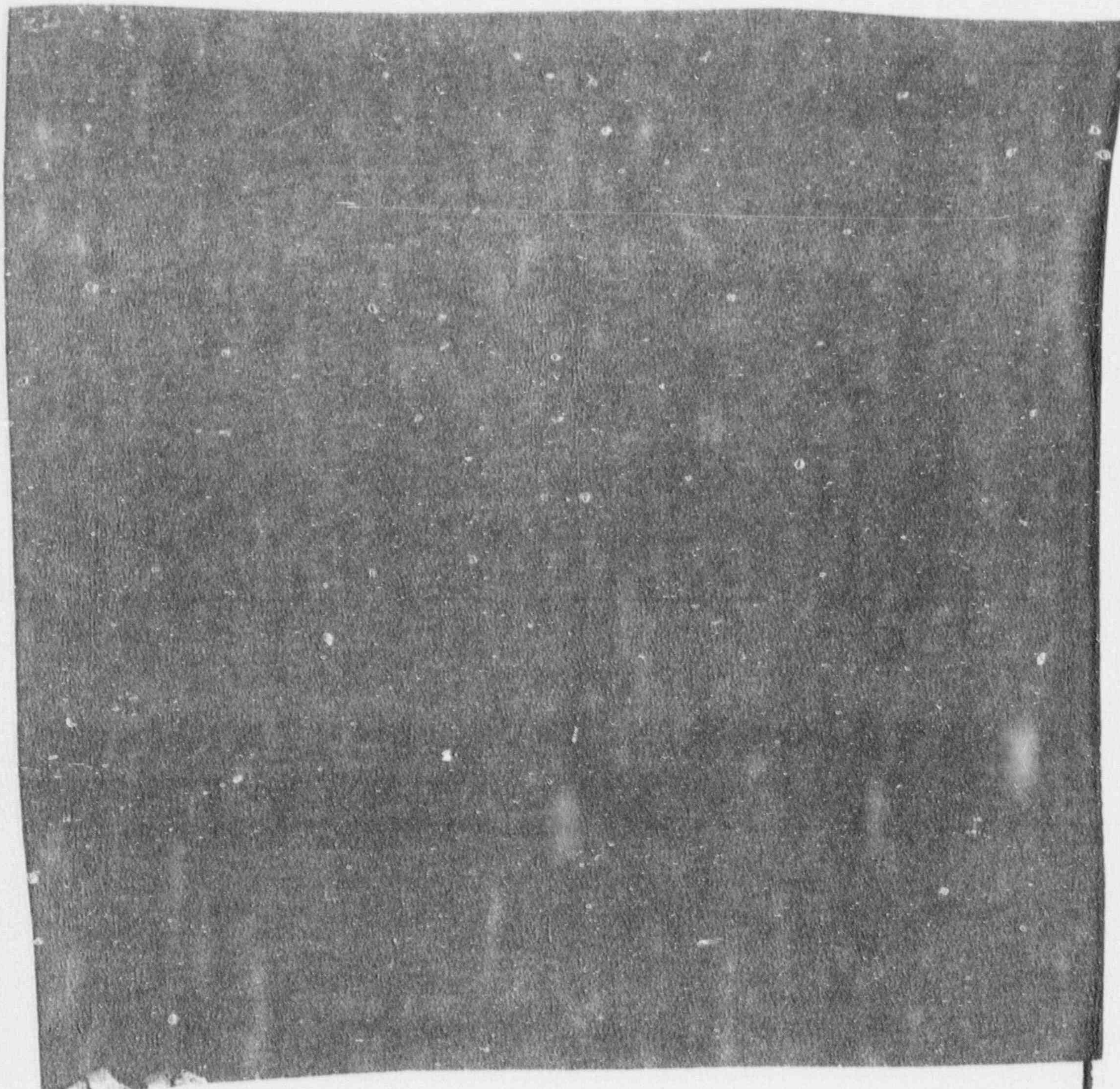


FIGURE 4-2

PROJECT BASELINE FOR TASK 1



5.0 QUALIFICATIONS AND EXPERIENCE

S. Cohen & Associates will serve as prime contractor to the NRC, and HydroGeologic and Eastern Research Group will serve as our subcontractors. The following presents brief corporate descriptions of each organization, along with a more detailed description of each organization's experience in areas directly related to this project.

5.1 S. COHEN & ASSOCIATES, INC.

S. Cohen & Associates (SC&A), a Virginia corporation, specializes in the technical analysis of environmental and safety issues, particularly those related to radiation and nuclear power. The firm also provides health physics and nuclear fuel cycle consulting services, mathematical modeling and computer code development, and estimates the costs of regulatory requirements.

SC&A is able to assemble, frequently on short notice, multidisciplinary working teams of technical specialists specifically designed to solve clients' problems. This is accomplished by maintaining close collaboration with scientists and engineers from the university and industry. By providing attractive forms of professional association, SC&A is able to secure many of the nation's leading experts in engineering and science.

SC&A was incorporated in 1981 and its clients have included:

- Electric Power Research Institute
- Edison Electric Institute
- Congressional Office of Technology Assessment
- Oak Ridge National Laboratory
- Brookhaven National Laboratory
- Argonne National Laboratory
- Pennsylvania Power and Light Company
- Baltimore Gas and Electric Company
- Commonwealth Edison Company
- South Carolina Electric and Gas Company

- Public Service Electric and Gas Company
- Atomic Industrial Forum
- G.A. Technologies
- U.S. Department of Energy
- Nuclear Safety Oversight Committee
- U.S. Nuclear Regulatory Commission
- U.S. Environmental Protection Agency
- State of New Mexico (Environmental Evaluation Group)
- NUMARC

In the area of radiation protection, SC&A's professional staff and close associates include 8 certified Health Physicists, all of whom have been directly involved in radiation protection in the nuclear power industry, including radiation protection management and supervisory experience at nuclear plants, at utility headquarters, with the NRC and with EPA.

The following summarizes SC&A projects which are directly relevant to this project. A more detailed summary of SC&A's project experience is provided in Appendix C, along with letters of commendation.

Under a number of contracts with the NRC, SC&A provided technical support to (1) the Office of Policy Evaluation, (2) the Office of Nuclear Reactor Regulation, (3) the Office of Resource Management, (4) the Office of Nuclear Regulatory Research and (5) the Office of Nuclear Material Safety and Safeguards. The technical support included a number of rulemaking and research activities related to nuclear plant safety, the cost of nuclear power and the protection of workers, patients and the nearby public at hospitals. This experience has direct applicability to Tasks 3 and 4.

The technical support provided to the NRC on these projects includes many areas directly applicable to this project, including value-impact analysis, database management, and rulemaking support.

In the area of database management, SC&A performed a survey of nuclear utilities and constructed a dose rate database for use in utility ALARA reviews.

In support of NRC rulemaking activities on severe accidents SC&A performed technical reviews of PRA's and IDCOR reports, emphasizing uncertainty analysis. SC&A also provided technical support to the NRC in the 10 CFR 20 rulemaking. The support included the performance of economic analyses of the proposed rulemaking on nuclear utilities, fuel cycle facilities and 10 CFR 30 licenses. The results were presented before the ACRS. On another NRC contract, SC&A assisted in the evaluation of the costs associated with the revisions to 10 CFR 50 Appendix J, and prepared a book of abstracts on generic cost estimates (NUREG/CR-4627, June 1986).

SC&A assisted the NRC Office of Resource Management in estimating the costs of the disposal of low-level wastes from nuclear power plants, and developed a method for predicting the volumes of wastes generated. This work was published by the NRC (Generic Cost Estimates for the Disposal of Radioactive Wastes, NUREG/CR-4555, March 1986) and the method for estimated waste volumes was presented at the Second Radioactive Exchange Decisionmakers' Forum (May 1986).

Currently, SC&A is assisting the NRC in the development of training and experience criteria for personnel involved in the medical use of byproduct material. This includes gathering data from hospitals and creating a database on training practices to support a possible rulemaking.

SC&A has provided technical support to the EPA Office of Radiation Programs in the development and implementation of pathways models for radioactive material released to the environment by NRC licensees. This modeling experience and the associated support provided in the preparation of Background Information Documents has direct applicability to Tasks 2, 3 and 4. Included among these projects was an evaluation deminimis criteria.

SC&A has also performed numerous studies for EEI, AIF, DOE and private nuclear utilities in: (1) Quality Control for Radiation Measurements, (2) Radiological Record Keeping Practices, (3) Costs of Nuclear Power, and (4) Safety Goals.

SC&A has managed several policy contracts with the Office of Technology Assessment, the Council on Environmental Quality, and the Nuclear Safety Oversight Committee which included:

(1) An assessment of the contributions of existing legislation and regulations on the economic future of nuclear power in the United States.

(2) Policy options regarding radioactive waste management.

(3) A review of reactor safety improvement programs.

(4) Policy options regarding plant safety.

5.2 HYDROGEOLOGIC, INC.

HydroGeologic will serve as SC&A's subcontractor on this project responsible for the review and application of pathways models in Task 2. In addition, Hydrogeologic will provide pathways modeling support to Tasks 3 and 4, and will identify data needs for modeling in Task 1.

HydroGeoLogic, Inc. was formed in early 1987 to provide the most advanced technical consulting services available for soil and groundwater contaminant assessment and remediation, numerical modeling of groundwater flow and contaminant transport, and water supply investigations. HydroGeologic's personnel are among the most accomplished and best known experts in numerical modeling and formulation of practical solutions to groundwater problems. Corporate and research activities are directed by two senior principals, Peter S. Huyakorn and John B. Robertson, who are internationally recognized experts in hydrogeologic field investigations and numerical simulation of groundwater flow and contaminant transport. In addition, Dr. Edward A. Sudicky is internationally recognized as one of the foremost experts in hydrogeologic field investigation and groundwater modeling. These three senior principals are supported by ten highly qualified professionals and technicians with multidisciplinary experience in numerical modeling of groundwater systems and field investigations. HydroGeoLogic's 13 technical personnel have a combined total of over a century of experience and are dedicated to performing quantitative analyses and modeling of groundwater systems according to the highest standards of technical excellence.

The HydroGeoLogic provides the most advanced technical consulting services available for the following areas:

- numerical simulation of groundwater flow and contaminant transport;
- stochastic analysis of groundwater flow and contaminant transport;
- development of numerical and analytical models for simulation of groundwater flow and contaminant transport;
- groundwater protection technology;
- hazardous chemical and nuclear waste disposal;
- groundwater contamination monitoring;
- groundwater resource management;
- leaking underground storage tank technology;
- design and evaluation of remedial actions;
- environmental impact assessment;
- field investigation of soil and groundwater contamination problems;
- site environmental assessments for property transfer or development;
- expert testimony, environmental litigation support, and regulatory compliance assistance.

Being a relatively small company, HydroGeoLogic has the additional advantages of minimal potential conflicts of interest and no overcommitments. Due to its specialization and expertise in soil and groundwater investigations, HydroGeologic is highly responsive to project milestone schedules, project changes, and specific client requests.

5.2.1 Directly Related Experience

Though a young company, HydroGeologic has compiled corporate experience in many areas directly related to this project. In addition, HydroGeologic's three principals have over 100 years of experience all of the technical areas required for Task 2.

The following summarizes the corporate experience of HydroGeologic in areas directly related to this project specifically, pathway modeling for low-level waste, solid waste landfills and hazardous waste disposal sites.

In the area of low-level waste, HydroGeologic has performed the following projects:

- HydroGeologic has been contracted by the U.S. NRC to provide NRC with a robust computationally efficient finite-element code with the capacity to accommodate highly non-linear soil moisture conditions and a large number of nodal unknowns necessary for detailed representation of spatial variability.

- Under contract to EG&G, HydroGeologic served as special technical consultant on a valve engineering workshop to identify and screen potential remedial measures for radionuclide and volatile organic chemical contaminants associated with the mixed-waste Radioactive Waste Management facility. Mr. Robertson also served in 1988 as an invited member of an Expert Peer Review Panel convened at the request of DOE Idaho Operations and EG&G, Inc. to critically review and evaluate current and planned remedial investigations and corrective measures for the RWMC complex at INEL.

- HydroGeologic was hired by Roy F. Weston under a contract with the New York State LLW Siting Commission to provide specialized hydrogeological and modeling assistance including: technical review of plans and draft reports; input to program review and planning meetings; analysis of hydrogeologic data and modeling of groundwater flow and radionuclide migration pathways at potential sites; assistance with site performance assessment and regulatory compliance.

- o HydroGeoLogic was retained by Roy F. Weston to assist the Los Alamos National Laboratory, Section HSE-12, in conducting the investigation of moisture movement and pathway of the potential migration of radionuclides and chemical waste constituents within the site. The contaminants of concern are plutonium 239, americium 241, fluoride, and ammonium Citrate. The scope of work includes: review and evaluation of data on hydraulic properties and moisture retention characteristics of fractured Bandelier tuff; parameter estimation using regression analysis and least-square fitting; two-dimensional modeling of transient unsaturated flow and solute transport under rather dry soil conditions; sensitivity analysis; database management; and remedial feasibility study.

- o HydroGeoLogic, Inc. has been retained by Savannah River Plant to provide modeling and related assistance in the following areas:

  - upgrading the SRP's existing FLAMINCO (ver. 3.5) code so that it can be used to implement the desired model

  - developing a three-dimensional flow and transport model that accurately represents the existing hydrogeology and constituent geochemistry

  - documenting the final model

  - implementing the model on site at the SRP

The three-dimensional flow and transport model include both the saturated and unsaturated zones.

In the area of landfill modeling HydroGeologic has performed the following projects:

- o Under contract to Woodward-Clyde, HydroGeologic performed quantitative analyses using numerical simulation to determine potential impacts of liquid disposal lagoons on a landfill site near Casmalia, Ca.

- o Under a subcontract to SAIC for the EPA Office of Solid Waste, HydroGeoLogic performed a comprehensive series of deterministic and Monte Carlo uncertainty analyses using both the EPACML and EPACMS codes for landfill and surface impoundments under Subtitles C and D. Site data were used together with the nationwide distributions of aquifer parameters and well locations to determine (by means of Monte Carlo simulations with EPACML and EPACMS) 80, 85, and 90 percentile values of the Dilution Attenuation Factors (DAF). Hydrogeologic provided OSW with comprehensive sensitivity analyses and modeling comparisons to support EPA's selection of regulatory levels for the Toxicity Characteristic (TC).

- HydroGeoLogic has been a key member of a team of technical consultants selected by EPA to provide technical assistance and advice related to national, regional, and state groundwater protection policies and strategies. The Scope of Work included the following: (1) develop a comprehensive series of semi-analytical models for predicting well capture zones under various aquifer conditions; (2) develop a finite-element interfaced particle-tracking code for delineation of wellhead protection areas for complex site conditions; (3) develop a Monte Carlo module for performing uncertainty analysis; (4) produce a menu-driven Personal Computer utility software that integrate all newly-developed computational modules with the previously developed RESSQ code and call this software WHPA code; (5) assist EPA (OGWP) in the nationwide distribution of the WHPA code; and (6) provide model training courses to OGWP staff and expected participants from various EPA regions.

- The Office of Solid Waste of EPA requested HydroGeoLogic, Inc. to review and enhance two fate and transport models, EPACML and EPACMS (developed under this contract for the investigation of leachate migration from landfills and surface impoundments). These models are composite models containing unsaturated and saturated zone flow and transport components. Both models will be used by OSW under RCRA Section 3001

The following is HydroGeologic's experience in the area of modeling licensed hazardous waste disposal facilities:

- HydroGeoLogic, Inc. has been contracted by the US EPA Region III Office (through A.T. Kearney Associates) to provide senior expert review, evaluation, and opinions on two applications for waivers of RCRA requirements for retrofitting existing hazardous waste impoundments to meet new criteria. The principal issue at each facility is the protection of groundwater resources and the capability of the impoundment to prevent migration of hazardous constituents into groundwater.

- HydroGeoLogic was retained by Woodward-Clyde Consultants to develop subsurface flow and transport components of EPA's multimedia model for assessing exposure from disposal of hazardous waste at specific sites. The multimedia model is a systematic integration of codes designed to perform leachate migration and exposure assessment in three media: air, surface water, and groundwater.

- HydroGeoLogic was contracted by the US Navy through Tech International for preparation of a RCRA Part B permit application for waste treatment facilities at the Naval Ordnance Station, Indian Head, Maryland

5.2.2 Facilities, Equipment, and Software

HydroGeoLogic, Inc.'s offices are located just outside Washington, D.C. in Herndon, Virginia, in close proximity to SC&A's office in McLean, Va. and NRC headquarters. In addition, HydroGeologic's our location is ideally situated in close proximity to one of the most comprehensive technical libraries for hydrogeological research, the U.S. Geological Survey National Library at Reston, Virginia, as well as several local university libraries and the Library of Congress.

HydroGeoLogic's in-house computer equipment is sufficient to meet all types of database management, numerical computation, and graphic display requirements. For large numerical model application and code development needs, HydroGeologic has a dedicated computer system to handle numerical computations and a high-speed printer that is essential for printing large volumes of output from complex three-dimensional simulations. The system features a powerful PRIME 2550 CPU with four megabytes of virtual memory that can support up to 32 users; two 315 mb rapid-access hard disks; a Kennedy nine-track, 1600 BPI, reel-to-reel tape subsystem; a high-speed 600 LPM printer; and six remote Qume work stations. Off-site access to the system is afforded through a programmable 300/600/1200 baud modem.

Graphics output on the PRIME 2550 can be generated by several of HydroGeoLogic, Inc.'s proprietary utility programs or DISSPLA (Display Integrated Software System and Plotting LAnguage) which is commercially available. These programs allow data to be displayed as spatially-interpolated contour plots, three-dimensional surfaces, x-y axes plots using Cartesian, logarithmic, or radial coordinates, scatter plots, histograms and bar graphs, and hydrochemical plots (e.g., Durov, Piper-Hill).

Data can also be downloaded to microcomputer and graphics output

can be generated using either GRAPHER, SURFER, GRAFMATIC, DESIGN CAD-2D and 3D, or DISSPLA.

HydroGeoLogic has an in-house library as well as access to university, government, and private libraries. The in-house technical library holdings include journals, reference materials, texts, brochures and pamphlets, government reports and documents, and bibliographies related to the areas of groundwater hydrology, numerical methods, and field investigation methodologies. Hydrogeologic also have interlibrary loan arrangements with the U.S. Geological Survey library and the numerous university libraries in the area.

HydroGeoLogic has an extensive computer code library for simulation of a wide range of groundwater flow and contaminant transport problems. These codes include two-dimensional and three-dimensional finite difference and finite element models as well as composite analytical and numerical models. Table 5-1 lists HydroGeoLogic's proprietary software.

In addition, HydroGeologic has numorous analytical models for describing the migration of dissolved contaminants in groundwater systems under a variety of conditions. HydroGeoLogic personnel are also actively involved in developing new analytical and numerical models to account for various combinations of solute properties, source characteristics, hydrogeologic parameters, and groundwater velocity distributions. If a particular site requires a model that is not currently available, then HydroGeoLogic personnel can create a custom-made code that is tailored to the specific site.

5.3 EASTERN RESEARCH GROUP, INC.

Eastern Research Group, Inc. (ERG) is a consulting firm specializing in economic and environmental policy analysis and technical communications. ERG's key corporate personnel have worked for federal and state agencies for the past eight years, and have established a reputation for high quality, responsive services. ERG's principal clients have included the U.S. Environmental Protection Agency (EPA), the U.S. Department of Energy (DOE), the Occupational Safety and Health Administration (OSHA), the U.S. Department of Transportation (DOT), the U.S. Department of the Interior (DOI), state governments, and private clients.

ERG conducts technical and economic analyses of a wide range of environmental issues including hazardous waste and hazardous materials management, sludge management, air quality, water quality, and health and environmental risk assessment. Many of these analyses include cost/benefit studies and regulatory impact assessments. In addition, ERG evaluates the economic and environmental impacts of regulatory programs and policies on energy-generating industries. ERG's staff is trained in economics, public policy, finance, and environmental sciences (geology, biology, chemistry, engineering).

On this project ERG will serve as a subcontractor to SC&A and have responsibilities in the following areas:

<u>Task 1</u>

- identify waste disposal options
- identify and characterize waste disposal facilities
- support the construction of solid waste disposal databases
- characterization of sludge contamination and methods of disposal

<u>Task 2</u>

- support the pathway modeling efforts, especially in the areas of sludge disposal
- assemble solid waste disposal data for use as input to the pathway models

<u>Task 3</u>

- perform value-impact analysis in support of rulemaking
- provide logistics support for the rulemaking process
- provide information regarding state and local regulations pertaining to solid waste management

<u>Task 4</u>

- perform economic analyses of petitions
- serve as lead on selected Task orders

The following summarizes ERG's experience in rulemaking support, solid waste management, sludge management, and value-impact and regulatory impact analyses.

ERG's rulemaking has included the evaluation of the impact of the Clean Water Act (CWA), the Clean Air Act (CAA), the Resource Conservation and Recovery Act (RCRA), the Noise Abatement and

Control Act (NACA), and the Occupational Safety and Health Act (OSHA) on affected industries and on the United States' economy. These studies typically involve

- o development of an economic and financial database on the affected industry,
- o economic and technical definition of model facilities
- o review of the costs of pollution control or other compliance systems required under proposed regulations,
- o assessment of the impact of these costs on model facilities,
- o assessment of impacts on the industry,
- o measurement of regulatory benefits,
- o comparison of costs and benefits of alternative regulatory approaches,
- o preparation of technical support documents and, where appropriate, the record of the rulemaking effort, and
- o technical and organizational support at public information meetings associated with the rulemaking process.

The following briefly summarizes selected projects:

- o For the U.S. Environmental Protection Agency, ERG is currently estimating the costs, benefits, and economic impacts of new EPA regulations concerning the use and disposal of municipal wastewater sludge.
- o For the Environmental Protection Agency, ERG is evaluating the cost and economic impact of proposed water quality regulations for offshore oil and gas operations.
- o For the U.S. Department of Transportation, ERG conducted an extensive study of the economic and environmental analysis of a proposed Coast Guard regulation to restrict disposal of garbage generated on vessels in the Gulf of Mexico.
- o For the Occupational Safety and Health Administration, ERG described all aspects of work occurring at uncontrolled hazardous waste sites and prepared a

cost/benefit and economic impact analysis of the proposed OSHA health and safety standard.

- For the U.S. Coast Guard, ERG performed an economic and environmental study to support the Coast Guard's regulatory analysis of rules prohibiting disposal overboard of non-biodegradable garbage by ocean-going vessels.

- For the Environmental Protection Agency, ERG evaluated current electrical utility practices with respect to waste management and assessed the economic impacts of alternative RCRA scenarios.

- ERG analyzed the economic impacts of alternative regulations for hazardous waste management in the industrial organic chemicals industry for EPA.

- ERG conducted a literature search and survey of low-level radioactive waste generators for EPA. Based on this research, ERG prepared a report documenting the type, volume, and disposal mode for low-level wastes generated in the United States. The report also covered the cost of low-level radioactive waste disposal, and the importance of these costs in the overall budgets of waste generators.

ERG personnel have developed a variety of environmental and occupational health databases to allow clients to quickly access technical information. ERG staff have designed database structure; selected system hardware and software; tailored software to customer needs; conducted data collection, quality assurance, abstracting, indexing, and coding; and trained clients in the use of the databases. The environmental and occupational health databases developed by ERG include:

- ERG staff created an on-line database that incorporated the results of 30,000 laboratory and field tests. The information covered human health and safety, occupational hazards, accidental exposures, toxicology, residue chemistry, and other aspects of pesticide products.

- ERG created a national database concerning the use of personal protective equipment in all U.S. industries. ERG developed and implemented the survey questionnaire and created and delivered a database containing the results of more than 5,000 survey responses.

- ERG has developed and maintains a database containing disciplinary experience, substance-specific experience, and training of several hundred environmental health scientists. As explained in the Peer Review section of this document, ERG can use this database to locate and access scientists with highly specialized expertise.

- ERG personnel developed a database for the U.S. Food and Drug Administration concerning the chemistry and toxicology of food additives.

- For the Administrative Conference of the United States, ERG developed a comprehensive database concerning all Federal programs charging fees to users. The database covers every Federal agency in more than 1,500 programs. Detailed case studies were prepared for those programs generating the largest revenues through user fees. The database was formatted to allow computerized searching of the data using list-processing software. The database included major EPA and other consumer and environmental protection programs.

The following summarizes ERG's experience in the area of regulatory impact analyses for rulemaking activities pertaining to sludge management:

- For the U.S. Environmental Protection Agency, ERG is currently estimating the costs, benefits, and economic impacts of new EPA regulations concerning the use and disposal of municipal wastewater sludge. The regulations will cover all of the major sludge disposal and reuse modes including land application, landfilling, incineration, ocean disposal, and distribution and marketing. ERG has assembled a comprehensive national database concerning sludge generation, contaminant levels in sludge, sludge disposal and use practices, costs of sludge disposal, and the environment and health effects of sludge.

- For the Environmental Protection Agency, ERG organized and conducted a workshop on the health and legal implications of sewage sludge composting. The purpose of this project was twofold: (1) to investigate the potential disease problems associated with the production, distribution, and use of composted sewage sludge; and (2) to develop specific legal, institutional, and engineering measures that would serve to minimize any health risks.

In addition to technical and economic analysis support to Federal rulemaking programs, ERG has provided support for over 10 years to Federal and State agencies, scientific experts, and industry in communicating environmental health information to specific target audiences, including regulatory decision-makers, the general public, corporate managers, laboratory technicians, and field staff. ERG's staff of technical communications specialists compile, organize, and synthesize health and environmental information, and develop a wide variety of communications products including manuals, brochures, books, newsletters, workshops, conferences, expert systems, training programs, slide shows, videos, posters, and booths.

Table 5-1. LIST OF HYDROGEOLOGIC, INC.'S PROPRIETARY SOFTWARE

MOT2D:	Multiphase Organic Transport MOdel in 2 Dimensions
CASMOT:	Composite Analytical Solution Package for Multiphase Organic Transport
PAM:	Package of Analytical Models
MAST2D:	Model for Analyzing Saturated Seepage and Transport in 2 Dimensions
MAST3D:	Model for Analyzing Saturated Seepage and Transport in 3 Dimensions
VAM2D:	Variably Saturated Analysis Model in 2 Dimensions
VAM3D:	Variably Saturated Analysis Model in 3 Dimensions
STAFF2D:	Solute Transport And Fracture Flow in 2 Dimensions
STACE3D:	Seepage and Transport Analysis Using Curvilinear Elements in 3 Dimensions
STEAM2D:	Seepage, Transport, and Energy Analysis Model in 2 Dimensions
STEAM3D:	Seepage, Transport, and Energy Analysis Model in 3 Dimensions
DSTRAM:	Density Dependent Saltwater Flow and TRAnsport Model in 3 Dimensions
MESH2:	MESH Generation Program in 2 Dimensions
MESH3:	MESH Generation Program in 3 Dimensions

REFERENCES

AIF 86 Atomic Industrial Forum. National Environmental Studies Project. Evaluation of the Potential for De-Regulated Disposal of Very Low-Level Wastes From Nuclear Power Plants. AIF/NESP-035, May 1986.

Dur 83 Durfee, R.C. and Coleman, P.R. Population Distribution Analyses for Nuclear Power Plant Siting, NUREG/CR-3056. December 1983.

EPA 88 Environmental Protection Agency. National Survey of Municipal Solid Waste Landfills. EPA 530-SW88-0034. September 1988.

EPA 88a Environmental Protection Agency, Background Information Document. Low-Level and NARM Radioactive Wastes. Draft EIS for Proposed Rules. EPA 520/1-87-012-1. June 1988.

EPRI 84 Electric Power Research Institute. Identification of Radwaste Sources and Reduction Techniques. EPRI NP-3370. January 1984.

EPRI 88 Electric Powe· Research Institute. Below Regulatory Concern Owners Group: Evaluation of Candidate Waste Streams. EPRI NP-5760. March 1988.

For 86 Forstom, J.M. and Goode, D.L. DeMinimis Waste Impacts Analysis Methodology: IMPACTS BRC Users Guide and Methodology for Radioactive Waste Below Regulatory Concern, Draft Report for Comment; NUREG/CR-3585 Vol 2, Issued by the US NRC 1986.

Gru 88 Gruhlke, J.M., Galpin F.L. and Holcomb, W.F. Overview of EPA's Environmental Standards for the Disposal of LLW and NARM Waste-1988. Proceedings of the Tenth Annual DOE Low-Level Waste Management Conference. CONF 880839. August 30 - September 1, 1988. Denver, Colorado.

Hol 88 Holcomb, W.F., Gruhlke, J.M. and Galpin, F.L. Considerations in the Development of EPA's Proposed BRC Criteria. Proceedings of the Tenth Annual DOE Low-Level Waste Management Conference. CONF 880839. August 30 - September 1, 1988. Denver, Colorado.

IAEA 88 International Atomic Energy Agency. Principals for the Exemption of Radiation Sources and Practices from Regulatory Control. Safety Series No. 89. 1988.

ICRP 77 International Commission on Radiological Protection. Annals of the ICRP, 1 (3). Recommendations of the ICRP. ICRP26, 1977.

ICRP 83 International Commission on Radiological Protection. Annals of the ICRP, 10 (1). Cost-Benefit Analysis in the Optimization of Radiation Protection ICRP 37, 1983.

ICRP 85 International Commission on Radiological Protection. Annals of the ICRP, 15 (4). Radiation Protection Principals for the Disposal of Solid Radioactive Waste. ICRP 46. 1985.

Meta 88 Meta System, Inc. Municipal Solid Wastes Landfilling: A Review of Environmental Effects. November 1988.

NRC 74 U.S. Nuclear Regulatory Commission. Regulatory Guide 1.86. Termination of Operating Licenses for Nuclear Reactors. June 1974.

NRC 78 U.S. Nuclear Regulatory Commission. Commission Draft Radiological Effluent Technical Specifications for PWRs (NUREG 0472) and BWRs (NUREG-0473). Revision 1 1978.

NRC 78a U.S. Nuclear Regulatory Commission. Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants. NUREG-0133, 1978.

NRC 81 U.S. Nuclear Regulatory Commission. Draft Environmental Impact Statement on 10 CFR 61 "Licensing Requirements for Land Disposal of Radioactive Waste." NUREG-0782. September 1981.

NRC 85 U.S. Nuclear Regulatory Commission. Standards for the Protection Against Radiation; Proposed Rule; 50 FR 51992.

NRC 86 U.S. NRC Onsite Disposal of Radioactive Waste Guidance for Disposal of Subsurface Burial. NUREG-1101. March 1986.

Oz 81 Oztunali, O.I., et al, "Data Base for Radioactive Waste Management." U.S. NRC Report NUREG/CR-1759, November 1981.

Oz 84 Oztunali, O.I. and Roles, G.W. Deminimis Waste Impacts Analysis Methodology. NUREG/CR-3585. February 1984.

Oz 86 Oztunali, O.I. et al. Update of Part 61, Impacts Analysis Methodology. NUREG/CR-4370. January 1986.

Po 87 Pollard, C.G., and McBurney, R.F. Below Regulatory Concern Rulemaking in Texas: Disposal of Short Lived Waste in Municipal Landfills. Abstracts of the 32nd Annual Meeting of the Health Physics Society, July 5-9, 1987.

Ro 87 Rogers, V. Hung, C. PRESTO-BRC: A Low-Level Radioactive Waste Environmental Transport and Risk Assessment Code; Methodology and Users Manual, EPA 520/1-87-027, Issued by the us EPA.

Wes 86 Westat, Inc. Census of State and Territorial Subtitle D Non-Hazardous Waste Programs, Contract 68-01-7047. U.S. EPA 1986.

REFERENCES FOR APPENDIX D

EPRI NP-5670, "Below Regulatory Concern Owners Group: Evaluation of Candidate Waste Stream," March, 1988.

EPRI NP-5671, "Below Regulatory Concern Owners Group: Radionuclide Prioritization Study," March, 1988.

EPRI NP-5672, "Below Regulatory Concern Owners Group: Selection of Plants for Sampling Program," March, 1988.

EPRI NP-5077, "Updated Scaling Factors in Low-Level Radwaste," March, 1987.

T. J. Overcamp, "Low-Level Radioactive Waste Disposal By Shallow Land Burial," Handbook of Environmental Radiation, Florida: CRC Press, Inc., 1982.

NRC NUREG/CR-4289, "Residual Radionuclide Contamination Within and Around Commercial Nuclear Power Plants," February, 1986.

NRC NUREG/CR-2082, "Monitoring for Compliance With Decommissioning Termination Survey Criteria," June, 1981.

APPENDIX A

US ECOLOGY AND CHEM-NUCLEAR MANIFESTS

BARNWELL WASTE MANAGEMENT FACILITY

Operated by CHEM-NUCLEAR SYSTEMS, INC.
PO Box 726, Barnwell, South Carolina 29812
(803) 259-1781
RADIOACTIVE SHIPMENT MANIFEST FORM

ERATOR NAME ______

RESS ______

______ STATE ______ ZIP CODE ______

TACT ______ PHONE ______

igned to
-NUCLEAR SYSTEMS, INC.
OX 726, OSBORN ROAD
NWELL, SC 29812

(3) RADIOACTIVE WASTE TRANSPORTATION PERMIT NO. ______

(4) USE THIS NUMBER ON ALL CONTINUATION PAGES — SHIPMENT I.D. NUMBER ______ PAGE ______ OF ______

(5) CARRIER ______ ADDRESS ______

TELEPHONE ______ SHIPPING DATE ______

SHIPMENT TYPE ______ SHIPMENT SURFACE EXPOSURE ______ mR/hr

CASK IDENTIFICATION NO. ______ USA / /

SHIPMENT NO. ______ LINER TYPE ______

LINER SERIAL NO. ______

DRIVER SIGNATURE ______ DATE ______

TAL FOR CLASS — ES	WEIGHT (POUNDS)	PROPER SHIPPING NAME & HAZARD CLASS (PER 49 CFR 172.101)	I.D. NUMBER	Reportable Quantity
		Radioactive Material, empty packages	UN2908	
		Radioactive Material, fissile, n.o.s. - Radioactive Material	UN2918	
		Radioactive Material, low specific activity n.o.s. - Radioactive Material	UN2912	
		Radioactive Material, n.o.s. - Radioactive Material	UN2982	
		Radioactive Material, limited quantity, n.o.s. - Radioactive Material	UN2910	
		Radioactive Material, special form, n.o.s. Radioactive Material	UN2974	
		Radioactive Material, instruments and articles Radioactive Material	UN2911	
		Other (Specify)		

(7) SHIPMENT TOTALS

Disposal Volume (ft.³)	Total Pkder Volume (ft.³)	Total No. of Packages	ACTIVITY (10CFR20.311) Millicuries: All Isotopes	Tritium	C-14	Tc-99	I-129	Source (Pounds)

(8) TOTAL SNM

Isotope	Grams	No. Packages
U-233		
U-235		
Total		

(9) MINIMUM % FILL FOR STABILIZATION PROCESS ______

(10) SOLIDIFICATION AGENT ______

(11) NUMBER AND TYPE OF CONTAINERS ______

STE DESCRIPTION ______ (13) PHYSICAL FORM ______

(14) CHEMICAL FORM ______

(15) NAME AND % OF CHELATING AGENT(S) ______

(16) WASTE FORM CLASS
☐ AU ☐ AS ☐ B ☐ C

Yes ( ) No THIS VEHICLE IS CONSIGNED EXCLUSIVE USE. LOADING AND UNLOADING MUST BE ACCOMPLISHED BY CONSIGNOR OR CONSIGNEE OR HIS DESIGNATED AGENT.

ORTANT: "This is to certify that the above named materials are properly classified, described, packaged, ked, and labeled, and are in proper condition for transportation according to the applicable regulations of Department of Transportation.

ature ______

pany ______ Date ______

(19) "Certification is hereby made to the South Carolina Department of Health and Environmental Control that this shipment of low-level radioactive waste has been inspected in accordance with the requirements of South Carolina Radioactive Material License No. 097 as amended, and the Nuclear Regulatory Commission's License No. 12-13536-01 as amended, and the effective Barnwell Site Disposal Criteria within 48 hours prior to shipment, and further certification is made that the inspection revealed no items of non-compliance with all applicable laws, rules and regulations."

Date ______ Signature ______

Title and Organization ______

Telephone No. ( ) ______

CNSI USE ONLY

] This material meets all license requirements.

] This material was disposed of in accordance with license.

] Discrepancy ______

Date ______

Authorized Signature ______ Title ______

DISPOSAL SITE COPY

Form No. CNS-201

(5-87)

SEE INSTRUCTIONS ON REVERSE SIDE FOR FILLING OUT THIS FORM

Arrival Date ______ Arrival Survey No. ______

Date/Time Buried ______ H.P. Initial ______

Trench No. ______ Location Code ______

Waste Class Code ______

Trench No. ______ Location Code ______

Waste Class Code ______

Personnel Exposure ______

BARNWELL WASTE MANAGEMENT FACILITY

Operated by: CHEM-NUCLEAR SYSTEMS, INC.

CONTINUATION SHEET

GENERATOR NAME ______________________

USE THIS NUMBER ON ALL CONTINUATION PAGES

SHIPMENT I.D. NUMBER ____________

PAGE ____ OF ____

ITEM NO	RADIO-NUCLIDE EACH CONTAINER	PERCENT OF ACTIVITY OR NCi OF EACH NUCLIDE	ACTIVITY EACH CONTAINER mCi	PHYSICAL FORM	CHEMICAL FORM AND NAME & % OF CHELATING AGENT	WASTE DESCRIPTION	WASTE FORM CLASS	SPECIAL NUCLEAR MATERIAL (grams)	SOURCE MATERIAL (pounds)	DISPOSAL CONTAINER: CONTAINER WEIGHT (pounds)	CONTAINER VOLUME (Cu Ft)	CONTAINER TYPE	RADIATION LEVELS: CONTAINER SURFACE ☐ mR/hr ☐ R/hr	RADIATION LEVELS: 1 METER mR/hr	CONTAMINATION CONTAINER SURFACE (DPM/100 cm2)	FISSILE CLASS	LABELS-MARKINGS USED
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
																	Radioactive
					PAGE TOTALS												

Form No. CNS-201
(5-87)

DISPOSAL SITE COPY

RADIOACTIVE WASTE SHIPMENT & DISPOSAL MANIFEST

US ECOLOGY, INC.

EXECUTIVE OFFICE: (502) 426-7160

P.O. BOX 7246 • LOUISVILLE, KENTUCKY 40207

PAGE 1 OF

92686

(1) GENERATOR NAME

ADDRESS

CITY STATE ZIP

CONTACT PHONE

USER PERMIT # SHIPMENT #

(2) BILL DISPOSAL CHARGES TO:

NAME PURCHASE ORDER #

ADDRESS

CITY STATE ZIP

(3) AGENT/BROKER

ADDRESS

CITY STATE ZIP

CONTACT PHONE

(4) CARRIER

ADDRESS

CITY STATE

PHONE

CASK TYPE CASK SURFACE EXPOSURE RATE

TOTAL FOR EACH CLASS		PROPER SHIPPING NAME & HAZARD CLASS (PER 49 CFR 172.101)	ID NUMBER
# OF PACKAGES	WEIGHT (Pounds)		
[illegible]	[illegible]	Radioactive Material, empty packages	[illegible]
[illegible]	[illegible]	Radioactive Material, fissile, n.o.s. — Radioactive Material	[illegible]
[illegible]	[illegible]	Radioactive Material, low specific activity, n.o.s.	[illegible]
[illegible]	[illegible]	Radioactive Material, n.o.s. — Radioactive Material	[illegible]
[illegible]	[illegible]	Radioactive Material, limited quantity, n.o.s.	[illegible]
[illegible]	[illegible]	Radioactive Material, special form, n.o.s.	[illegible]
[illegible]	[illegible]	Radioactive Material, instruments and articles	[illegible]
[illegible]	[illegible]	Thorium Nitrate — Radioactive Material	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

SHIPMENT TOTALS (DO NOT WRITE IN SHADED AREAS)

VOLUME (cu ft)	TOTAL # OF PACKAGES	SOURCE MATERIAL (kgs)	U-233	U-235	PLUTONIUM	TOTAL

ACTIVITY

ACTIVITY TOTALS ☐ Curies ☐ Millicuries	TRITIUM	C-14	Tc-99	I-129	ALL ISOTOPES

Authorized Signature Title Date

TERMS AND CONDITIONS

A. TITLE: [illegible]

B. [illegible]

C. [illegible]

FOR US ECOLOGY'S USE ONLY

TYPE OF CONTAINER	CONTAINER VOLUME CU FT	# OF PKGS	CU FT PER CONTAINER TYPE
CHEMICALS	[illegible]	[illegible]	[illegible]
OTHER	[illegible]	[illegible]	[illegible]
1st SHIP	[illegible]	[illegible]	[illegible]
2nd SHIP	[illegible]	[illegible]	[illegible]
3rd SHIP	[illegible]	[illegible]	[illegible]
OTHER	[illegible]	[illegible]	[illegible]
OTHER	[illegible]	[illegible]	[illegible]
SHIPMENT TOTALS			

LOAD EVALUATION

BURIAL DATA

Date Received

Date Disposed

Trench No.

AUTHORIZED INITIALS

BATES #

CARRIER COPY

CONTINUATION SHEET

...TOR NAME ______________________

BROKER ______________________

MANIFEST # ______________

PAGE ______ OF ______

PAGE TOTALS

CARRIER COPY

APPENDIX B

RESUMES

APPENDIX C

SC&A SELECTED PROJECTS AND LETTERS OF COMMENDATION

U.S. Nuclear Regulatory Commission
Office of Resource Management

DEVELOP A METHOD TO ESTIMATE VOLUMES OF LOW LEVEL
WASTE GENERATED AS A RESULT OF
REGULATORY REQUIREMENTS

The NRC Office of Resource Management has been changed with the responsibility of providing other parts of the Agency with estimates of the costs of regulatory requirements. Science and Engineering Associates, Inc. (SEA) provided the NRC with generic cost estimates of low-level waste disposal at nuclear power plants. As a subcontractor to SEA, SC&A was responsible for developing a method for estimating waste volume generated as a result of regulatory requirements. The following waste streams were considered:

- Ion Exchange Resins
- Concentrated Liquids
- Filter Sludges
- Compactible Trash
- Noncompactible Trash

SC&A conducted site visits to two nuclear power plants which tracks waste volumes by point of origin - a PWR and a BWR - in the course of the study.

This method was discussed in an NRC report, Generic Cost Estimates for the Disposal of Radioactive Wastes, NUREG/CR-4555, March 1986), and was presented at the Second Radioactive Exchange Decisionmakers' Forum (May 1986).

U.S. Environmental Protection Agency
Office of Radiation Programs

REVIEW OF THE PATHRAE CODE

The EPA has developed a family of computer codes to provide assessments of the risks associated with low-level radioactive waste disposal practices. One of the codes, PATHRAE, is used to calculate the doses to the critical population group from the disposal of "below regulatory concern" waste streams. SC&A was asked to review the health physics aspects of the PATHRAE code.

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

DEVELOPMENT OF A DOSE RATE DATA BASE
FOR OPERATING NUCLEAR POWER PLANTS

Many proposed regulatory requirements involve physical modifications to operating nuclear power plants. Work performed in operating reactors will frequently subject workers to radiation exposure, which can be an important consideration in an overall value-impact assessment. Although data exist on the radiation exposures associated with several tasks already performed in operating nuclear power plants, a generic methodology does not exist for the purpose of making estimates of the exposure associated with plant modifications that have yet to be performed.

The objective of this task is to construct a dose-rate data base for the major plant systems in commercial LWRs. The product of the number of in-field man-hours estimated for the postulated modification and the dose rate for the system would constitute a first-order approximation to the radiation exposure for the postulated modification.

The data base is being assembled from the survey data for area dose rates at representative operating plants. Representative plants were selected for each of the four reactor vendors based on historical exposures at the plants and the availability of readily retrievable data. Sufficient data are being collected over the spatial extent of each system and over time so as to obtain appropriate spatial and temporal averages.

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

IMPACT OF REVISED STANDARDS FOR PROTECTION AGAINST RADIATION (10 CFR PART 20)

The U.S. Nuclear Regulatory Commission (NRC) is proposing revised standards for protection against radiation (Part 20 to Title 10, Code of Federal Regulations). These revised standards incorporate the system of dose limitations recommended by the International Commission on Radiological Protection (ICRP-26). In particular, NRC is proposing risk-weighted guidelines for combining doses received by individual organs from internal and external exposures. Also, new occupational limits on annual dose equivalent are proposed.

SC&A, together with an economic analysis firm (Jack Faucett Associates), estimated the impact on the industry of these proposed revisions to the NRC regulations. This was accomplished by conducting a number of case studies, and by reassessing the results of previous work conducted by SC&A for the Environmental Protection Agency. In particular, case studies were conducted on five nuclear power plants, a university research reactor, a uranium mill, a uranium conversion facility, and a nuclear pharmacy. For each of these facilities, site visits were conducted with the corporate health physicist and his staff. The revision was disaggregated into its component parts and each part was discussed individually. During the course of the work, several necessary changes in the revised regulation were identified and reported to the NRC.

SC&A presented the results of its cost evaluation to the Advisory Committee on Reactor Safeguards (ACRS), and the evaluation was used by the staff in the preparation of NRC's Regulatory Impact Analysis.

U.S. Environmental Protection Agency
Office of Radiation Programs

CONCEPTUAL DESIGN AND COST ESTIMATE OF METHODS FOR
LOW LEVEL RADIOACTIVE WASTE DISPOSAL

The EPA Office of Radiation Programs is developing environmental standards for the land disposal of low-level radioactive wastes. Two advanced methods for low-level waste disposal under evaluation are the French design, known as an Earth Mounded Concrete Bunker (EMCB), and the Westinghouse/Hittman design, which incorporates encapsulation of wastes in concrete containers known as SUREPAKS. These disposal methods have received considerable interest from the states and industry.

SC&A (under a subcontract with Jack Faucett Associates) made preliminary cost evaluations of the disposal of low-level radicactive wastes using these methods. Costs were expressed as increments from the conventional shallow land burial technique.

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation

DETERMINATION OF THE IMPLEMENTING REQUIREMENTS
OF CERTAIN GENERIC SAFETY ISSUES

The NRC Division of Safety Technology is responsible for establishing priorities for reactor safety issues. Many of the safety issues that have been prioritized by the NRC have resulted in the implementation of multi-plant actions (MPAs). These MPAs are licensing actions that apply to a class of reactors. SC&A is assisting the NRC by correlating the generic safety issues to the resulting MPAs, in order to track the issues to completion.

For each generic issue assigned to SC&A for tracking, the following information was collected and documented:

- Brief History of the Generic Issue
- Statement of Requirement(s)
- Identification of the Document Approving the Requirement(s)
- Identification of the Document(s) Implementing the Requirements, Including the MPA Number, Where Appropriate

U.S. Environmental Protection Agency
Office of Radiation Programs

SEARCH FOR A DE MINIMIS LEVEL OF RISK

In establishing radiation standards, regulatory agencies generally assume that all exposures to radiation, regardless of how small, result in adverse health effects. This assumption is also frequently applied to the regulation of human exposure to chemicals. Although this conservative approach may be prudent, particularly if the agent is a known or suspected carcinogen, it may also result in the misallocation of societal resources. This consideration has resulted in the search for a "de minimis" level of risk -- below the range of regulatory concern.

SC&A, in collaboration with an economic consulting firm (Jack Faucett Associates), sought a quantitative definition of a de minimis level of risk, using the revealed preference method. Starting with the fatality statistics maintained by the National Center for Health Statistics (NCHS), a candidate list of diseases and accidents was compiled for analysis. For each of the categories of risk on the candidate list, an attempt was made to determine if government entities have or are planning to expend resources to reduce the level of risk below the existing level.

Graphical displays of the presence or absence of government expenditures versus the level of risk were developed to aid in interpreting the results. A statistical comparison of the categories of risk analyzed was performed using discriminate analysis to determine the level of risk which best separates the categories of risk into two groups. The results suggested no evidence of a de minimis level of risk down to a lifetime risk level of 0.1×10^{-6}, the lowest level of risk in the NCHS data base.

Congress of the United States
Office of Technology Assessment

NUCLEAR REACTOR REGULATION VIS-A-VIS SAFETY

The purpose of this study conducted for the Office of Technology Assessment (OTA), was to analyze the relationship between the nuclear reactor regulatory process and nuclear reactor safety. It was used to complete an OTA report which deals with the future of conventional nuclear power (Nuclear Power in an Age of Uncertainty, 1984). The study consisted of two parts -- a survey of informed attitudes toward the regulatory process and an analysis of two case examples.

The survey was performed by means of telephone interviews. The people interviewed consisted of nuclear critics, reactor vendor senior managers, architect-engineer senior managers, electric utility senior managers, members of the Advisory Committee on Reactor Safeguards, and Nuclear Regulatory Commission senior managers. The individuals interviewed were chosen based on their qualifications to address the issues.

Two case examples of recent regulatory requirements were examined in order to illustrate through example how the system actually works. The two examples selected were fire protection and ATWS (Anticipated Transients Without Scram). These were chosen both out of expediency (ready availability of documentation) and in order to illustrate two significantly different issues.

The study concluded that although the existing regulatory system has a number of deficiencies, all parties have learned to work within the system and there are no obvious changes that would substantially increase the level of safety.

Nuclear Safety Oversight Committee

OVERVIEW OF NUCLEAR REGULATORY COMMISSION ASSESSMENT PROGRAMS

The Nuclear Safety Oversight Committee (NSOC) was established by the President in the wake of the accident at Three Mile Island and was abolished in October 1981. In July 1981, the staff of the Committee initiated a study of the NRC's major inspection, event evaluation, and safety improvement programs. SC&A assisted the staff in the analysis of NRC programs.

The purpose of the NSOC study was to establish a framework for evaluating the nation's regulatory approach to nuclear safety. A working list of major NRC assessment programs was drawn up and refined in the course of the study. More than 50 NRC staff members were interviewed to gain an insight into these programs. SC&A reviewed the following programs:

- Revision of the Standard Review Plan (SRP)
- Systematic Evaluation Program (SEP)
- Unresolved and Generic Safety Issue Reviews
- Interim Reliability Evaluation Program (IREP)
- National Reliability Evaluation Program (NREP)
- Quality Assurance Reevaluation Program
- Environmental Qualifications Program
- Systematic Assessment of Licensee Performance (SALP) Program
- Control Room Design Reviews
- Emergency Operating Procedures Reviews
- Systems Interaction Studies
- Emergency Plan Appraisals
- Fire Protection Reviews
- Implementation of the Three Mile Island Action Plan
- AEOD Engineering Evlaluations and Case Studies
- Management Appraisals by the Performance Appraisal Branch (PAB)
- Inspection & Enforcement Investigations

Department of Energy
Energy Information Administration

REGULATORY INFLUENCES ON THE HIGH COSTS OF NEW NUCLEAR POWER PLANTS

Over the past several years, capital costs of nuclear power plants in the latter stages of construction have escalated well beyond anyone's reasonable expectations. In some cases, the discrepancies between originally estimated and actual capital costs approximate an order of magnitude. More than 50 plants with $50 million or more invested have been cancelled. In a few cases, plants with billions invested and presumably close to completion have been cancelled. At a recent workshop sponsored by the Office of Technology Assessment, utility executives stated that no new nuclear power plants would be ordered in the United States until the industry was assured that costs were under control.

It has been repeatedly alleged that new and changing safety requirements imposed by the Nuclear Regulatory Commission are responsible for most, if not all of the cost growth. The purpose of this study was to test this hypothesis by analyzing actual construction cost data at two plants. Two plants of different vintages were selected as case studies. These two plants had the same utility management, the same NSSS vendor, the same A-E/constructor, and were originally intended to be twins. They were separated in time by approximately seven years, and each plant incurred a cost growth of nearly 300%. The A-E scope changes were reviewed in detail for each plant to determine the causative factors for the cost growth.

It was concluded that, contrary to expectations, the role of regulation in the growth in costs was more pronounced in the earlier plant. Moreover, a noticeable shift occurred from an ad-hoc mode of regulation for the first plant to a more prescriptive process in the second. These results indicate that regulation may have been in the process of stabilizing in the late 1970s and early 1980s, rather than the opposite, which is generally held.

U.S. Nuclear Regulatory Commission
Office of Policy Evaluation

TECHNICAL ASSISTANCE ON SEVERE
ACCIDENT RESEARCH AND POLICY DEVELOPMENT

As a consequence of the Three Mile Island nuclear power plant accident, the Nuclear Regulatory Commission initiated a high priority program to establish a policy for current and future generation nuclear reactors regarding severe accidents. Accordingly, an extensive research program was initiated by NRC's Office of Nuclear Reactor Research called the Severe Accident Research Program Plan (SARP).

SC&A provided technical assistance to the NRC Office of Policy Evaluation by reviewing the pertinent NRC and IDCOR (Industry Degraded Core) reports related to severe accidents, and identifying areas of uncertainty that could be significant to regulatory decisions on severe accident policy. Additionally, potential design changes were identified that could reduce the risks associated with severe accidents.

The work also included an extensive review of existing Probabilistic Risk Assessments (PRAs). From this review, SC&A estimated the overall uncertainty in the evaluation of the generic LWR risk. In support of this evaluation, the following topics were explored:

- Uncertainty in the source term
- Contribution of external events to risk
- Contribution to risk of station blackout and loss of decay heat removal
- Contribution to risk and uncertainty from low frequency sequences
- Contribution to risk from outliers
- Accident sequences which have been neglected in source term assessments
- Contribution to uncertainty from lack of knowledge regarding core migration into the lower plenum
- Contribution to risk and uncertainty from human error

Congress of the United States
Office of Technology Assessment

EXAMINATION OF REACTOR REGULATION

The Office of Technology Assessment (OTA) conducted an assessment on the future of conventional nuclear power. The objective of the study was to determine the impediments to the future growth of the industry, and to advise the Congress on ways to remove these impediments. SC&A was responsible for examining the regulatory impediments.

The principal proposals for reform of the regulatory process were reviewed, and the relative strengths and weaknesses of each of the major proposals were assessed from the perspective of the utilities, vendors, regulators, and environmental groups. Case studies of existing LWR's were conducted to determine the principal contributory factors to delays in the licensing and construction schedules. Finally, technological options other than conventional LWR's (redesigned LWR's, smaller LWR's, HTGR's, and CANDU reactors) were examined to assess significant differences in siting and licensing.

The case studies focussed on three units under construction and near completion, one with an exemplary construction history, another with an average history, and a third with a protracted and difficult history. An attempt was made to sort out the regulatory contributions to construction delays. In particular, the impact of NRC- mandated backfits was explored.

The results were summarized in a report to OTA and presented to a workshop on reactor technology and regulation. The OTA report, Nuclear Power in an Age of Uncertainty, was published in January 1984.

Private Electric Utilities

TRAINING WORKSHOP ON QUALITY CONTROL IN RADIATION MEASUREMENTS

SC&A has conducted a number of two to three day training programs on the subject of quality control in radiation measurements. These programs were directed to utility professionals who are engaged in in-plant and environmental radiological measurements. Typically, the participants had backgrounds in health physics, radiochemistry, engineering, or the natural sciences. The program was designed to teach the participants how to make sure that their radiation measurements are adequate, how to evaluate QC data in time to take any necessary corrective actions, and how to document the acceptability of the measurements.

The workshops are conducted on the clients' premises. The first day is appropriate for managers and executives who are not involved in radiation measurements on a daily basis, but who desire a general knowledge of QC and its applicability to contracting. Part of the third day is devoted to consultation on specific problems. A course manual, custom designed for the training program, is given to each participant. It consists of the following seven chapters:

- Quality Assurance and Quality Control
- Statistics
- Acceptable Standard Deviation
- Selection of Measurement Types for Quality Control
- Evaluation Procedures-Precision
- Evaluation Procedures-Accuracy
- Minimum Detectable Levels

Executive Office of the President
Council on Environmental Quality

SUPPORT SERVICES IN THE AREA OF NUCLEAR WASTE/RADIATION

The Council on Environmental Quality (CEQ) is responsible under the National Environmental Policy Act for the conduct of studies concerning policies, programs, standards, mediation, public involvement, and international cooperation. The purpose of this contract is to assist the CEQ and related interagency coordinating groups with joint projects in the area of nuclear waste/radiation. The objectives of the contract are to provide:

- analytical support for environmental policy options;
- an independent forum for peer review of scientific and policy matters;
- opportunities to facilitate mediation and public involvement in environmental programs to encourage resolution of complicated issues or regulations; and
- support for international cooperation in matters involving global resources.

Argonne National Laboratory
Energy and Environmental Systems Division

DEVELOPMENT OF A GUIDE TO ESTIMATE THE COSTS OF GENERIC NUCLEAR REGULATORY COMMISSION REQUIREMENTS

Argonne National Laboratory developed for the Nuclear Regulatory Commission (NRC) a Handbook for Cost Estimating (NUREG/CR-3971) to revaluate the costs associated with generic NRC requirements. The Handbook is used by the NRC, together with independent estimates of accident risks and consequences, to establish priorities within the agency for dealing with generic issues. The methodology used in the Handbook consists of a "decision tree" to allow the NRC to identify all of the significant cost elements associated with the implementation of a proposed NRC generic requirement.

SC&A developed the decision methodology for use in the Handbook and additionally performed the following three tasks. In the first task, SC&A selected two recent examples of generic backfit requirements imposed by the NRC and traced the effects of these requirements through the nuclear industry. The second task provided detailed models of the NRC and a typical nuclear utility to identify all significant functions and to detect all cost elements associated with the generic requirements. In the final task, SC&A gathered cost data references to assist the user of the guide in preparing cost estimates of each element identified in Task 2.

SC&A conducted site visits at three utilities to determine the cost impact of the two selected backfit requirements. From discussions with utility project management personnel, a common basis was developed to categorize backfit cost impacts. Additionally, the differences between estimated and actual costs were determined for the two specific backfit requirements.

Environmental Protection Agency
Office of Radiation Programs

DEVELOPMENT OF AN ENVIRONMENTAL PATHWAY MODEL FOR EVALUATING RADIATION DOSES FROM RESIDUAL RADIOACTIVITY

A risk-level approach has been developed for estimating the maximum annual radiation dose to individuals at decontaminated and decommissioned sites and facilities. The approach has been implemented in a computer code entitled REUSEIT. The code will be used by the Environmental Protection Agency in establishing criteria and standards for residual radioactivity.

The approach considers initially contaminated surface soil, subsurface soil, and buildings. The environmental media modeled include the atmosphere, surface soil, subsurface soil, groundwater, and surface water. The environmental exposures include external exposure from contaminated ground and from immersion in contaminated air and water, and internal exposure from inhalation of suspended surface soil and from ingestion of contaminated water, crops, animal-derived foods and aquatic foods. Contamination of internal building surfaces, in ventilation systems and on residual equipment is taken into account. The exposures in buildings include external exposure from all types of building contamination and internal exposure from inhalation of contaminated dust.

For the atmosphere, (re)suspension of surface soil and subsequent deposition are taken into account. For surface soil, additions of radioactivity by irrigation, by percolation from upper layers and by radioactive ingrowth, and removal by leaching accompanied by subsequent downward transport and by radioactive decay, are included. For subsoil, additions both by percolation from surface soil and by ingrowth, as well as losses by both removal of groundwater for irrigation and by decay, are considered. For surface water, contamination both by erosion and/or runoff of surface soil and by subterranean flow of subsoil contamination are included.

U.S. Environmental Protection Agency
Office of Radiation Programs

VERIFICATION OF AN ENVIRONMENTAL TRANSPORT MODEL

An environmental transport model, AIRDOS-EPA, is used to predict radiation exposures to individuals and populations in the environment from atmospheric emissions of radionuclides. Although the model is used to verify compliance with environmental standards and regulations, clean comparisons with actual measurements are virtually non-existent.

SC&A, under a subcontract with Jack Faucett Associates, compared the predictions using AIRDOS-EPA against existing measurements of radionuclide concentrations in the environment. The comparisons were made for several Department of Energy facilities and Nuclear Regulatory Commission licensees which satisfy the following:

- Measured annual average emissions by radionuclide
- Measured environmental concentrations by radionuclide
- Single stack releases in relatively flat terrain
- On-site meteorological data

The predicted and measured environmental concentrations were subjected to statistical analyses to determine the ranges of validity of each. From the extent of agreement between measurement and prediction, and taking into account the statistical uncertainties in each, a determination will be made of the degree of conservatism which is necessary when the model is used to determine compliance with standards.

U.S. Nuclear Regulatory Commission
Fuel Cycle Safety Branch

ASSISTANCE IN THE DEVELOPMENT OF AN ENVIRONMENTAL ASSESSMENT FOR THE BABCOCK & WILCOX APOLLO FACILITY

Babcock and Wilcox Corporation has submitted a license application renewal for its Nuclear Service Operation facility in Apollo, Pennsylvania. Before the license renewal can be granted, the NRC must prepare an Environmental Assessment. As a subcontractor to Science Applications International Corporation, SC&A is assisting in the preparation of the Environmental Assessment. SC&A is responsible for the following sections of the Environmental Assessment:

- Description of the Site Environment
- Description of the Facility
- Occupational Radiation Exposure Assessment

The section which portrays the site environment contains descriptions of the site location, demography, land use, geology, hydrology, meteorology and climatology, background radiological characteristics, and ecology.

U.S. Department of Energy
Office of Health and Environmental Research

TECHNICAL REVIEW OF HEALTH AND ENVIRONMENTAL RISK ANALYSIS

SC&A assisted the Department of Energy (DOE) in the technical review of the 1981 and 1982 health and environmental risk analyses. These risk analyses, performed by contractors for DOE, were intended to provide the Department with independent assessments of the potential health and environmental impacts of emerging energy technologies. SC&A was the principal reviewer of the battery risk analyses. As principal reviewer, technical reviews and discussion meetings were led, and written comments and recommendations were submitted to the DOE. SC&A also served as DOE advisor at the Fourth Annual Contractors meeting, held in February 1983.

U.S. Environmental Protection Agency
Office of Radiation Programs

TECHNICAL SUPPORT FOR INACTIVE URANIUM MILL TAILINGS GROUND WATER STANDARDS

There are 24 inactive uranium mill tailings sites in the United States. The Department of Energy is responsible for cleanup and reclamation of tailings at these sites. SC&A assisted the Environmental Protection Agency in preparing a Background Information Document in support of the development of ground water protection standards for these sites. In particular, SC&A contributed to the Background Information Document in the following areas:

1. Concise descriptions were prepared for the 24 sites, including summaries of the topography, geohydrology, meteorology, local population, and waste characteristics.

2. The ground water data were compiled and summarized, and compared against standards in 40 CFR 192.32 (a).

3. Feasible ground water restoration methods were described, and each method was evaluated in terms of its applicability and approximate costs at each of the sites.

U.S. Environmental Protection Agency
Office of Radiation Programs

REVIEW OF APPLICATIONS FOR ALTERNATIVE STANDARDS UNDER REGULATIONS GOVERNING URANIUM MINES

In April 1985, the EPA promulgated a National Emission Standard for Hazardous Air Pollutants covering radon emissions from underground uranium mines. This standard requires large underground uranium mines to bulkhead all abandoned or temporarily abandoned areas. However, the mine operator is allowed to apply to EPA for an alternative standard, should compliance with the bulkheading requirements present a health and safety hazard to the miners.

SC&A reviewed the mining operations and ventilation practices at a uranium mine that requested an alternative standard under the EPA regulations. The review addressed the following questions posed by the EPA:

(a) Is the use of abandoned areas as ventilation passageways necessary in order to protect the health and safety on the miners?

(b) Can practical modifications of the ventilation system be made to avoid extensive use of abandoned areas as ventilation passage ways?

(c) Are there additional abandoned areas of the mine which could be bulkheaded without increasing the radiation exposure to the miners?

(d) Is it necessary for mine development to allow 18 months before an area can be considered permanently abandoned?

SC&A and its subcontractors also performed an assessment of the exposures to individuals and populations resulting from radon emissions from the mine. The exposure assessment to individuals required the use of a complex terrain dispersion model.

U.S. Department of Energy
Office of Environmental Assessment

ANALYSIS OF HIGH-LEVEL
WASTE STANDARDS AND CRITERIA

For the Regulatory Analysis Divison of the DOE Office of Environmental Assessment, SC&A performed an analysis of the EPA environmental standards and Federal radiation protection guidance for the management and disposal of spent nuclear fuel, high-level, and transuranic radioactive wastes. The following aspects of the standards were critically reviewed:

- The reasonableness of the risk criterion, which is the foundation of the standards, including a comparison against societal risks from other components of the nuclear fuel cycle.

- The alternative forms for the standard -- limits on risk, radiation dose (individual and/or population), or risk.

- The validity of the models and parameters used in the environmental pathways and population dose assessments.

The results of the work were summarized in a paper presented at <u>Waste Management 83</u>, a symposium held in February 1983.

Department of Energy
Office of Civilian Radioactive Waste Management

DEVELOPMENT OF A SAFETY PLAN FOR THE DOE OFFICE
OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

SC&A, under a subcontract with Roy F. Weston, Inc., developed a Safety Plan for the DOE Office of Civilian Radioactive Waste Management (OCRWM). The Safety Plan covers the policies, procedures, and strategies employed by OCRWM to achieve compliance with all applicable environmental, safety, and health codes, standards, and regulations. The OCRWM Safety Plan provides guidance to the field for the development of project-specific safety plans.

The Safety Plan (DOE/RW-0119, December 1986) is subdivided into the following parts:

I.	Safety Manageme[illegible] - Describes safety policy and organization. Defines required documentation, training, and appraisals.
II.	Systems Safety - Describes design criteria and safety analysis.
III.	Radiological Safety - Describes safety considerations pertaining to occupational radiation exposure, transportation of radioactive materials, inadvertant criticality, and radiological monitoring.
IV.	Industrial Safety - Describes conventional non-nuclear safety considerations, including occupational health, fire, construction safety, and transportation.
APP. A	Cites applicable safety standards and criteria.
APP. B	Cites safety reporting requirements.

Department of Energy
Office of Civilian Radioactive Waste Management

DEVELOPMENT OF A PROJECT MANAGEMENT
SYSTEM FOR THE DOE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

The Nuclear Waste Policy Act of 1982 established the Civilian Radioactive Waste Management Program within DOE Headquarters, funded by fees levied on the nuclear utilities. The Act also set many requirements that cannot be handled within the traditional DOE management systems, such as the important institutional component, the direct line of Headquarters' control, and the responsibility to the utilities (as well as traditional government audit agencies) for cost-effective expenditure of funds. Thus, an additional layer of management control was established and was tasked to manage the cost, schedule, and technical performance of the program. The unique nature of the management task within DOE called for a program management system that encompasses, to the extent practicable, existing DOE Orders and directives, but also meets the requirements of the Act.

SC&A assisted Roy F. Weston, Inc. to develop a Project Management System for the Office of Civilian Radioactive Waste Management (OCRWM). The OCRWM Program Management System (DOE/RW-0043, January 1986) is a set of mutually supportive, interrelated policies, processes, procedures, and data bases, the purpose of which is to enable OCRWM to plan and control the implementation of the Civilian Radioactive Waste Management Program. The specific objectives and functions of the Program Management System are to provide mechanisms to:

(1) Plan program baselines (technical, schedule, and budget); and authorize the work to be executed;
(2) Control the implementation of the program (technical, schedules, and cost control);
(3) Monitor and report on program activities to enable comparison of progress (technical, schedule, and cost) against program baselines;
(4) Analyze reported information and review progress so that problems can be identified and analyzed, and so that appropriate corrective action can be taken.

U.S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards

STUDY ON TRAINING AND EXPERIENCE CRITERIA FOR MEDICAL PERSONNEL

SC&A is assisting the NRC in the development of training and experience criteria for personnel involved in the medical use of byproduct material. This is being accomplished by conducting a study on the duties and responsibilities of medical personnel, and the standards and regulations that organizations impose on their training programs. The specialities that are being evaluated include the following:

- Physicians
- Medical Physicists
- Dosimetrists
- Radiopharmacists
- Technologists
- Technicians
- Nurses

Standards, guidelines, and regulations that are imposed on training programs are being obtained from Federal agencies, state health departments, and professional organizations. These are being analyzed for overlaps and gaps. Also, the oversight programs that each organization uses to ensure implementation and compliance with its standards, and the extent to which these standards are covered in training programs and certification exams are being described.

U.S. Nuclear Regulatory Commission
Office of Resource Management

ESTIMATE OF COSTS AND RADIATION EXPOSURES
ASSOCIATED WITH REGULATORY REQUIREMENTS

In accordance with a recent emphasis on the use of value-impact techniques in its regulatory decisions, the NRC Division of Budget and Analysis has been charged with the responsibility to provide other parts of the Agency with estimates of the costs of regulatory requirements. Contractors are being used to provide assistance in evaluating costs. SC&A is a subcontractor to one of these contractors, Science and Engineering Associates.

In its initial task for the NRC, SC&A estimated the radiation exposures from startup, shutdown, defueling, and refueling of generic BWRs and PWRs. Exposure data for the startup and shutdown tasks were obtained directly from five utilities for eight units. Exposure data for defueling and refueling were obtained from the high dose job data base, being compiled for the NRC by Brookhaven National Laboratory.

In the second task, SC&A assisted in the evaluation of the costs associated with the revisions to 10 CFR Part 50, Appendix J, Leak Tests for Primary and Secondary Containments of Light-Water-Cooled Nuclear Power Plants. SC&A evaluated the impact to both the industry and the NRC of the changes to Technical Specifications engendered by the changes to Appendix J. SC&A also evaluated the impact on occupational radiation exposures of the changes.

In a third task, SC&A assisted in estimating the costs of the disposal of low-level wastes from nuclear power plants, and developed a method for predicting the volumes of wastes generated. This work was published by the NRC (Generic Cost Estimates for the Disposal of Radioactive Wastes, NUREG/CR-4555, March 1986) and the method for estimating waste volumes was presented at the Second Radioactive Exchange Decisionmakers' Forum (May 1986).

In a fourth task, SC&A assisted in compiling a book of abstracts on generic cost estimates (NUREG/CR-4627, June 1986).

U.S. Environmental Protection Agency
Office of Radiation Programs

COSTS OF COMPLIANCE WITH PROPOSED
CLEAN AIR ACT STANDARDS FOR RADIONUCLIDES
FOR MEDICAL RESEARCH FACILITIES

In 1977, Congress amended the Clean Air Act to address emissions of radioactive materials. The Environmental Protection Agency subsequently listed radioactive materials as hazardous air pollutants under Section 112 of the Clean Air Act. Then in 1982, the Court ordered EPA to publish proposed regulations establishing emission standards for radionuclides, acting in response to a suit filed by the Sierra Club. EPA proposed standards for radionuclides in April 1983. Separate standards were proposed for Department of Energy Facilities, NRC licensee facilities, elemental phosphorous plants, and uranium mines.

SC&A investigated the compliance costs to medical research facilities of the proposed standards for Nuclear Regulatory Commission licensees. The investigation included case studies of approximately 30 users who had the potential to exceed the proposed limits. The users were selected by screening a large number of medical institutions for possession limits and distances to the nearest human receptors. The case studies also identified the controls used, the additional controls required to bring these facilities into compliance with the proposed standard, and the estimated costs of these additional controls. The study concluded that few, if any of the facilities would be unable to comply with the proposed standards, but that a significant fraction would have difficulty in demonstrating compliance.

Atomic Industrial Forum
NESP Project

OCCUPATIONAL EXPOSURE AND ALARA IMPLICATIONS OF NRC MULTI-PLANT ACTIONS

SC&A evaluated the impact of NRC-initiated multi-plant actions on worker radiation exposures. A list of multi-plant actions potentially resulting in occupational radiation exposures was compiled from the NRC "orange book" for the period 1979 through 1983, and this list was supplemented by the relevant I&E Bulletins over the same time period. The next step was to divide the operating reactors into classes, based on distinguishing parameters, and to select representative plants from each of the classes.

Occupation radiation exposure data were obtained from the Radiation Work Permits at ten representative plants for tasks corresponding to the NRC multi-plant actions. The exposures from these representative plants were used to estimate the total exposures at light water-cooled reactors. The results were presented in a form which illustrates the contribution of dose from NRC-initiated multi-plant actions to total worker dose.

The report was published as AIF/NESP-033, Occupational Radiation Exposure Implications of NRC-Initiated Multi-Plant Actions, March 1986.

Atomic Industrial Forum
NESP Project

STUDY OF THE TEMPORARY NUCLEAR WORK FORCE IN THE UNITED STATES

The nuclear energy industry is employing an increasing number of non-permanent radiation workers at nuclear power plants. These non-permanent workers have been variously referred to as "temporary" or "transient." Little was known about these workers, aside from their radiation exposures, which were alleged to be higher, on the average, than those of permanent station employees.

In a joint effort with Jack Faucett Associates, SC&A conducted a study to characterize the non-permanent radiation workers at nuclear power plants. The workforce was subdivided into permanent station employees, non-station utility employees, temporary station utility employees, permanent contractor employees, and temporary contractor employees. For each category of workers, data were collected on numbers of individuals by craft, age, sex, geographical origin, duration of employment, and radiation exposure. Additionally, radiation exposures were evaluated by specific job, including steam generator repair, control rod drive maintenance, decontamination, and waste management. Finally, the training in radiation safety was assessed for both permanent and temporary workers.

In evaluating the job-specific radiation exposures, it was necessary to disaggregate radiation work permits by worker category. Although this task was simplified at some plants through the use of automated data bases, tedious reviews were necessary at other plants. In total, one to three years of exposure data were obtained for 15 units at nine stations operated by six utilities.

The work was published as a report entitled, "Characterization of the Temporary Radiation Work Force at U.S. Nuclear Power Plants," AIF/NESP-028, May 1984.

U.S. Department of Energy
Office of Environmental Assessment

SAFETY GOALS FOR NUCLEAR POWER PLANTS: A COMPARISON OF RISK CRITERIA

For the Regulatory Analysis Division of the DOE office of Environmental Assessment, SC&A is performed an analysis of NRC's proposed safety goals for nuclear power plants. These safety goals include numerical criteria for acceptable levels of risk to individuals and populations in the area around reactor sites.

Other regulations, standards, and guidelines applicable to individual components of the nuclear fuel cycle were compiled. Radiation exposure limits applicable to both workers and members of the general public were converted to risk and compared with the numerical guidelines in the proposed safety goals. The compatibility between the safety goals and existing standards were assessed. It was determined that the societal risk guideline is well outside the range of population risk limits applicable to other activities in the nuclear fuel cycle, and moreover provides no incentive for selecting sites with low surrounding population densities.

U.S. Environmental Protection Agency
Office of Radiation Programs

RADIONUCLIDE EMISSIONS FROM WASTE INCINERATORS AND COMPACTORS

A review document was written to assist the EPA in reviewing applications under the Clean Air Act for new radioactive waste incinerators and compactors. The document summarizes the Federal regulations governing these waste volume-reduction facilities, both those of the Environmental Protection Agency and the Nuclear Regulatory Commission. It provides descriptions of the technologies, including schematic diagrams. It gives radionuclide spectra for wastes handled by each class of volume-reduction technology. It discusses emission control from these facilities, including expected efficiencies. Finally, it provides principles for stack sampling and analysis of the primary radionuclides emitted by incinerators and compactors.

U.S. Environmental Protection Agency
Office of Radiation Programs

DEVELOPMENT OF PROCEDURES FOR COMPLIANCE WITH THE CLEAN AIR ACT STANDARDS FOR RADIONUCLIDES

In February 1985, the Environmental Protection Agency (EPA) promulgated, under Section 112 of the Clean Air Act, standards for radionuclides emitted into the air. The standards for NRC-licensed and non-DOE Federal facilities (40 CRF 61 Subpart I) required facilities to demonstrate compliance using the EPA computer codes, AIRDOS-EPA and RADRISK. However, these codes will be difficult to run for the majority of the estimated 6000 NRC licensees subject to the standards.

SC&A assisted the NRC in developing less cumbersome compliance procedures. These consist of:

1) A table of annual quantities of radionuclides that can be handled without causing any member of the public to receive a dose that is more than 20 percent of the standards. These annual quantities were derived using empirically-derived release fractions.
2) A table of stack concentrations that limit the dose to any member of the public to less than 20 percent of the standards.
3) A computer code which automates the methodology given in NCRP Commentary No. 3.
4) A computer code which extends the methodology given in NCRP Commentary No. 3 by providing a more complete treatment of air dispersion and a more sophisticated calculation of organ dose.

Demonstration of compliance using methods 1) through 3) also exempts licensees from reporting to the EPA.

The procedures are explained in a "user-friendly" guidance manual which sets down the alternative steps for demonstrating compliance.

U.S. Environmental Protection Agency
Office of Radiation Programs

DETERMINATION OF PRINCIPLES FOR SAMPLING AND ANALYTICAL METHODS FOR DEPARTMENT OF ENERGY FACILITIES

Under Section 112 of the Clean Air Act, the Environmental Protection Agency has issued National Emission Standards for Hazardous Air Pollutants. Subpart H of these standards, which applies to Department of Energy (DOE) Facilities, specifies that compliance with the standard is to be monitored by determining radionuclide emissions and calculating dose equivalents to members of the general public. Emissions are to be determined by EPA approved sampling procedures, and the portion of the regulation which was to have specified these approved procedures was reserved at the time of promulgation.

SC&A assisted the EPA in defining approved "principles" for sampling emissions from DOE facilities. These principles were applied to the 20 principal radionuclides released from DOE facilities. The principles were derived, in part, by reviewing the diverse methods applied by DOE facilities for measuring emissions. Principles were also derived for radiochemical analysis of the samples, including counting principles. The 20 principal radionuclides released from DOE facilities were keyed to one or more of the 14 radiochemical principles provided.

U.S. Environmental Protection Agency
Office of Radiation Programs

REVIEW OF THE MODELS USED TO DERIVE REPORTABLE QUANTITIES
OF RADIONUCLIDES UNDER CERCLA

SC&A reviewed for the EPA Office of Radiation Programs the calculations of Reportable Quantities of Radionuclides under CERCLA ("Superfund") conducted by the EPA Office of Solid Wastes (OSW). "Reportable Quantities" are defined under CERCLA as the amount of material which, if released to the environment in the event of an incident, trigger the requirement for a report to the EPA.

The following three aspects of OSW's analysis were evaluated by SC&A:

1) The appropriateness of the models with respect to the objectives of computing reportable quantities of radionuclides under CERCLA.

2) The appropriateness of the alternative assumptions and parameters used in the models.

3) The lucidity and accuracy of the presentation, and the accuracy of the numerical calculations.

SC&A found that the close-range models were inappropriate to use in pathways analysis, and that some of the alternative assumptions were inappropriate. Also, the manner in which radioactive decay was considered in the inhalation pathway model was considered to be inappropriate. Several of the equations were missing one or more terms, and the time-dependent calculations in one of the scenarios was performed incorrectly. The results of the review were summarized in a letter report to the EPA Office of Radiation Programs.
incomplete

"Equal Opportunity Employer"

HEALTH
ENVIRONMENT
department

STATE OF NEW MEXICO

ENVIRONMENTAL EVALUATION GROUP
320 E. Marcy Street
P.O. Box 968
Santa Fe, NM 87503
(505) 827-8280

May 27, 1985

Dr. Sanford C. Cohen
S. Cohen and Associates, Inc.
8200 Riding Ridge Place
McLean, Virginia 22102

Dear Sandy:

The purpose of this letter is to express our appreciation and admiration for the excellent job you did in evaluating the transportation regulations relevant to the shipping container (TRUPACT) scheduled to be used for the transport of transuranic waste to WIPP.

Not only was your written report complete but your thoroughness in reviewing the past history of the regulations in this area of the Atomic Energy Commission, the Nuclear Regulatory Commission, and the Department of Energy provided a key perspective to the problem of the intent of the regulations.

Your presentation at the two day meeting with DOE and other contractors was succinct, clear and objective and was well received by all the participants including Governor Dixie Lee Ray. It was most helpful to EEG in our role of insuring that the waste shipments will not pose an undue threat to the health and safety of the citizens of New Mexico.

Thanks again and I look forward to continuing to work with you.

Sincerely,

Bob

Robert H. Neill
Director

RHN:cmp

WESTON
DESIGNERS CONSULTANTS
WESTON WAY
WEST CHESTER, PA. 19380
PHONE: (215) 692-3030
TELEX: 83-5348

16 December 1986

Dr. Sanford C. Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, Virginia 22101

Dear Dr. Cohen:

I would like to express my appreciation for the excellent support provided to WESTON by you and other members of your firm on the contract with the DOE Office of Civilian Radioactive Waste Management (OCRWM). Your help in drafting and finally implementing a Program Management System Manual, after many iterations, was essential to our success in providing OCRWM with a tool to effectively manage this $30-40 billion program. In addition, your knowledge and experience on health and safety issues, which culminated in the OCRWM Safety Plan, assured that all legal and other requirements by numerous federal, state and local agencies were met, both in letter and spirit.

We were also very pleased with your help on total systems life-cycle costing, and program management information systems, among others.

In summary, the knowledge, experience, and professionalism of you and the members of your firm was outstanding, and significantly contributed to our success over the past two years. I look forward to many further associations on OCRWM and other projects in the future.

Very truly yours,

ROY F. WESTON, INC.

Samuel C. Colwell

Samuel C. Colwell
Vice President and
Operations Manager
Systems and Policy Division

lsy

Department of Energy
Washington, D.C. 20545

January 25, 1983

Dr. Sanford Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, Virginia 22102

Dear Dr. Cohen:

Thank you for your note and very great congratulations on getting through the impossible first year.

I can say nothing but good things about your work for HERAP. Your reports have been: sharply targeted; perceptive; on time; and extremely useful.

I look forward to seeing you at Contractor IV.

Sincerely,

Nathaniel F. Barr, Manager
Health and Environmental Risk
Analysis Program
Human Health and Assessments
Division
Office of Health and Environmental
Research, Office of Energy Research

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439

November 20, 1984

Dr. Sanford Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, VA 22102

Dear Dr. Cohen:

The NRC has recently published NUREG/CR-3971, "A Handbook for Cost Estimating." The publication of this report marks the successful completion of the project to which you were a major contributor. As you are aware, this project was established amid some skepticism by our NRC sponsors that any useful tool could be developed to assist the NRC analyst in the complex task of estimating the national cost of generic requirements. Prior to publication, this report was reviewed extensively within the NRC and was submitted to outside peer review by the Atomic Industrial Forum. The comments received from the reviewers were very complimentary in terms of the technical content and usefulness of the methods presented in the report.

The success of this project was due, in large part, to your efforts in helping to develop the cost model and in characterizing the functional responses for the model and to your sound professional judgment which helped keep the project scope within bounds. Your contributions to the presentations which we made to the sponsors over the course of the project were instrumental in maintaining strong and effective communication with the sponsors. I want to commend you for the quality of your contribution to this project and for your willingness to contribute to activities that went beyond the scope of your contract.

I look forward to working with you again.

Sincerely,

John Ball

John R. Ball
Project Manager,
Special Projects and
Industrial Applications Group
Energy & Environmental Systems Division

JRB/jc

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 3 1983

Mr. Sanford Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, Virginia 22102

Dear Sandy:

I would like to take this opportunity to thank you for your high-quality performance on the occupational exposure study. Your company's energy and enthusiasm for gathering the appropriate information and performing the required tasks has made this a very thorough study, as evidenced by your well-written reports. Your responsiveness to our needs during the course of the project created a cordial and productive atmosphere within which to conduct this study. It was a pleasure working with you.

Sincerely,

Andrew J. Leiter

GA Technologies

GA Technologies Inc.
P.O. BOX 81608
SAN DIEGO, CALIFORNIA 92138
(619) 455-3000

February 17, 1983

Mr. Sanford Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, VA 22102

Dear Sandy:

GA Technologies Inc. has been very pleased with the consulting work that you have done for us over the last year and a half. We have found your counsel to be informed, accurate, and most helpful to us in both the preparation of proposals and in contract performance. We particularly appreciate your attention to schedules and your innovativeness.

We look forward to a long and mutually beneficial association with SC&A Associates.

Sincerely yours,

John

John C. Peak
Director,
Program and Product Development

JCP:phs

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DEC 17 1986

Dr. Sandy Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, VA 22102

Dear Dr. Cohen:

I want to thank you, and all those who participated on behalf of SC&A, for your effective contribution to the Cost and Statistical Analysis Staff (CSAS) of the U.S. Nuclear Regulatory Commission (NRC).

In late 1983, at the direct urging of the Commission, the Cost Group was established to provide overall direction and oversight to cost analysis issues associated with regulatory impact analyses (RIA). As you are aware, the development of RIA's in support of regulatory requirements has become an increasingly important and highly visible activity within the NRC.

Through your contributions, the CSAS has instituted a generic cost estimating methodology that enables the NRC to generate meaningful cost estimates in a highly efficient manner. Your efforts with respect to specific regulatory requirements have also resulted in high quality products that have played an important role in NRC's decision making process. Your commitment to this contract, your innovative and intelligent approach to each of the tasks assigned, and your responsiveness to NRC needs, oftentime in the face of very tight scheduling requirements, are all greatly appreciated.

Sincerely,

Sidney Feld

Sidney E. Feld, Chief
Cost and Statistical Analysis Staff
Division of Budget and Analysis
Office of Resource Management

EDISON ELECTRIC INSTITUTE The association of electric companies

1111 19th Street, N.W.
Washington, D.C. 20036
Tel. (202) 828-7400

February 23, 1983

Mr. Sanford Cohen
S. Cohen and Associates, Incorporated
8200 Riding Ridge Place
McLean, Virginia 22102

Dear Sandy:

In response to your letter of January 11, 1983, I would like to thank you for all the excellent work you have done in the past for the EEI Electrical System & Equipment Committee.

In our involvement with committee work, it is important to find people who are industrious, intelligent, creative and pleasant to work with. You have always lived up to these qualities and have always "gone the extra mile."

I hope we will have the opportunity to work together again in the near future.

Sincerely,

Jamei

Jamei C. Goellner
Engineering Department

JCG/lp

EPRI

Electric Power
Research Institute

8 January, 1987

Mr. Sanford Cohen
S. Cohen and Associaties, Inc.
8200 Riding Ridge Place
McLean, Virginia 22102

SUBJECT: EFFORTS BY STUART K. BEAL ON EPRI PROJECT RP 2160-8

Dear Mr. Cohen:

EPRI takes this opportunity to thank you and Mr. Stuart K. Beal for Stu's outstanding performance on EPRI project RP 2160-8.

The final report, "A Model of Sludge Behavior in Nuclear Plant Steam Generators," EPRI NP-4620, provides a new mathematical model with important insights into the processes by which large amounts of sludge accumulate on the tubesheets of PWR steam generators. The creative and resourceful approaches used by Stu to identify, model, and analyze this complex subject is most appreciated. Again, thank you for the fine work by Stu Beal.

Sincerely,

C. Lamar Williams

C. Lamar Williams, Project Manager
Steam Generator Project Office

CLW:vrt99

cc: Stuart K. Beal

Atomic Industrial Forum, Inc.
7101 Wisconsin Avenue
Bethesda, MD 20814-4805
Telephone (301) 654-9260
TWX 7108249602 ATOMIC FOR DC

A. Scott Leiper
Project Manager

National
Environmental
Studies
Project

May 28, 1987

To: NESP Task Force on "Dose Estimating Software"
Subject: May 19 meeting results

The Task Force met on May 19 at the Gaithersburg office of Bechtel Power Corporation for a demonstration of the software designed by SC&A. Both Sandy Cohen and Don Loomis, the programmer, were present. A list of the Task Force members who attended the meeting is enclosed.

Those present seemed to find the software well designed and user-friendly. A few minor changes were suggested in order to make the package more adaptable to the end-user.

Questions did arise concerning legal implications and response to inquiries regarding the software. These matters are still being discussed.

After the modifications proposed at the meeting have been made, the software will go through a final field testing at a utility which has a representative on our Technical Advisory Group (TAG). This final test and review will serve as TAG approval for publication.

The projected time for publication as a NESP report is early August. It will consist of a user's manual and both a compiled and uncompiled version of the program. We plan to distribute the report in a three-ringed binder in order to accommodate the plastic diskette sleeves and to allow the user to add his own notes to the manual.

SC&A has done another really first rate job for us and we are all looking forward to the completion of this important and useful project.

Please call if you have any questions or concerns.

Sincerely,

Scott

ASL:pmm
Enclosure

cc: Sandy Cohen

Congress of the United States
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

JOHN H. GIBBONS
DIRECTOR

January 19, 1983

Mr. Sanford Cohen
SC&A, Inc.
8200 Riding Ridge Place
McLean, Virginia 22102

Dear Mr. Cohen:

We have now received the final report of your study for us on nuclear reactor regulation. The report clearly reflects a commitment to quality and thoughtfulness all too rare in contractor reports. Your effort has made a significant contribution to our project and will help raise the level of debate on regulatory reform. It is especially noteworthy that this report was produced within the original schedule and budget. Your presentations at the workshop were also quite effective.

I look forward to working with you again in the future.

Sincerely,

Alan T. Crane
Project Director

APPENDIX D

OVERVIEW OF THE METHODS USED TO CHARACTERIZE RADIONUCLIDES IN NUCLEAR POWER PLANT Low-level WASTE

OVERVIEW OF THE METHODS USED TO CHARACTERIZE RADIONUCLIDES IN NUCLEAR POWER PLANT LOW-LEVEL WASTE

1.0 STANDARD PROCEDURES FOR CHARACTERIZING WASTE

The Nuclear Regulatory Commission regulates the possession, transfer, and disposal of licensed byproduct, source and special nuclear material. Regulations pertaining to these activities are contained in 10 CFR 61 "Licensing Requirements for Land Disposal of Radioactive Waste", and 10 CFR 71 "Packaging and Transportation of Radioactive Material". Additionally, the Department of Transportation (DOT) regulates shippers and carriers of hazardous materials in interstate and foreign commerce. Applicable DOT regulations are contained in 49 CFR 173 "Shippers - General Requirements for Shipments and Packaging".

In compliance with Federal regulations, it is the responsibility of each waste generating licensed facility to provide documentation which characterizes radioactive waste shipments destined for one of the three land disposal sites. Regulations require that specific activity (or total radionuclides) in the waste be identified. Because of time and cost factors, not all waste is subject to detailed isotopic analysis. Therefore, the specific activities and isotopic profiles of wastes such as evaporator bottoms, resins, filters, sludge, and other routine materials are determined by analysis of "representative samples". Knowing the specific activity of each radionuclide present and the total volume of a particular, the total activity is calculated as follows:

$$T.A. = V (SAa + SAb + SAc)$$

Where: TA is total activity in shipping container
V is the volume of container
SAa,b,c is specific activity of nuclide a, b, c, respectively

When repeated shipments of the similar waste material are packaged in identically shaped and sized containers (i.e. drums, LSA boxes), specific activity and radionuclide content is inferred by averaging multiple air dose rate readings at fixed distance(s) from the container. Standard practice among utilities is to take six readings at a prescribed distance from the surface of standard waste shipping containers with a calibrated dose rate instruments (standard instruments include Eberline Model RO-2 and Eberline Model E520). Approved computer codes such as ISOSHLD are used to calculate conversion factors which convert air dose rate readings to total curie content of a shipping container. Input parameters for computer generated conversion factors include geometry, shielding and radionuclide data.

The computer generated conversion factor K represents the following ratio:

$$K = TA/DR$$

Where: K is the conversion factor

TA is the total activity calculated from the specific activities derived from the isotopic analysis

DR is the average dose rate at a specific distance from container

For a given waste stream, isotopic analysis must be conducted periodically to ensure that isotopic ratios remain relatively constant. Only when the relative abundance of radionuclides remain constant does K remain constant.

The conversion factor can then be used to calculate total activity for shipments of the same material/container using only measured dose rate as follows:

$$TA = K (DR)$$

In accordance with regulations, each waste shipment is accompanied with a Notification and Manifest Form which includes a complete isotopic analysis. The analysis must identify the following:

- radionuclides present
- percent abundance of each radionuclide
- total curie content
- specific activity of each radionuclide including transuranics
- explanation of how the radionuclides are distributed in the medium

A considerable database exists which provides waste generation data for each utility inclusive of waste characterization data as defined by the Radioactive Waste Shipment Prior Notification and Manifest Form.

2.0 IDENTIFICATION OF LOW-LEVEL WASTE FOR BRC CONSIDERATION

A comprehensive effort has been made in recent years to provide data in support of rulemaking petitions to NRC which would exempt specific low-level waste streams from burial at licensed facilities. In 1987, EPRI initiated a major effort to develop technical basis for rulemaking petitions which would embrace the NRC policy statement that actual radionuclide concentration and variabilities should be characterized for each BRC waste stream. In 1988, EPRI published three comprehensive reports:

1. EPRI NP-5670, "Below Regulatory Concern: Evaluation of Candidate Waste Streams", 1988.

2. EPRI NP-5671, "Below Regulatory Concern: Radionuclides Prioritization Study", 1988.

3. EPRI NP-5672, "Selection of Plants for Sampling Program", 1988.

The first report identified and characterized BWR and PWR waste streams and established a ranking system for each waste stream by means of weighted selection criteria. EPRI's objective was to identify eight waste streams (four BWR and four PWR) for potential inclusion in the BRC program.

The second report evaluated the relative importance of each of the major radionuclides expected in BRC waste streams relative to BRC dose impact assessments. Dose assessment computations were performed for on-site and off-site landfill or incineration conditions using the NRC IMPACTS - BRC Computer Code. Calculations determined the inventory of each nuclide that could result in a dose of one mrem per year to the maximum exposed individual. The relative importance of BRC radionuclides was established by means of a ranking system which incorporated the following two elements:

1. limiting inventory - the amount of each radionuclide in the assumed waste stream that is calculated to result in a one mrem per year individual dose by the limiting pathway

2. relative abundance - the expected quantity or abundance of a particular nuclide relative to other nuclide(s).

The third report evaluated the relationship of fuel performance to various radionuclide ratios found in waste streams. It was found that because of similar chemical and physical properties, plutonium and cobalt generally track each other well regardless of the waste streams as assessed by 10 CFR 61 data. The relatively stable ratio of cobalt to plutonium provides a suitable means of assessing the content of plutonium (and other non-gamma emitting transuranic elements) in waste streams. This was not found to be the case for cesium/plutonium ratios which exhibited highly variable ratios.

Candidate BRC waste streams may contain a spectrum of radionuclides which are (1) activation products from corrosion and chemical additives in the cooling water and (2) fission and activation products originating from fuel including tramp uranium. Owing to their chemical/physical properties and relative abundance about twenty-five radionuclides have been identified for consideration in potential BRC waste streams as identified in Table D-1 (NUREG/CR-1759, Vol. 3; NUREG/CR-0784, Vol. 2; EPRI NP-4037).

Analysis has shown that these twenty-five major nuclides are commonly found in low-level waste streams of nuclear power plants. Table D-1 reveals that several radionuclides are gamma emitters which are readily identified and quantified by standard gamma detection equipment. Also included are radionuclides with principal emissions of alpha and beta particles. In terms of radionuclide analysis of waste streams, these nuclides are considered difficult-to-measure (DTM) and require tedious and

TABLE D-1

RADIONUCLIDES IN CANDIDATE BRC WASTE STREAMS

Nuclide	Half-life	Principal Emission	*Abundance Relative to CO-60
H-3	12.26 yr	beta	1.19E-02
C-14	5730.00 yr	beta	1.09E-02
Fe-55	2.60 yr	X-ray	1.55
Co-60	5.26 yr	gamma	1.0
Ni-59	8.0E4 yr	X-ray	
Ni-63	92.00 yr	beta	3.67E-01
Sr-90	27.70 yr	beta	5.11E-03
Nb-94	2.0E4 yr	beta/gamma	
Tc-99	2.12E5 yr	beta	3.75E-04
I-129	1.7E7 yr	beta	1.19E-04
Cs-134	2.05 yr	gamma/beta	
Cs-137	30.00 yr	gamma	3.60E-01
Ce-144	284 d	beta	8.17E-02
U-235	7.1E8 yr	alpha	
U-238	4.51E9 yr	alpha	
Np-237	2.14E6 yr	alpha	
Pu-238	86.4 yr	alpha	1.09E-04
Pu-239	24,390 yr	alpha	1.02E-04
Pu-240	6,580 yr	alpha	
Pu-241	13.20 yr	beta	1.43E-02
Pu-242	3.79E5 yr	alpha	
Am-241	4.58 yr	alpha	5.56E-05
Am-243	7,950 yr	alpha	
Cm-242	162.5 d	alpha	1.09E-04
Cm-243	32.00 yr	alpha	
Cm-244	17.60 yr	alpha	5.56E-C5

* Based on data for all waste streams reported in EPRI Report 5077, "Updated Scaling Factors in Low-Level Radwaste", March 1987.

costly radiochemical separations and counting techniques.

Radionuclide correlation methods are presently utilized by utilities to estimate the activities of DTM radionuclides defined in 10 CFR 61. As was previously described, this is usually accomplished by performing comprehensive sampling and radiochemical analyses of waste streams to provide reasonably valid correlation factors for those radionuclides not identifiable and/or measurable by gamma responsive instrumentation. Once adequate correlation factors have been established relative to some easily measurable gamma emitting radionuclide (i.e. Co-60, Cs-137/134, Ce-144), the DTM radionuclides can be estimated in representative waste stream samples for future nuclide concentration determination.

Attempts have been made to define generic BWR and PWR radionuclide correlation factors. Relative radionuclide concentrations as residual contamination within primary system piping/hardware of six power plants were compared to radionuclides cited on the manifest for LLW shipments (NUREG/CR-4289, "Residual Radionuclide Contamination Within and Around Commercial Nuclear Power Plants", 1986). However, typical waste streams of resin, sludge, evaporator bottoms, or DAW demonstrated that relative radionuclide concentrations were highly variable. The best correlation observed was the 239-240Pu/60Co ratio which gave an average value and associated standard deviation of 8.3 +/- 6.8 x 10-5. Correlation values for 241Am/60Co and 244Cm/60Co were 15 +/- 15 x 10-5 and 9.0 +/- 9.3 x 10-5, respectively. Thus, the transuranic radionuclide concentrations could be estimated to within about one order of magnitude from the 60Co concentration.

Other radionuclide ratios which showed variability within an order of magnitude included 55Fe/60Co and 63Ni/60Co. Extremely poor Co-60 correlation ratios were found for Cs-137, Tc-99, Nb-94 and I-129.

When Cs-137 was used as the reference radionuclide, only strontium showed a correlation ratio which varied within one order of magnitude (Sr/Cs = 0.16 +/- 0.16). Factors which contribute to radionuclide variability among plants include:

1. elemental composition and purity of materials used in construction of reactor systems

2. general design of the primary and secondary system

3. fuel integrity

4. reactor power level and length of operation

5. operational parameters including water chemistry, corrosion control and radwaste management

In summary, radionuclide correlation variability is high for:

1. various waste streams in a single plant

2. a specific waste stream among plants

It becomes obvious therefore that any hope of accurately assessing radionuclide concentrations in LLW must rely on comprehensive sampling and radiochemical analysis of each waste stream. Furthermore, this must be done separately for each utility.

3.0 STANDARD ANALYTICAL PROCEDURES

Radionuclide analysis for representative waste stream samples from which nuclide correlation values are extracted involve direct gamma-ray spectrometry and a combination of radiochemical analyses for non-gamma-ray emitting radionuclides. These standard analytical procedures are described below.

3.1 Spectrometric Analysis

Using solid state detectors (GeLi or intrinsic germanium), samples are counted for sufficient time intervals to gain sufficient statistical confidence in identifying representative energy peaks of suspected radionuclides. Using NBS traceable calibrated radionuclide mixtures prepared in counting geometries identical to samples, computer assisted gamma spectrometry is able to yield the identity and quantity of radionuclides in an unknown sample. Quantitative results incorporate compton decay and volumetric correction and identify the associated percent error in activity values expressed in pCi/g of sample. Table D-2 identifies those radionuclides from Table 1 which are determined by gamma-ray spectroscopy.

TABLE D-2

Radionuclides Determined by Gamma-ray Spectrometry

Radionuclide	Half-life (years)	Gamma-ray (Kev)	Gamma/Dis.	Alt. Gamma-ray	Alt. Gamma/Dis.
Co-60	5.27	1173	0.999	1332	1.0
Cs-134	2.06	796	0.890	605	0.98

Cs-137	30.1	662	0.846
Ce-144	0.78	134	0.108
Am-241	433.0	60	0.353

3.2 Radiochemical Analysis

For most non-gamma or DTM radionuclides, radiochemical separation followed by measurement of either beta, alpha or X-ray is necessary. Chemical separation at low radionuclide concentration is generally required for Fe-55, Ni-59, Ni-63, Tc-99, I-129, Pu-238, Pu-239, Pu-240, Am-241, Cm-242, Cm-243, Cm-244. In order to obtain accurate quantitative information on chemical yield, isotopes of the element are generally used. Table D-3 identifies DTM radionuclides, the yield tracer utilized, the detection method(s) employed and the specific emission with its corresponding energy. Following radiochemical purification, the isolated radionuclide is analyzed by the appropriate detection system which may include liquid scintillation counters, gas proportional detectors, intrinsic germanium detectors optimized for low-energy photons, or surface barrier alpha energy detectors.

TABLE D-3

Radionuclides Determined After Radiochemical Separations

Radionuclide	Yield/Tracer	Detection Method	Type	Energy
H-3		Liquid Scintillation	beta	18.6 Kev
C-14		Gas Proportional Counter	beta	0.2 Mev
Fe-55	Stable Fe	Intrinsic Ge Detector	Mn X-ray	5.9 Kev
Ni-59	Stable Ni or Ni-65	Intrinsic Ge Detector	Co X-ray	6.9 Kev
Ni-63	Stable Ni or Ni-65	AC. Shielded Gas Proportional Counter	beta	0.07 Kev
Sr-90	Sr-85	Gas Proportional Counter	beta	0.5 Mev
Tc-99	Tc-99m	Gas Proportional Counter	beta	0.3 Mev
I-129	I-131	Intrinsic Ge Detector	Xe X-ray	0.3 Mev
U-235		Alpha Energy Spectrometer	alpha	4.4 Mev
U-238		Alpha Energy Spectrometer	alpha	4.2 Mev
Np-237	Np-239	Alpha Energy Spectrometer	alpha	4.78 Mev
Pu-238	Pu-242	Alpha Energy Spectrometer	alpha	5.5 Mev
Pu-239	Pu-242	Alpha Energy Spectrometer	alpha	5.16 Mev
Pu-240	Pu-242	Alpha Energy Spectrometer	alpha	5.17 Mev
Pu-241	Pu-242	AC. Shielded Gas Proportional Counter	beta	21.0 Kev
Pu-242		Alpha Energy Spectrometer	alpha	4.9 Mev

Am-241	Am-243	Alpha Energy Spectrometer	alpha	5.49 Mev
Am-243		Alpha Energy Spectrometer	alpha	5.28 Mev
Cm-242	Am-243	Alpha Energy Spectrometer	alpha	6.1 Mev
Cm-243	Am-243	Alpha Energy Spectrometer	alpha	5.79 Mev
Cm-244	Am-243	Alpha Energy Spectrometer	alpha	5.8 Mev

4.0 LIMITATIONS AND ERRORS ASSOCIATED WITH RADIONUCLIDE ESTIMATES IN BRC WASTE STREAMS

The likelihood of granting BRC classification to specific low-level waste streams is intimately tied to the level of accuracy with which the specific activity of each radionuclide can be assessed. From the foregoing discussion, there may be too high a variability among utilities and/or waste streams for generic radionuclide correlations to provide accurate data. However, even when radionuclide correlation values are determined at each utility and for every BRC candidate waste stream through a comprehensive sampling and analysis program, quantitative accuracy may still represent a serious handicap to BRC. Since the purpose of exempting BRC waste from regulatory requirements is principally motivated by economics, establishing acceptable levels of accuracy in radionuclide characterization of BRC waste must equally take cost factors into consideration. Improved accuracy (at increasing costs) are achieved by more frequent sampling of waste streams and decreasing the lower limits of detection (LLD) for radionuclides by sophistication of radiochemical separation techniques and length of counting times. This implies that the overall cost(s) of assessing low-level waste as BRC waste, should not exceed the cost of conventional low-level waste disposal.

Errors of uncertainty associated with BRC waste characterization can be broadly grouped into two discrete categories. The first involves errors pertaining to radionuclide correlation values obtained through periodic sampling and analysis of waste streams. The second involves errors associated with the techniques of qualifying low-level waste as BRC waste.

Radionuclide correlations must be defined in terms of their standard error. The standard error is influenced by (1) the level of variability of radionuclide concentrations in a specific waste stream with regard to time and space, (2) the frequency and number of samples used, (3) the specificity of radiochemical separation techniques and their respective recovery yields, and (4) the lower limit of detection (LLD) for a given radionuclide relative to its concentration in the waste sample.

The LLD is a statistical value which for a specific set of conditions defines the smallest amount of sample activity that can be detected on a routine basis. LLD values can be reduced by minimizing background count rates and increasing counting intervals. Mathematically the LLD is expressed as:

LLD = MDA + kC sD

Where: MDA is the minimum detectable activity which represents some multiple of the standard deviation of the "zero net counting rate" or background.

kC is the pre-selected confidence factor for concluding that the nuclide activity is present in a sample.

sD is the standard deviation of the net counting rate which is equal to the LLD.

Assessment of Low-Level Waste for non-licensed disposal must be both practical and cost-effective. For most utilities, this involves taking multiple air dose measurements of low-level waste packaged in standard containers at specified distances. Standard portable air dose instruments include the Eberline RO-2 and E-520 models which are calibrated to Cs-137 sources. Calibration requires that instruments do not exceed +/- 15% to 20% of true dose rates for mid-scale readings. The percent error increases significantly for readings approaching the lower or upper end of the scale. The air dose rate measurement when converted to total curie content through manual or computer code calculation is subject to additional errors. Errors are those involving waste aggregate geometrical shape, package dimension, density of waste and degree of homogeneity with regard to the distribution of activity in waste.

5.0 SUMMARY AND CONCLUSION

A review of the current practices used by utilities for the characterization of low-level waste reveals that the methods may have some accuracy and precision limitations with regard to their use for characterizing candidate BRC waste streams BRC. For some non-gamma emitting radionuclides, it is likely that manifest reported activities may be in error by over an order of magnitude. This has potential cost implications that will need to be addressed as part of a BRC rulemaking.

SC&A, INC.

S. COHEN AND ASSOCIATES

April 27, 1990

U.S. Nuclear Regulatory Commission
Division of Contracts and Property Management
10th Floor, Room 1012
7920 Norfolk Avenue
Bethesda, Maryland 20814

Re: Best and Final Offer and Response to NRC Questions regarding Request for Proposal No. RS-RES-89-052, "Generic Deregulation of Below Regulatory Concern Radioactive Waste"

Dear Ms. Wiggins:

S. Cohen & Associates, Inc. (SC&A) is pleased to submit to the NRC the original and 5 copies of our Best and Final Offer and Response to NRC Questions regarding Request for Proposal No. RS-RES-89-052, "Generic Deregulation of Below Regulatory Concern Radioactive Waste." In addition, in accordance with your instructions at our April 9th meeting, a copy of our Best and Final Offer has also been sent to our DCAA auditor. Except for out mailing address, which has changed since the preparation of our original submittal, our Representations and Certifications remain unchanged. Accordingly, is was not considered necessary to revise our Solicitation Package as part of this Best and Final Offer.

Very truly yours,

John J. Mauro, PhD CHP
Vice President

1311 DOLLEY MADISON BOULEVARD McLEAN, VIRGINIA 22101 (703) 893-6592