ATTACHMENT 3

TO P-91138

FSV INITIAL RADIOLOGICAL SITE CHARACTERIZATION PROGRAM REVISION 2 (NON-PROPRIETARY)

FORT ST. VRAIN NUCLEAR GENERATING STATION

INITIAL RADIOLOGICAL SITE CHARACTERIZATION PROGRAM FSV-P-SCP-100

PROGRAM DESCRIPTION

May 10, 1991

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1.0 INTRODUCTION

1.1 Purpose

The purpose of the Initial Site Characterization Program (SCP) is to collect and analyze radiological survey data needed to determine the extent of decontamination/dismantlement activities at the Fort St. Vrain (FSV) facility. This will be accomplished by providing radiological data that indicates whether FSV equipment, systems and structures have become internally or externally contaminated and/or activated. This data will be used to verify and supplement information provided by Public Service Company of Colorado (PSC), (Request For Proposal dated December 8, 1989, Reference 7.1). This data will also serve as the baseline radiological information for future reference during the decommissioning project.

The SCP defines the methodologies that will be used to radiologically characterize structures and systems at FSV. The program defines the information needed to accurately characterize the FSV facility. This data will be obtained for the purposes of project planning, cost estimation, evaluation and verification of historical data, and to determine the decontamination, dismantling and sequencing techniques necessary for effective plant decommissioning. The information generated from the SCP will be compared against the established regulatory criteria for site release. Using this criteria, Westinghouse will be able to determine the extent of decontamination/dismantlement activities.

1.2 Scope

The SCP addresses the use of FSV historical radiological information, methods for selection of sample locations, methods for analyzing data, requirements for documentation and quality assurance.

This program will be used by PSC and Westinghouse for completing the FSV facility decommissioning. The scope of this program is limited to the radiological characterization of the site structures and buildings, balance of plant (BOP) systems and equipment, the prestressed concrete reactor vessel (PCRV) and internal parts. The determination of whether site materials are suitable for unrestricted release is beyond the scope of the site characterization program and will be addressed in the final radiation survey program. The SCP divides the FSV structures and systems into four (4) major elements which are:

[ ] a,c

[a,c]

1.3 Organization and Responsibilities

The SCP will combine the efforts and expertise of various personnel to ensure that all facets of the program are properly implemented. The SCP Organization will provide the sound technical guidance to ensure that the characterization program is effectively implemented. The SCP organizational structure is shown in Appendix A.

Responsibilities of the SCP organization members are as follows:

- The Westinghouse Project Director (WPD) is responsible for overall project management.
- The Westinghouse Technical Services Manager is responsible for administrative project support and management and reports to the WPD.
- The Scientific Ecology Group (SEG) Project Director is responsible for overall technical direction and management of the radiological site characterization operations.
- The Scientific Ecology Group SCP Manager is responsible for implementation of the radiological site characterization operations and reports to the SEG Project Director. This position will assume the authorities and responsibilities of Project Radiation Protection Manager during the decommissioning project.

The SCP Manager will interface with FSV health physics, maintenance and operations staff. This interface will ensure all characterization activities are planned, coordinated and scheduled in conjunction with normal FSV operations. The SCP Manager responsibilities include:

- Managing and planning characterization activities.
- Supervising the site characterization staff.
- Performing evaluations for report preparation.

- Coordinating the preparation of the initial site characterization report.

The site characterization staff will have the primary responsibility for implementing the SCP procedures, performing surveillance and documenting the characterization results.

1.4 SCP Management Oversight and Controls

The SCP management organization will provide direction and oversight to personnel performing site characterization activities. Some specific management oversight and controls that will be used include:

- Personnel will meet the applicable training and qualifications as described in the SEG QAP-107, "Quality Plan, Initial Radiological Site Characterization FSV/PSC" (Reference 7.6).

- Onsite gamma isotopic analysis of characterization samples will be performed in accordance with FSV radiochemistry procedures.

- Specific SEG site characterization implementing procedures will be provided for each major site element to be characterized (structural, BOP system and equipment, PCRV and environmental).

- Instruments used to perform radiological characterization surveys will be calibrated, operated and maintained in accordance with approved SEG site characterization procedures.

- Characterization sample locations will be identified in the specific work packages for each area being characterized.

- FSV maintenance procedures will be used when characterization activities require system isolation or entry. Station Service Requests (SSRs) will be generated when applicable.

The quality assurance responsibilities for the SCP are as follows:

- The SEG Quality Assurance Manager is responsible for performing surveillance and auditing of the site characterization activities.

- The Westinghouse Nuclear and Advanced Technology Division (NATD) Quality Assurance Manager is responsible for surveillance of SEG quality assurance.

- PSC quality assurance personnel will conduct oversight of the Westinghouse quality assurance surveillance and auditing functions through the PSC Quality Assurance (PSC QA) monitoring program. In addition to monitoring of Westinghouse QA activities, PSC QA may perform monitoring of physical site characterization work.

The interface between SEG QA, NATD QA and PSC QA is described in FSV-QA-001, "FSV Quality Assurance Interfaces" (Reference 7.7).

2.0 GENERAL SITE INFORMATION

2.1 FSV Site Description

FSV is owned by Public Service Company of Colorado. PSC was licensed by the Nuclear Regulatory Commission to operate the 330 MWE High Temperature Gas-Cooled Reactor (HTGR). Commercial operation began in July 1979, and ended in August 1989.

FSV is located approximately thirty-five miles north of Denver and three and one-half (3 1/2) miles northwest of the town of Platteville in Weld County, Colorado. PSC owns the 2798 acre site and has designated a distance of 100 meters from the reactor building as the exclusion area boundary.

2.2 Historical Radiological Information

Historical information regarding the pre-operational and operational phases of FSV will be made available by PSC to assist in establishing the radiological status of the facility. These documents are controlled and stored at the FSV records center.

The historical files will provide the operational information necessary to assist in site characterization efforts and aid in determining the radiological status of the facility. This information will be reviewed and used to determine the most appropriate methods for performing site characterization activities.

A review of FSV operational history will be performed, as appropriate, to determine the radiological status of FSV structures and systems. The results of this review will be applied in determining the location for radiological measurements.

The types of documentation that will be reviewed include:

[a,c]

A preliminary review of site radiological data has identified the following site structures as having a potential to be radioactively contaminated. These structures are:

- Reactor Building
- Turbine Building
- Radiochemistry Laboratory
- Helium Storage Building
- Waste Compacting Building
- New Fuel Storage Building

3.0 SAMPLING METHODOLOGY

3.1 General Considerations

This section of the SCP describes the methods that will be used to determine the current radiological status of FSV structures, equipment and systems, reactor components, and the immediate site environment. This data will be used in conjunction with PSC site characterization records and FSV historical information to verify the facility radiological status, as presented in the PSC proposed decommissioning plan.

The SCP will utilize both unbiased and biased characterization schemes to obtain radiological data. Both methods (unbiased and biased) will employ the same analytical techniques for determining radioactive concentrations and radiation levels.

Work packages will be developed to describe the characterization requirements for specific FSV structures and systems. Work packages will be implemented in accordance with approved SEG implementing procedures. Work packages will typically include details such as; type of survey (biased or unbiased), number of sample locations, radiological history, type of instrumentation to be used, and if applicable, maps and diagrams needed to identify sample locations. Work packages will be approved by the SCP Manager or designee.

3.2 [a,c]

a,c

[a,c]

3.3 Biased Survey Method

The biased survey method will be used to assess structures and systems which are known or potentially contaminated. PSC site characterization records, FSV historical information, and SEG unbiased survey data will be used to determine if, and how, biased survey techniques will be employed. Areas will be selected based on the potential for deposition of radioactive material (e.g., crud traps). Heavily traveled areas, horizontal surfaces and surfaces under known contaminated systems will be included as part of the biased survey method (e.g., pipe or pump leakage, floor drains, sumps, etc.).

This method of surveillance will define the radioactivity levels in areas where there is a high probability of contamination. Biased sample locations will be selected to ensure that the radiological characterization is adequate to define known or suspected contaminated areas throughout the facility. In addition, survey locations found to be contaminated using the unbiased method will be resurveyed using this biased method.

Biased survey locations will also be divided into Survey Areas and Survey Units in the same manner as the unbiased survey method. However, when necessary these areas will be divided into smaller divisions than the unbiased survey areas.

3.4 Radiological Survey Methods

Measurements will be performed in accordance with the SEG site characterization procedures and will meet applicable standards provided by industry guidance documents. Radiological measurements will be performed by qualified personnel using calibrated portable survey instruments. Instrumentation used for characterization surveys will be calibrated in accordance with approved SEG implementing procedures. Sources used for instrument calibration will be traceable to the National Institute for Standards and Technology (NIST).

Radiological measurements taken at a sample location will normally be as follows:

[ ] a,c

Bulk sampling of various materials such as insulation, concrete, paint chips and sediment deposits will be analyzed for gamma isotopic content on a case-by-case basis. The analysis of bulk samples will be performed by qualified personnel or vendors using calibrated equipment.

The requirement for performing specific radiation measurements will be evaluated by the SCP Manager or designee. If it is determined that a radiation measurement is not appropriate, the SCP Manager or designee may modify the requirements. Sufficient radiological data will be provided in the work package, to support modifications of radiological measurements.

3.4.1 Removable Surface Contamination Determinations

Smear samples will be taken at all selected sampling locations. All smear samples will be analyzed for

[ ] a,c

All smears collected in the New Fuel Storage Building will be counted for gross alpha activity.

3.4.2 Total Surface Contamination Determinations

Total surface contamination (fixed and removable) will be measured at each sample location. The type of equipment and detectors will be defined in approved SEG implementing procedures and the work packages for the specific types of characterization. Direct beta/gamma measurements will be made at approximately one cm from the surface of interest. Direct alpha measurements will be made as close to the monitoring surface as possible, when applicable.

If a Geiger-Mueller (GM) type detector is used, it will be a thin-window (less than 7 mg/cm^2) pancake type detector. Alternate detectors may be used when access constraints preclude the use of the pancake detectors and will be defined in the work packages. The count rate obtained will be corrected for background, geometry, detector area and efficiency to yield measured results in dpm/100 cm^2.

In situations where surface contamination is found and there is a likelihood of deposition below the surface, (i.e., a porous surface), it will be necessary to determine the depth of the contamination. This task will be performed by core sampling or other appropriate methods. Sampling activities of this nature will be performed in accordance with applicable FSV station procedures.

3.5 Data Collection

Radiological data will be collected by a team of qualified characterization specialists working to approved work packages and procedures. This team will receive day-to-day directions from the SCP Manager or designee.

Radiological survey records will provide traceability and are the primary method for documenting the current radiological status of FSV structures and systems. Characterization data will be collected and compiled to provide a basis for decisions regarding the scope and methods for decommissioning and dismantling of the FSV facility. In addition, the SCP data will provide initial information to plan and schedule decommissioning activities.

To accurately characterize the FSV facility, SCP personnel will use industry standard survey techniques and instrumentation to measure radiation levels and radioactivity concentrations. The various survey methods will result in measurement and documentation of some, or all of the following:

- The type of equipment and instrumentation used to survey the facility and analyze samples collected.

- The amount of fixed and removable gross beta/gamma and alpha surface contamination.
- The isotopic distribution of gamma emitting nuclides.
- Surface radiation exposure rates.

The radiological data collected during SCP will be recorded to provide specific information and identification of the FSV structures and systems. This information will typically include:

- Area locations and surface activity levels of the FSV structures and systems.
- Depth and estimated activity levels of contaminant penetration into surfaces, when applicable.
- Location and activity levels, if any, of the radioactive materials in soil.
- Location and estimated activity levels in accessible systems and equipment.
- Activity levels induced by activation in the PCRV and associated components, as they become available.

This data will also be used to verify the radiological status of the FSV facility as described in the proposed decommissioning plan. Based on the characterization results, structures and systems will be segregated by level of radioactive contamination. These are as follows:

[ ] a,c

[Structures and systems with results in] a,c

[Structures and systems with results] a,c

[Structures and systems with results in

during the decommissioning project.] a,c

4.0 CHARACTERIZATION SCHEME

[This section is divided into four subsections:

Each subsection describes the means of obtaining the required data and a rationale for the approach to be taken.] a,c

4.1 [ ] a,c

[a,c]

4.2 [a,c

] a,c

[ ] a,c

a,c

4.3

a,c

4.4

Environmental media to be collected during the SCP includes soil, sediment, surface water and ground water samples. The Radiological Environmental Monitoring Reports

(REMP) for 1988 and 1989, the first and second quarter 1990 REMP Tables (Reference 7.8), and a report dated February 26, 1990, from Industrial Compliance, Inc. (Reference 7.9) evaluating the results of samples collected from 13 ponds associated with FSV, were all reviewed as a prelude to determining the types and location of specific samples. The following conclusions were contained in these reports:

1) Gross beta concentrations in the Gilcrest Well have routinely been greater than the reference supply in Fort Collins, Colorado. However, this difference cannot be due to reactor effluent activity for the following reasons:

- None of the individual fission or activation product radionuclides measured were significantly higher in the Gilcrest drinking water.

- Tritium concentrations measured at Gilcrest were only slightly statistically greater than those at Fort Collins.

- The city of Gilcrest does not treat its water to the same degree as Fort Collins. Gross beta concentrations are due to the elevated concentration of the naturally occurring U-238 and Th-232 decay products in the suspended solids.

2) Elevated concentrations of tritium have been routinely detected in the outlet of the Farm Pond which correlates well with release schedules of blowdown effluent from FSV.

3) I-131 has been detected in milk and ditch surface water. Neither the milk or the water contains any other fission products. This indicates a source other than FSV. The source of the I-131 was determined to be due to nuclear medicine use and release upstream of the sample point.

4) There is no evidence that the two onsite ground water wells (REMP location 251 and 1352) have been contaminated.

5) Cs-137 was observed in many environmental samples due to the Chernobyl fallout.

6) Co-60 was identified in a sample from the Goosequill Stub and Co-60, Fe-59 and Mn-54 were identified in a sample from the Farm Pond Inlet. It was reported by Industrial Compliance, Inc. that these results are considered by the analyst as false positive.

In summary, tritium is the only radionuclide reported in any effluent pathway. Other reported radionuclides have been dismissed for various reasons. However, it is incumbent that verification of these conclusions be obtained during the SCP. There is

no basis for assuming deposition of radionuclides as having occurred from plant airborne emissions.

Based on the aforementioned review, sampling and analysis will include samples of soil, sediment and surface water. Both biased and unbiased sampling will be performed which will provide a reasonable assurance that all areas of potential contamination have been surveyed. There will be approximately 40 unbiased sample locations selected. These sample locations will not include any paved areas or areas covered with concrete.

4.4.1 [a,c]

[ ] a,c

The unbiased sample locations and the method of sampling will be prescribed in the work packages and indicated on survey maps. This will be supplied to the characterization specialist before sample collection. These maps, will indicate a target sample area approximately [ ] a,c A sample may be taken anywhere within the area shown. If, for any reason, the sample cannot be taken within the designated area, an alternate location near the indicated location will be identified. The actual sample locations with sample coordinates will be identified in a work package. Samples will also be collected from selected "control points" that are removed from the FSV site.

4.4.2 Biased Environmental Samples

Within the scope of this program, "biased samples" are those for which there is a reasonable scenario or basis for suspecting that radiological contamination could have occurred. As an example, samples will be obtained from Goosequill Stub, the Farm Pond inlet and outlet, the Farmers Independent ditch, the Goosequill ditch and the Gilcrest well. As previously noted, samples from these locations have contained elevated levels of radioactive material. In addition, samples will be collected along all known or potential release paths from the facility. Examples of areas where samples will be collected include areas where radioactive waste materials have been stored, the entry into the Waste Compacting Building and areas where roof drains empty onto the ground.

The sample locations and a description of the manner in which biased samples are to be collected will be provided in SEG implementing procedures. The actual sample locations and a description of the sample will be identified in the work package. Samples will also be collected from selected "control points" that are removed from the FSV site.

4.4.3 Environmental Analytical Methods

Environmental samples will be collected and sent to an outside vendor laboratory for analysis. The laboratory will be selected on the basis of its ability to achieve the desired lower limits of detection (LLD) for the specific analyses requested. a,c

[ ]

A portable survey instrument will be used by a characterization specialist to measure the exposure rate at one meter above the surface of the sampling location. The instrumentation used will be calibrated with NIST traceable sources and the survey will be performed in accordance with the SEG implementing procedures.

4.4.4 Environmental Data Reporting and Analysis

A number of isotopes, either naturally occurring or not attributed to FSV operations have been detected in the past and are expected to be detected in the analyses. However, as reported in the PSC Radiological Environmental Monitoring Program, there appears to be no individual measurement exceeding reporting levels. Nonetheless, the Chernobyl fallout effects are still observable. The isotopes Sr-90 and Cs-137 are the result of atmospheric nuclear weapons testing and/or the April 1986 accident at the Chernobyl plant in the Soviet Union. The isotopes K-40, Ra-226, and Th-228 are naturally occurring and are in concentrations which are consistent with the Colorado Front Range area. As long as the measured concentrations are within the same range as the control samples, it will be assumed that their presence in the samples is naturally occurring or consistent with local background.

If the only isotopes detected are naturally occurring or consistent with the concentrations of the local background, then it will be concluded that there is no soil contamination on the site or its environs due to FSV operations. Samples containing isotopes other than expected, will be re-analyzed on a case-by-case basis. If the analyses provides a reasonable basis for the isotope to be consistent with natural background or to be a statistical anomaly, then the same conclusion of no contamination will be drawn.

If the identified isotopes are attributed to FSV operations, then the same statistical test as the one for the appropriate number of biased samples will be applied. If more samples are required, they will be collected. If the number of samples is deemed acceptable, then the concentrations will be compared to the proposed acceptance criteria for unrestricted use and the appropriate remedial action will be determined.

5.0 CHARACTERIZATION DOCUMENTATION AND REPORT

5.1 Documentation (General)

Documentation of site characterization survey results will be specified in the SCP implementing procedures. This will ensure that all documentation is accurately recorded in a format that can be used for future reference.

5.2 Data Reporting And Analysis

The unbiased results for the total surface contamination (fixed and removable) determinations will be converted into units of dpm/100cm^2. Data for each type of determination from a Survey Area or a Survey Unit will be presented in a tabular format and cross referenced to the specific location at which it was taken. The data from each Survey Area or Survey Unit will be evaluated and compared to determine the extent of remediation required. The mean, standard deviation and standard error of the mean will be calculated for each Survey Area or Survey Unit to establish the radiological status for specific FSV areas, structures and systems.

Surface contamination results of biased surveys will be converted to units of dpm/100cm^2 and presented in tabular form by Survey Area and Survey Unit. Location of these measurements will be similar to those used for the unbiased results.

The data will be sorted into the following categories:

[ ] a,c

[Structures and systems with results in] a,c

[Structures and systems with results in] a,c

[Structures and systems with results in] a,c

5.3 Final Report on Initial Site Characterization

The data will be presented in such a manner that: first, the radiological condition of the site is accurately depicted; second, the radiological condition of the site can be determined without further manipulation of the data; and third, types and locations of conditions exceeding decommissioning guidelines are easily identified. In order for these goals to be met, the radiological survey report will be written on two levels. The first level consists of a written description of the radiological condition of the site supplemented with figures illustrating significant radiological conditions. The second level consists of a detailed presentation of data in the form of tables, figures and maps. All areas, systems or structures requiring remedial action will be identified. Complete information concerning contamination and radiation levels will be given in tables so that data compilation and conclusions can be verified.

All original data will be available for examination on request. The original data will be stored by Westinghouse SEG in accordance with the SEG-QAP-107, "Quality Plan, Initial Radiological Site Characterization FSV/PSC" (Reference 7.6).

5.4 [a,c]

5.5 [

5.6

5.7] a,c

6.0 QA/QC REQUIREMENTS

6.1 Data Collection

The Westinghouse SEG QA Program, as defined in the SEG-QAP-107, "Quality Plan, Initial Radiological Site Characterization FSV/PSC," is applicable to the conduct of the SCP. Samples and measurements at all locations will be collected using accepted and proven techniques and methodologies to ensure accurate results and consistent collection methods. Onsite sampling and measurement instrumentation will be subject to daily operational checks and periodic calibration to ensure both accuracy and precision of results. Records and calculations will be checked for errors and the use of appropriate recording and calculational techniques will be employed. Vendor laboratories will be required to verify data quality in accordance with SEG implementing procedures.

6.2 Measurement Quality Control

To ensure measurement quality, the following controls will be implemented:

- [ ] of soil, silt and liquid samples will be split and analyzed by an outside vendor laboratory. a,c
- Approximately [ ] of swipes will be reanalyzed (gross beta). a,c
- Approximately [ ] of the direct measurements taken for fixed surface contamination and exposure rates will be conducted and verified independent of the original characterization survey. a,c

6.3 Records Retention And Control

The storage, maintenance, transmittal and retention of SCP records will be performed in accordance with the SEG-QAP-107, "Quality Plan, Initial Radiological Site Characterization FSV/PSC" (Reference 7.6).

Documentation collected during the characterization program are required to have a document reference number for purposes of information tracking, reference, and future retrieval. Instrument measurements and analytical results will be documented and survey parameters will be recorded.

The document reference number shall be unique to those used during operational phases of FSV. In general, any information generated in the form of memorandum, reports, surveillance functions, analytical results or instrument measurements, etc. in support of the characterization program will be traceable.

NOTE: The following is a list of references considered during program development and is not intended to imply full compliance with the material listed.

7.0 REFERENCES

7.1 NDG-89-1526; "Decommissioning and Conversion of the Fort St. Vrain Nuclear Generating Station." Public Service Company of Colorado Request for Proposal, December 8, 1989. Also Addendum-A, February 12, 1990, and Addendum-B, February 16, 1990.

7.2 USNRC, "Below Regulatory Concern; Policy Statement," Effective Date, July 3, 1990.

7.3 NRC letter from Mr. P. Erickson to PSC Mr. C. Crawford, dated October 4, 1989, (Docket Number 50-267). Subject; "Fort St. Vrain Decommissioning Financial Plan and Preliminary Decommissioning Plan - Request for Additional Information."

7.4 USNRC, Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," June 1974.

7.5 NUREG/CR-5512, "Residual Radioactive Contamination from Decommissioning: Technical Basis for Translating Contamination Levels to Annual Dose," Draft Report for Comment, January 1990.

7.6 SEG-QAP-107, "Quality Plan, Initial Radiological Site Characterization FSV/PSC."

7.7 FSV-QA-001, "FSV Quality Assurance Interfaces."

7.8 Colorado State University, "Radiological Environmental Monitoring Reports (REMP)." 1988 and 1989 and REMP Tables, First and Second Quarter, 1990.

7.9 Industrial Compliance, Inc., report dated February 26, 1990.

7.10 "Decommissioning and Conversion of the Fort St. Vrain Nuclear Generating Station," Proposal to Public Services Company of Colorado, Reference Volume 6, Decommissioning Technical Information April 2, 1990.

7.11 USNRC, "Control of Radioactively Contaminated Material," IE Circular No. 81-07, May 14, 1981.

7.12 NUREG/CR 2082, "Monitoring for Compliance with Decommissioning Termination Survey Criteria," June 1981.

7.13 NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," August 1988.

7.14 USNRC, Draft Regulatory Guide, DG-1005, "Standard Format and Content for Decommissioning Plans for Nuclear Reactors," September 1989.

7.15 USNRC, Draft Regulatory Guide, DG-1006, "Records Important for Decommissioning of Nuclear Reactors," September 1989.

7.16 NUREG-0613, "Residual Radioactivity limits for Decommissioning," Draft Report, October, 1979.

7.17 "Basic Statistics with Business Applications," Second Edition, authors, R.C. Clelland, J.S. deCani and F.E. Brown, published by John Wiley and Sons, Inc., 1966/1973.

7.18 "Handbook of Radiation Measurement and Protection," Allen Brodsky, Editor, published by CRC Press, Inc., 1982.

APPENDIX A

SITE CHARACTERIZATION PROGRAM ORGANIZATION

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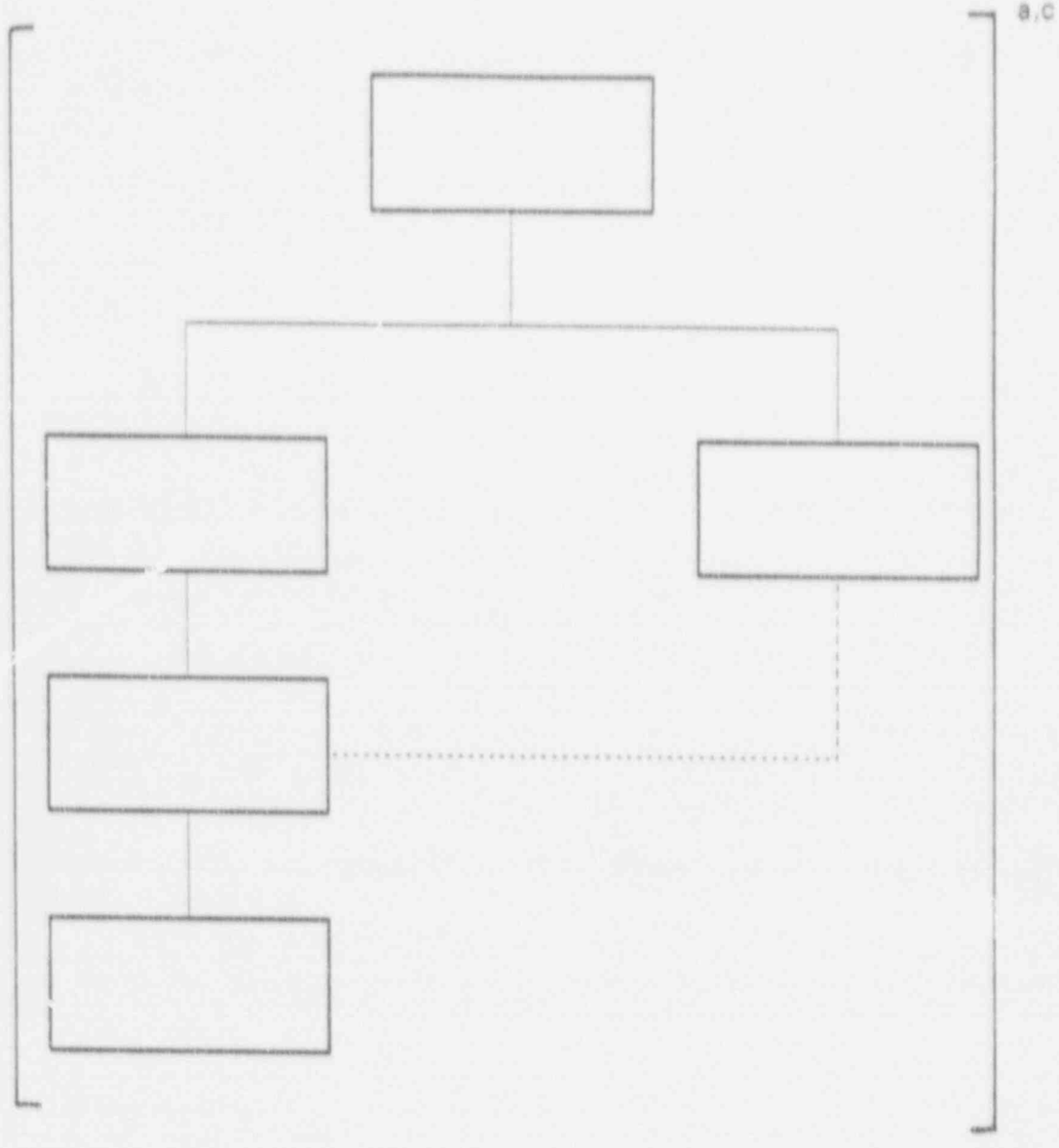

APPENDIX B

SCP IMPLEMENTATION SEQUENCE

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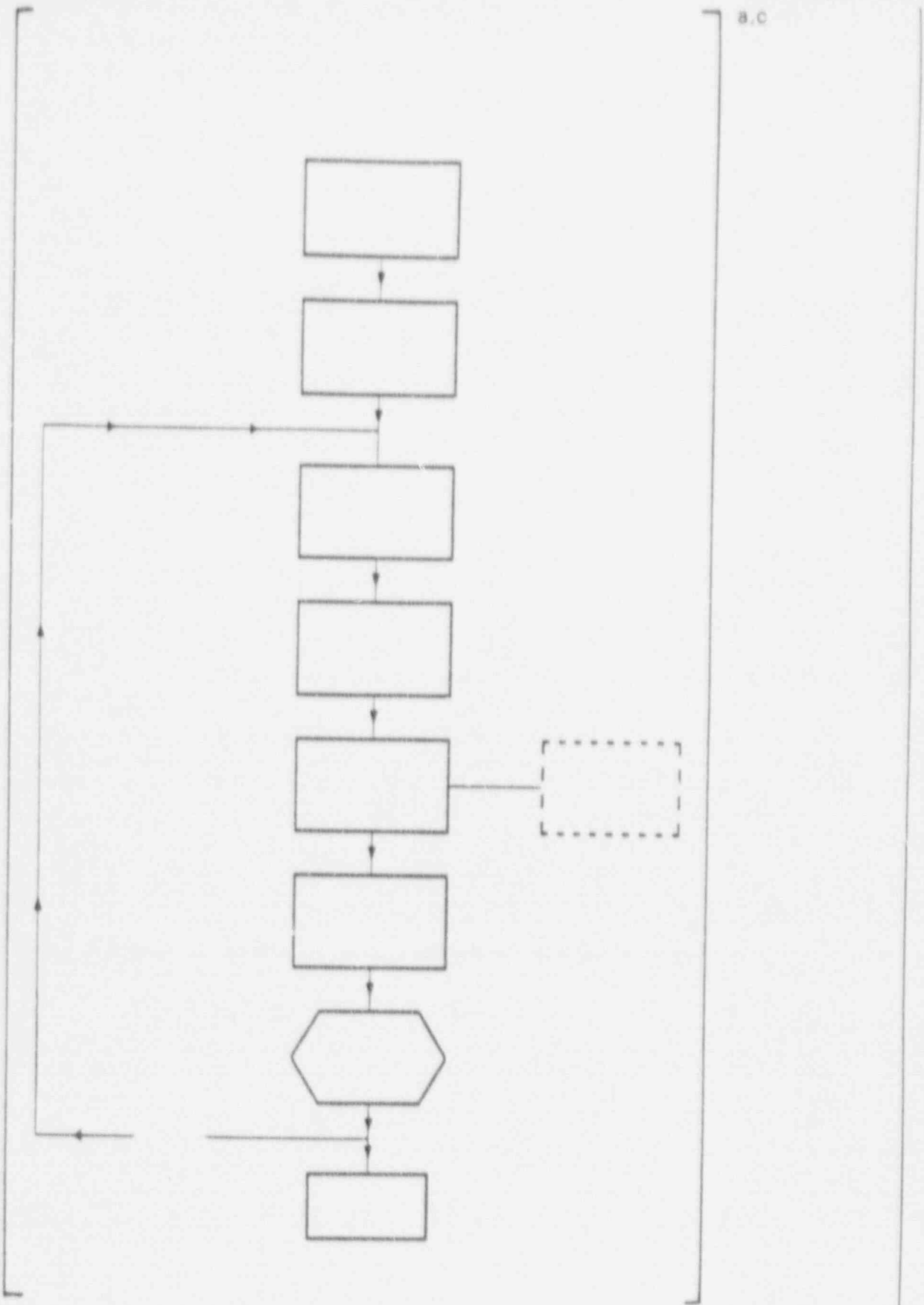
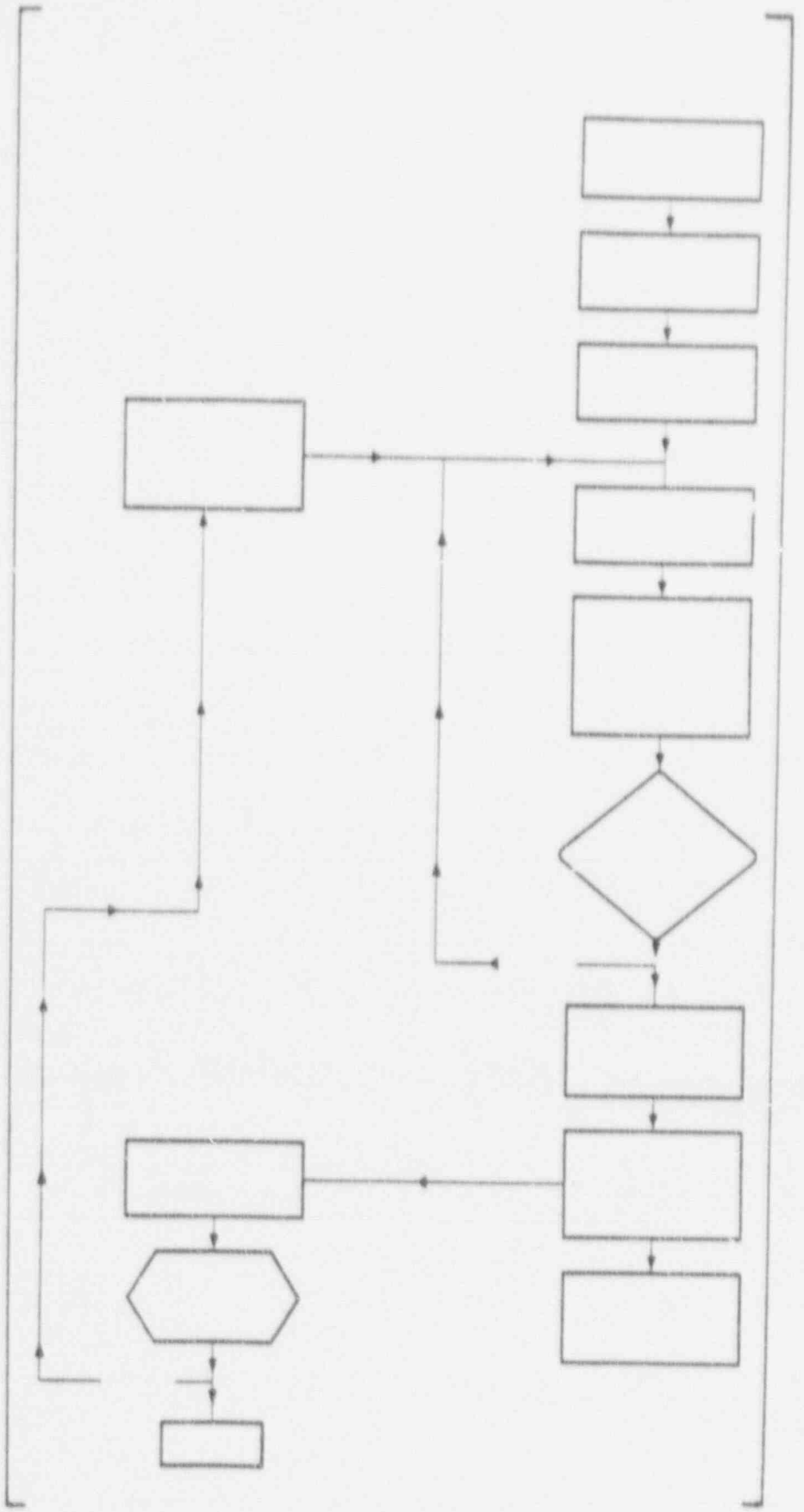
B-2

B-3

B-4] a,c

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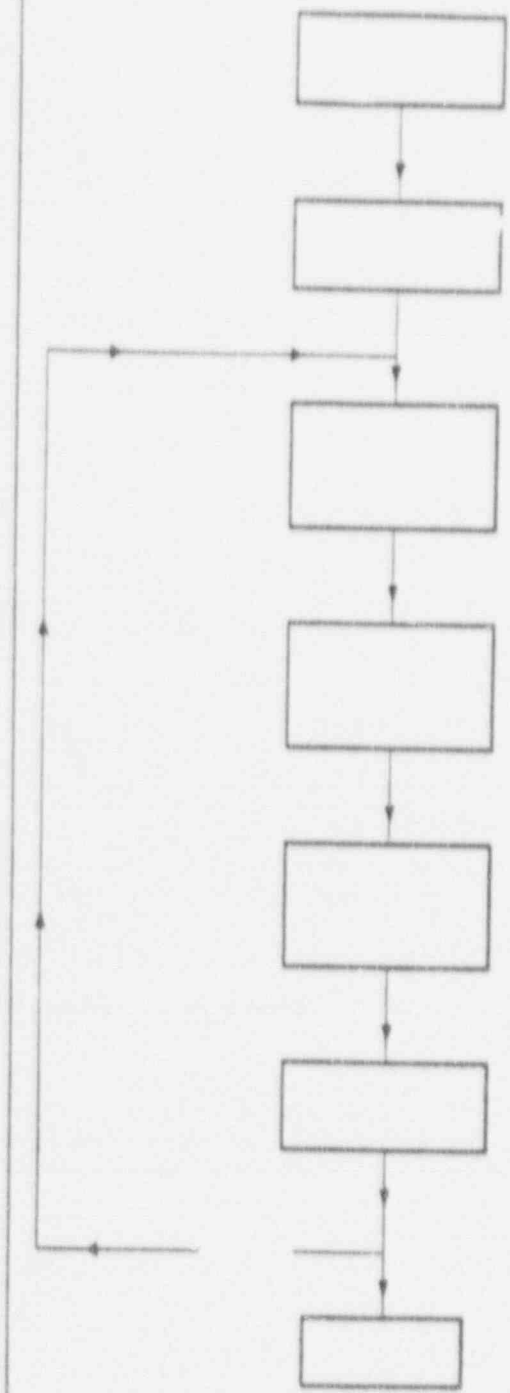

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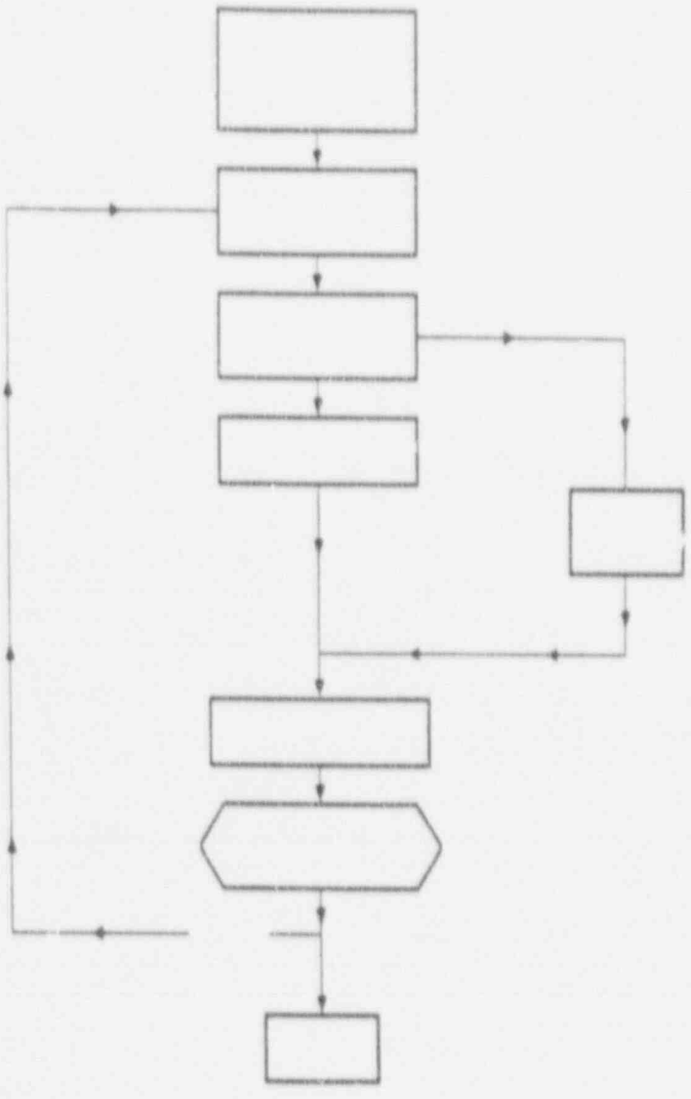

APPENDIX C

BACKGROUND DETERMINATION

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BACKGROUND DETERMINATION

Site characterization data will be compared to site background levels. Background will include both "instrument background" and background due to naturally occurring radioactive materials, including enhanced background radiation due to technology (e.g., nuclear weapons tests). Therefore, reliable background data will be obtained for each type of measurement or determination. This background determination will use:

[ ] a,c

Background data will be obtained by using:

[ ] a,c

Of primary importance will be the selection of background sampling areas which closely resemble the materials to be sampled or measured, but which have not been affected by FSV operation. Background data will also be obtained from existing background data from the FSV radiological environmental monitoring program.

Removable surface contamination determinations do not typically have a clean material background other than the counting instrument's background. Removable surface contamination background will be determined by counting an unused smear.

A measurement of background for the total surface contamination determinations will be made for bare concrete, painted concrete, concrete block and painted steel surfaces. Background will be determined from data obtained for [ ] measurements on each type of material. Surfaces used for the background determinations will be chosen to simulate the construction materials encountered during the characterization as closely as possible. a,c

Materials used for the total surface background determinations will be chosen from site structures at locations that are not likely to have been affected by FSV operation.

These locations will be upwind, upstream and up elevation, as appropriate, to avoid any contamination due to reactor operations. In addition, multiple background measurements may be taken from structures to better obtain representative background levels.

If detectable results are obtained, a "background level," (B), will be determined for each type of measurement. The definition of a "background level" will be based on the assumption that the distribution of background data is either lognormal (the logarithms fit a normal [Gaussian] distribution) or normal. Because the standard deviation of the distribution (either normal or log normal) is not known, the t statistic is used rather than the normal distribution and the coefficient, k, is taken from the attached table (Table 1, Percentage Points of the t Distribution with m Degrees of Freedom (Two-Tailed Probabilities), (References 7.17 and 7.18).

[a,c

However, the land elevation in the Denver-Platteville area is such that "background levels" are higher in this part of the country than elsewhere. In addition, consideration will be given to assessing levels of "background" within and without the FSV plant site.

Once the sample background measurements are made, the natural logarithms of each will be determined and the sample mean, $(\overline{\ln x})$, and sample standard deviation, s will be computed:

$$\overline{\ln x} = \frac{\sum \ln x_i}{n} \qquad (1)$$

$$s = \sqrt{\frac{\sum [\overline{\ln x} - \ln x_i]^2}{n-1}} \qquad (2)$$

The "maximum likelihood" estimate of ln B is then:

$$\ln B_{95} = [\overline{\ln x} + ks] \qquad (3)$$

so that B can be estimated from the formula:

$$B_{95} = \exp[\overline{\ln x} + ks] \tag{4}$$

The preceding equation will be used to obtain an estimate of the background level B_{95} for each radiological determination to be made. Where a normal distribution is assumed, the above equations become:

$$\bar{x} = \frac{\sum x_i}{n} \tag{5}$$

$$s = \sqrt{\frac{\sum [\bar{x} - x_i]^2}{n-1}} \tag{6}$$

$$B_{95} = \bar{x} + ks \tag{7}$$

For the 95% single tailed test, we will use the 0.1 Percentage Point Column from Table 1 because we are using a single-tailed test. Thus, if the value of m is 29 because we based our estimate on 30 samples, we would choose k = 1.699 and our equation for B_{95} becomes:

$B_{95} = \bar{x} + 1.699s$, normal distribution (8)

$B_{95} = \exp[\ \overline{\ln x} + 1.699s\ ]$, log normal distribution (9)

TABLE 1
PERCENTAGE POINTS OF THE t DISTRIBUTION WITH m DEGREES OF FREEDOM (TWO-TAILED PROBABILITIES)*
(Reference 7.17)

m	Percentage Point												
	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.05	0.02	0.01	0.001
1	0.158	0.325	0.510	0.727	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657	636.619
2	0.142	0.289	0.445	0.617	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	31.598
3	0.137	0.277	0.424	0.584	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	12.941
4	0.134	0.271	0.414	0.569	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	8.610
5	0.132	0.267	0.408	0.559	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	6.859
6	0.131	0.265	0.404	0.553	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.959
7	0.130	0.263	0.402	0.549	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	5.405
8	0.130	0.262	0.399	0.546	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	5.041
9	0.129	0.261	0.398	0.543	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.781
10	0.129	0.260	0.397	0.542	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.587
11	0.129	0.260	0.396	0.540	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.437
12	0.128	0.259	0.395	0.539	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	4.318
13	0.128	0.259	0.394	0.538	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	4.221
14	0.128	0.258	0.393	0.537	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	4.140
15	0.128	0.258	0.393	0.536	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	4.073
16	0.128	0.258	0.392	0.535	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	4.015
17	0.128	0.257	0.392	0.534	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.965
18	0.127	0.257	0.392	0.534	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.922
19	0.127	0.257	0.391	0.533	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.883
20	0.127	0.257	0.391	0.533	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.850
21	0.127	0.257	0.391	0.532	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.819
22	0.127	0.256	0.390	0.532	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.792
23	0.127	0.256	0.390	0.532	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.767
24	0.127	0.256	0.390	0.531	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.745
25	0.127	0.256	0.390	0.531	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.725
26	0.127	0.256	0.390	0.531	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.707
27	0.127	0.256	0.389	0.531	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.690
28	0.127	0.256	0.389	0.530	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.674
29	0.127	0.256	0.389	0.530	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.659
30	0.127	0.256	0.389	0.530	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.646
40	0.126	0.255	0.388	0.529	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.551
60	0.126	0.254	0.387	0.527	0.679	0.848	1.046	1.296	1.671	2.000	2.390	2.660	2.460
120	0.126	0.254	0.386	0.526	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617	3.373
∞	0.126	0.253	0.385	0.524	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.291

* This table is taken by consent from *Statistical Tables for Biological, Agricultural, and Medical Research*, by Prof. R. A. Fisher and F. Yates, published by Oliver and Boyd, Edinburgh.

APPENDIX D

INTERPRETATION OF UNBIASED DATA

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INTERPRETATION OF UNBIASED DATA

The unbiased structural surface contamination data will be used to determine which areas of the FSV site have or have not been affected by operation of the plant. It is currently believed that the majority of the FSV structural surfaces may not be contaminated; that is, these surfaces will not exhibit total surface beta/gamma levels, gross removable beta/gamma and alpha levels or gamma exposure rates in excess of those encountered on similar unaffected materials. Therefore, it will be necessary to decide if each set of data from each survey unit differs sufficiently from the accepted background levels to reflect a slight contamination resulting from FSV Plant operations.

1. Comparison of Sample Mean to Background Mean

[a,c

Comparison of the background data mean to each survey unit's data mean will use the following analytical process:

A. Set up null and alternate hypotheses:

- Null hypothesis (H_o): Sample mean = background mean
- Alternate hypothesis (H_a): Sample mean > background mean

B. Calculate standard deviation and standard error for the sample distribution:

Estimated population standard deviation s : $$s = \left[\frac{\sum (x_i - \bar{x})^2}{n-1} \right]^{1/2}$$

n = sample size

$\bar{x}$ = mean of n observations

x_i = each individual observation

Standard error of the mean, $\bar{x}$: $s_{\bar{x}} = \frac{s}{n^{1/2}}$

C. Accept or reject the null hypothesis:

- Test at 95% confidence level, with a one-tail alpha level of 0.05

  Reject H_o if: $\bar{x} \geq 1.699(s_x)$ + background mean

  (1.699 = number of standard deviations corresponding to a one-tailed alpha level of 0.05 for the Student t statistic with 29 degrees of freedom).

If the null hypothesis is rejected, the survey unit will be considered to be contaminated.

2. Examination of Individual Sample Results

Each individual sample result (direct contamination reading, smear, or soil sample) shall be compared to Regulatory Guidance as follows:

A. [ ] a,c
B. Compare to "average" values in the appropriate Regulatory Guide.
C. For areas where the Regulatory Guide criteria are exceeded, determine extent of the area which is contaminated.