DRAFT

PLUTONIUM IN SOILS TREATABILITY STUDIES WORK PLANS
TRUclean PROCESS AND MAGNETIC SEPARATION

ROCKY FLATS PLANT
OPERABLE UNIT 2

U S DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN COLORADO

ENVIRONMENTAL RESTORATION PROGRAM

NOVEMBER 14 1991

VOLUME I TEXT

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REVIEWED FOR CLASSIFICATION/UCNI
By K. L. Dalfonso (UNNI)
Date 11/18/91

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EXECUTIVE SUMMARY

The Plutonium in Soils Treatability Studies Work Plan provides procedures for conducting treatability studies on Rocky Flats Plant (RFP) plutonium-contaminated soils with the TRUclean Process and magnetic separation. TRUclean and magnetic separation were selected during the development of the Final Treatability Studies Plan (TSP - DOE, 1991) as technologies that require further evaluation through bench and laboratory treatability testing, respectively The TSP details the screening process that was utilized in selecting these technologies for bench/laboratory testing for the treatment of radionuclides in soil or sediments The TRUclean Process treatability study will be conducted at the Nevada Test Site (NTS) by AWC-Lockheed (AWC) personnel The magnetic separation treatability study will be conducted at Los Alamos National Laboratory (LANL) by LANL personnel Both will be performed on identical RFP soil samples obtained in accordance with the Field Sampling Procedure for Sampling Plutonium-Contaminated Soils to Support Treatability Tests at Nevada Test Site and Los Alamos National Laboratory included as Attachment 1 to this work plan

The primary objective of the plutonium in soils treatability studies is to evaluate the ability of the TRUclean Process and magnetic separation to reduce the concentration of plutonium as well as the levels of gross alpha and gross beta in RFP soils to acceptable levels The proposed cleanup goals (from Rules and Regulations Pertaining to Radiation Control - Colorado Department of Health, December 30, 1985) at RFP for plutonium, gross alpha, and gross beta are 0 9, 5, and 50 picocuries/gram (pCi/g), respectively Investigations in 1987 indicated that the TRUclean Process could remove radioactivity down to levels approaching the current proposed cleanup goals (AWC, 1987) The TRUclean treatability test developed as part of this work plan incorporates modifications to the 1987 TRUclean Process tests that focus primarily on soil feed preparation Results of the 1987 tests performed by AWC are summarized in Attachment 4 There are no known applications of magnetic separation to effect the isolation of plutonium from "soil type" solids, however, successful experiments applying magnetic separation as a plutonium enrichment process for graphite and bomb reduction residues have been conducted at LANL (Avens, 1990) Both technologies involve excavation of soils, ex-situ treatment, return of "clean" soil to the site of excavation, and transportation of soils with concentrated contaminants to off-site storage

The TRUclean Process is made up of several unit operations that effect segregation of solids based on differences in specific gravity and particle size The main components of the process include a gravimetric separator, a multi-gravity separator, a centrifugal gravity separator, and a spiral classifier

Magnetic separation isolates "magnetically susceptible" materials through the application of a magnetic field to a slurried or dry form of the material being treated

Performance data from the TRUclean and magnetic separation tests will be used to quantify the primary evaluation criteria. residual contamination and degree of separation Residual contamination refers to the concentrations of gross alpha, gross beta, and plutonium 239 plus 240 in the outlet streams of the TRUclean and magnetic separation processes Degree of separation refers to the mass percentage of the original soils meeting the residual contamination proposed cleanup goals as a result of treatment. When evaluating the performance of the treatment technologies with regard to the primary evaluation criteria, a technology will not be considered to "meet cleanup goals" if the clean soil it produces (clean with regard to goals for gross alpha, gross beta and plutonium 239 plus 240) is not a significant percentage of the original mass of contaminated soil A "significant percentage" means greater than 50 percent, based on engineering judgement at this stage A higher percentage would likely be required for full-scale operations

This work plan is structured to present information and requirements applicable to both the TRUclean Process and magnetic separation in the initial six sections A general overview of the treatability test steps is represented in Figure ES-1 Details specific to the treatability tests associated with each technology are presented in separate sections (Sections 7.0 - TRUclean Process and 8 0 - Magnetic Separation)

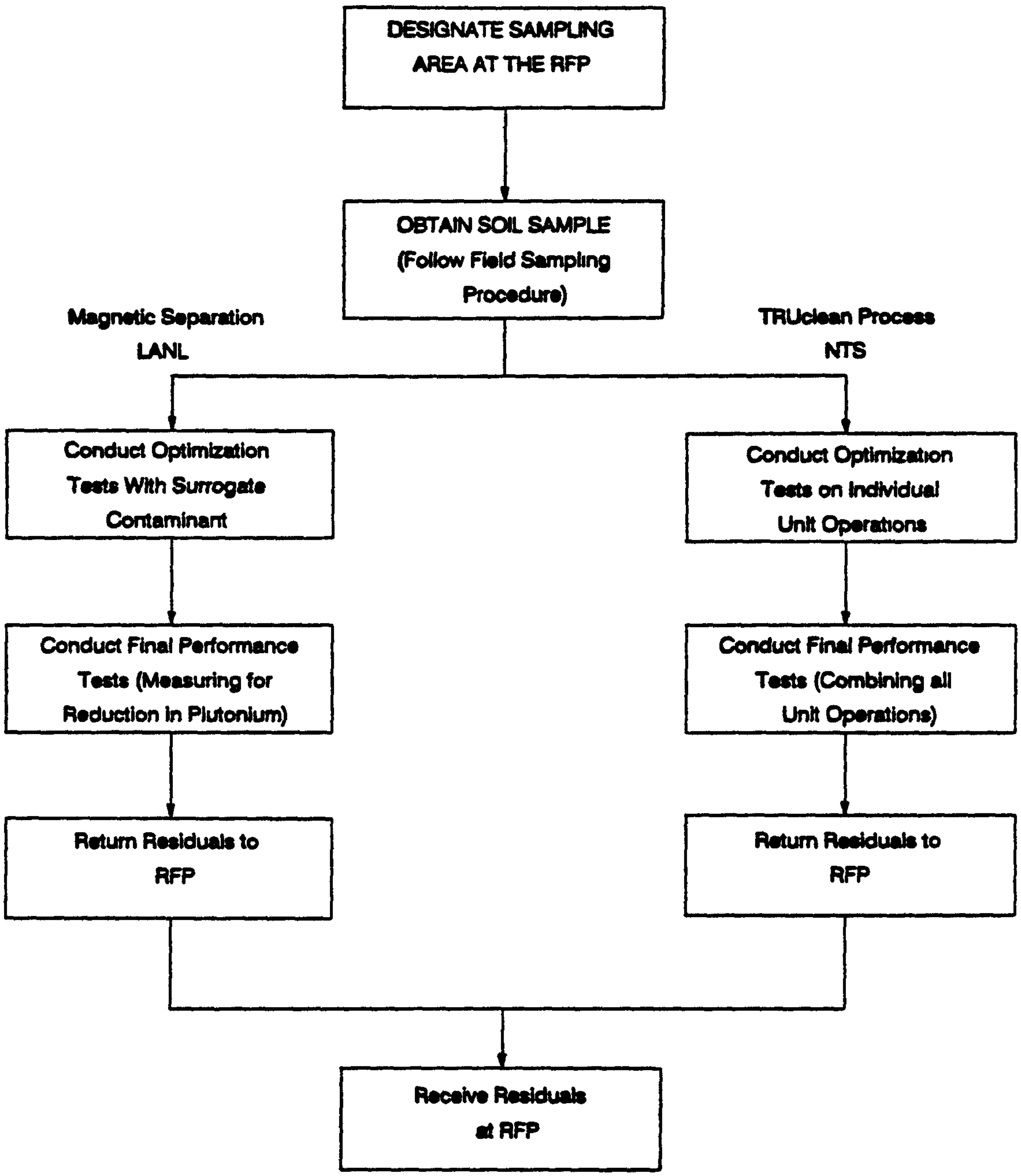

FIGURE ES-1
GENERAL OVERVIEW
TREATABILITY TEST STEPS

ACRONYMS

AP	Analytical Procedures
AWC	AWC-Lockheed
AWC-CS	AWC Characterization Sample
CDH	Colorado Department of Health
CLP	Contract Laboratory Program
DOE	Department of Energy
DOT	Department of Transportation
DQO	Data Quality Objectives
EM	Environmental Management
EM SOP	Environmental Management Standard Operating Procedures
EPA	United States Environmental Protection Agency
CMS/FS	Corrective Measures Study/Feasibility Study
GRRASP	ERP General Radiochemistry and Routine Analytical Services Protocol
GS	Gravimetric Separator
HGMS	High Gradient Magnetic Separator
LANL	Los Alamos National Laboratory
LSCOPP	Land Surface Clean-Up of Plutonium Project
MGS	Multi-Gravity Separator
NTS	Nevada Test Site
OU2	Operable Unit 2
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
pCi/g	Picocuries per Gram
QAA	Quality Assurance Addendum
QAPjP	Quality Assurance Project Plan
RAS	Routine Analytical Services
RFEDS	Rocky Flats Environmental Data Tracking System
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
RI/FS	Remedial Investigation/Feasibility Study
SOP	Standard Operating Procedures
SVOC	Semivolatile Organic Compounds
TCL	Target Compound List
TSP	Final Treatability Studies Plan
VOC	Volatile Organic Compounds

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TITLE·
Plutonium in Soils - Treatability Studies Work Plan

Approved By

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1 0 INTRODUCTION

1 1 Background

The Plutonium in Soils Treatability Studies Work Plan provides procedures for conducting treatability studies on Rocky Flats Plant (RFP) plutonium-contaminated soils with the TRUclean Process and magnetic separation TRUclean and magnetic separation were selected during the development of the Final Treatability Studies Plan (TSP) as technologies that require further evaluation through bench and laboratory treatability testing, respectively

The TSP was developed to meet the requirements of Article XI of the January 22, 1991 Final Inter-Agency Agreement The TSP identifies candidate technologies for use in corrective/remedial actions at the RFP and provides information regarding the screening of those technologies The candidate technologies for treatment of radionuclides in soil were identified through literature/database searches, review of conference proceedings, U S Environmental Protection Agency (EPA) guidance documents, government reports, and discussions with equipment vendors and other technical experts These technologies underwent screening based on the following screening factors

- Applicability to RFP soils
- Expected contaminant removal efficiency
- Potential to meet cleanup goals
- Technology maturity
- Operating and Maintenance requirements
- Implementability
- Adverse impacts

As a result of the screening process, TRUclean and magnetic separation were selected for bench/laboratory treatability testing, respectively, for treatment of radionuclides in soil

1.2 Previous Related Work

Successful removal of plutonium contamination from solids by the TRUclean Process has been demonstrated on plutonium-contaminated coral sand at the Johnston Atoll, and on plutonium-contaminated soil from RFP. There are no known applications of magnetic separation to effect the isolation of plutonium from "soil type" solids, however, successful experiments applying magnetic separation as a plutonium enrichment process for graphite and bomb reduction residues have been conducted at LANL (Avens, 1990)

The application of TRUclean to RFP soil was investigated in 1987 (AWC, 1987) At that time the results indicated that the TRUclean Process could remove radioactivity down to levels approaching the current proposed cleanup goals for radionuclides in soil at RFP (5, 50, and 0 9 pCi/g gross alpha, gross beta, and plutonium 239 + 240, respectively) The TRUclean treatability test developed as part of this work plan incorporates modifications to the 1987 TRUclean Process that focus primarily on soil feed preparation It is expected that these modifications will improve performance by achieving cleanup goals with an increased mass of soil.

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2 0 ROCKY FLATS PLANT SITE DESCRIPTION

The RFP is a U S Department of Energy (DOE) facility located approximately 16 miles northwest of downtown Denver RFP occupies approximately 6,550 acres of federally-owned land in northern Jefferson County, Colorado The majority of the plant buildings are located within a 400-acre area referred to as the RFP security area. The 6,150 acre balance of the total plant area provides a buffer zone around the RFP security area

RFP is managed by EG&G Rocky Flats, Inc (hereinafter referred to as EG&G-RF) for DOE The facility is one of several nationwide involved in nuclear weapons research, development, and production The production process at RFP results in the generation of radioactive and nonradioactive wastes Past production operations resulted in on-site storage and disposal of these wastes

Of particular importance in the development of this Plutonium in Soils Treatability Studies Work Plan is the area comprising Operable Unit 2 (OU2). OU2 includes the 903 Pad, Mound, and East Trench areas The soils in these areas are known to be contaminated with plutonium; thus, the soil in OU2 will be subject to the treatability test procedures included in this work plan

3 0 SITE CHARACTERIZATION DATA FOR SOILS

Characterization data will be obtained for the soil subject to treatability tests prior to shipment off site Characterization will include a radiological assay, radiological screening, metals assay, and a determination of volatile and semivolatile organics This characterization of untreated soils will be performed in accordance with the requirements of Section 5 2 of this work plan

Sampling and shipment preparation of the soil to be tested will be performed in accordance with the Field Sampling Procedure for Sampling Plutonium-Contaminated Soils to Support Treatability Tests at Nevada Test Site and Los Alamos National Laboratory included as Attachment 1 to this work plan. The procedure identifies four sampling locations within OU2 to support the TRUclean and magnetic separation treatability tests as well as future treatability tests at NTS The four sampling locations provide two types of soil to be tested Of the two types of soil, each will have a high and a low concentration of plutonium represented (see Field Sampling Plan included with Volume II of this work plan)

The sampling location at the southeast corner of the site (Figure 1.1 of Attachment 1) will provide the soil needed to support the TRUclean and magnetic separation tests as described in this work plan. Soil from this location is expected to have a plutonium concentration of approximately 10 pCi/g This soil is classified as 31-Denver-Kutch-Midway clay loam which has a fines (+200 mesh) concentration of 70-95 weight percent in the top 8 inches of soil (USDA, 1980) Reviews of existing site characterization data for soil provided no additional data for the southeast sampling location.

The three remaining sampling locations will provide soil to support future treatability tests at NTS Note that the magnetic separation tests will be conducted with soil from the southeast location only Also, the procedure for soil sampling specifically supports treatability tests with TRUclean and magnetic separation, however, the procedure may be applied (with minor modifications) when obtaining soil for future treatability tests

4.0 TEST OBJECTIVES

The primary objective of the plutonium in soils treatability studies is to evaluate the ability of the TRUclean Process and magnetic separation to reduce the concentration of plutonium in soils to an acceptable level If metals are present, their redistribution will be noted These technologies were selected during the development of the TSP for bench/laboratory treatability testing for treatment of radionuclides in soil or sediment

4.1 Level of Work Plan Development

The procedures developed as part of this treatability studies work plan cover both laboratory screening and bench-scale testing Laboratory screening tests performed on magnetic separation will be limited to small-scale bench-top studies and will require approximately 200 kilograms (1-30 gallon drum) of bulk soil sample from the RFP The intent of the laboratory screening will be to obtain qualitative data that when evaluated, will provide an indication of magnetic separation's potential to meet cleanup goals Bench-scale testing will be performed on the TRUclean Process to determine its ability to meet cleanup goals of plutonium-contaminated soils at RFP. The TRUclean Process tests will require approximately 1450 kilograms (4-55 gallon drums) of bulk soil sample from RFP to perform 10 to 15 process equipment tests with 22 to 23 kilograms each plus four to five record runs with 90 to 91 kilograms each

4 2 Basis for Clean Soils

Soil cleanup goals for the RFP have been proposed for gross alpha, gross beta, and plutonium 239 plus 240 based on human health and environmental risk assessment criteria or applicable state and federal requirements These proposed cleanup goals for gross alpha (5 pCi/g), gross beta (50 pCi/g) and plutonium (0 9 pCi/g) are listed in Table 4-2 of the TSP. In addition to the aforementioned cleanup goals, consideration must be given to a Technology's ability to achieve these goals while reducing the mass of soil exceeding the proposed cleanup goals (i e doing the best job of concentrating the bulk of the contaminants into the smallest soil mass - see Section 4.3)

4 3 Intended Use of Data

The data resulting from the TRUclean and magnetic separation tests will be used primarily to evaluate performance against the Basis for Clean Soils discussed in Section 4 2 The performance data will be used to quantify the following primary evaluation criteria. residual contamination and degree of separation Residual contamination refers to the concentrations of gross alpha, gross beta, and plutonium 239 plus 240 in the outlet streams of the TRUclean and magnetic separation processes Degree of separation refers to the mass split between those soils meeting the residual contamination cleanup goals for gross alpha, gross beta, and plutonium 239 plus 240 and those soils not meeting the cleanup goals

When evaluating the performance of the treatment technologies with regard to the primary evaluation criteria, a technology will not be considered to "meet cleanup goals" if the clean soil it produces is not a significant percentage of the original mass of contaminated soil A "significant percentage" means greater than 50 percent, based on engineering judgement at this stage This 50 percent value is considered appropriate for the level of treatability tests to be conducted (i.e. if the TRUclean and magnetic separation processes achieve the 50 percent level, then more advanced treatability tests are justified to further investigate performance) It would not be appropriate to consider TRUclean or magnetic separation "primary" treatment processes if either is unable to achieve the contaminant concentration cleanup goals with at least 50 percent of the soil being treated. The 50 percent level is not intended to be the final cleanup goal for the total mass of soil treated. Additional treatment of residuals can be studied in order to achieve a greater reduction in the mass of soil exceeding the proposed cleanup goals discussed in Section 4 2

Data obtained from the TRUclean Process and magnetic separation tests will supplement information found in technical literature during feasibility study efforts This supplemental information is needed in order to evaluate and select a treatment alternative for those operable units with plutonium-contaminated soils Specific remedial investigation/feasibility study (RI/FS) evaluation criteria that can be addressed as a result of the treatability tests include

1) Overall protection of human health and the environment
2) Compliance with applicable or relevant and appropriate requirements (ARARs)
3) Implementability
4) Reduction of toxicity, mobility, or volume
5) Short-term effectiveness
6) Cost
7) Long-term effectiveness

This work plan has been structured so that the TRUclean Process and magnetic separation tests will primarily provide information to assess evaluation criteria numbers 2 and 4 Evaluation of the remaining criteria may occur at a qualitative level in order to provide input to future investigations of these technologies during the RI/FS process.

5 0 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements that describe the data quality needs of a project The DQO development process is divided into three stages Stage 1 consists of identifying the decision makers and data users, reviewing existing information to assist in establishing the objectives of the treatability study, and establishing the study-specific objectives of the data collection program In Stage 2, the data uses and data types are established This requires the selection of appropriate analytical levels for the measurement data and the identification of the appropriate types of analyses to be utilized Stage 3 encompasses the data collection program The DQO process is used to establish the specific goals of the treatability study and to identify the data needs for achieving these goals

5.1 Stage 1 - Decision Types

5.1 1 Data Users

The collected data will be used by the decision makers, that is, the management and regulatory personnel of EG&G-RF, DOE, the U S EPA, and the Colorado Department of Health (CDH) The primary data users are the EG&G-RF and contractor technical staff who are involved in the daily, ongoing treatability activities These are the individuals involved in the collection and analysis of the data and the operation and evaluation of the TRUclean and magnetic separation process systems Secondary data users are those individuals that will rely on the outputs of these treatability studies to support their activities (e.g feasibility study managers).

5 1 2 Available Data/Sample Location

Available characterization data from previous OU2 investigations were evaluated to select appropriate sampling locations for treatability studies These data came from the Phase I Remedial Investigation (RI) and investigations that have been completed prior to the Phase II RCRA Facility Investigation/Remedial Investigation (RFI/RI) The sampling location supporting the TRUclean and magnetic separation treatability tests at the NTS and LANL, respectively, is identified in Attachment 1 as the southeast sample location. This location was selected because observed concentrations of plutonium in this area are approximately 10 pCi/g of soil The bulk of the plutonium contamination resulted from the windblown dispersion of plutonium from the 903 Pad area

5 1.3 Specific Treatability Study Objectives

Data will be obtained in order to evaluate the TRUclean and magnetic separation processes in terms of reducing plutonium contamination to an acceptable level (the target of the process technology is to reduce the plutonium concentration to 0 9 pCi/g, achieving this level with at least 50 percent of the original soil mass)

5.2 Stage 2 - Identify Data Uses/Needs

Stage 2 of the DQO process defines data uses and specifies the types of data needed to meet the project objectives The summary of Stage 2 of the DQO process is presented as Table 5-1

5 2.1 Identify Data Uses

Data uses for these treatability studies consist of evaluation of treatment technologies to support the soil characterization for remediation alternatives

5.2.2 Data Types

The types of measurement data that will be generated in support of these treatability studies include:

- Untreated soil chemical and radiological characterization data obtained from analysis of the bulk soil sample Chemical parameters to be analyzed include EPA Target Analyte List (TAL) metals, EPA Target Compound List (TCL) volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) Radionuclides to be analyzed for, include plutonium 239 plus 240, gross alpha, and gross beta Level IV as defined in Section 5.2 3

- Bench-scale screening data for the TRUclean Process produced from analyses of samples collected during expected process optimization test runs The screening data will be used to adjust the process operation to obtain optimum operating conditions These samples will be analyzed by AWC at the testing laboratory to provide estimates of particle size fractions and the associated gross alpha, gross beta, and plutonium 239 plus 240 concentrations Levels II or III as defined in Section 5.2 3

- Laboratory screening data for the magnetic separation process produced from analyses of samples collected during test runs These data will be used to optimize the magnetic separation process These samples will be analyzed by LANL personnel at the testing laboratory to provide estimates of particle size fractions and the associated gross alpha, gross beta, and plutonium 239 plus 240 concentrations Tests for TAL metals will be conducted if the characterization of the bulk soil sample indicates TAL metals are present. Levels II or III as defined in Section 5.2 3

- Analytical data produced from the analyses of split samples collected from effluent streams during and following the test runs at the optimal operating condition for the TRUclean Process. These samples will be analyzed by a laboratory chosen by EG&G-RF to determine posttreatment concentrations of TAL metals, gross alpha, gross beta, and plutonium 239 plus 240 Particle size distribution of posttreatment soils will also be determined Level IV as defined in Section 5 2.3

5.2.3 Data Quality Needs

The EPA defines five levels of analytical data in EPA/540/G-87/003, Data Quality Objectives for Remedial Investigations and Feasibility Studies Under CERCLA (OSWER Directive 9355 0-7B, March 1987) These five analytical levels are as follows

- Level I - field screening, which is characterized by measurement data produced using portable field measuring instruments
- Level II - field analysis, which is characterized by measurement data produced from the use of portable analytical instruments that can be used on site or in laboratories
- Level III - laboratory analytical data produced by adhering to standard EPA-approved analytical methods and procedures
- Level IV - laboratory analytical data produced by adhering to EPA Contract Laboratory Program (CLP) Routine Analytical Services (RAS) analytical methods and procedures or equivalent
- Level V - laboratory analytical data produced by using nonstandard analytical methods, which typically involves method modification and/or development.

The analytical levels appropriate for the data use are specified in Table 5-1 Level IV analytical methodologies are specified in General Radiochemistry and Routine Analytical Services Protocol Scope of Work (EG&G, 1990) Levels II and III analytical methodologies may be selected from either internal analytical procedures (APs) or from Test Methods for Evaluating Solid Waste, SW-846 (EPA, 1986)

TABLE 5-1
Summary of Data Uses and Analytical Levels

DATA USES	ANALYTICAL LEVEL	TYPE OF ANALYSIS
Untreated soil characterization	Level IV	TAL Metals, TCL VOCs and SVOCs, gross alpha, gross beta, and Pu 239 plus 240, using EPA CLP or equivalent methods.
Adjust treatment process/laboratory optimization	Level II or III	Particle size, gross alpha and beta, Pu 239 plus 240.
Posttreatment soil analysis to evaluate the treatment technology	Level IV	TAL Metals, gross alpha, gross beta, and Pu 239 plus 240.

5.2.4 Analytical Options

An important aspect of technology evaluation relates to the chemical and radiological characteristics of the initial or untreated sample This characterization data will be compared to posttreatment data to evaluate the performance objectives of the TRUclean and magnetic separation processes The data used to define the untreated soil characteristics should consist of analytical data of a known quality, which requires analysis by EPA CLP or equivalent methods capable of producing analytical Level IV data.

Data obtained from treatability tests includes optimization and analytical data The optimization data will be used to adjust the various components of the TRUclean and magnetic separation processes during initial test runs to determine optimum operating conditions Concentration data in the form of ranges are acceptable, and quick turnaround time is important It is not necessary to know the quality of this data because it will not be used to make final evaluations of the effectiveness of the treatment technology Analytical Level II or III data is sufficient for this optimization The analytical data that will be used to evaluate the effectiveness of a technology should be of a known quality generated from analytical methods capable of producing analytical Level IV data

5.2.5 Review PARCC Parameter Information

Parameters that are used as indicators of data quality are precision, accuracy, representativeness, comparability, and completeness (referred to as PARCC parameters) Precision and accuracy objectives for the analytical data will be based on the historical precision and accuracy achieved by the standard analytical method selected to generate the data. These objectives along with the objective for completeness are specified in the Quality Assurance Addendum (QAA) for this treatability studies work plan (included with Volume II of the Plutonium in Soils Treatability Studies Work Plan). Representativeness and comparability are qualitative parameters that will be ensured by obtaining representative samples for analysis prior to, during, and after the treatment process, comparing the results of these analyses, and by adhering to the sampling and analysis strategy presented in this work plan

5 3 Stage 3 - Data Collection Program

The purpose of Stage 3 of the DQO process is to design the data collection program for these treatability studies in order to meet the work plan's objectives The sample collection and analysis components of each study, discussed in Sections 7.3 6 (TRUclean) and 8 3 6 (magnetic separation) of this work plan, were based on the study objectives, the uses of the data and types of data needed to meet those uses, and the types of decisions that will be made concerning the evaluation of the TRUclean and magnetic separation processes as support technologies to remedial alternatives

5.3.1 Sampling and Analysis

The untreated soil characterization data will be obtained for the RFP split of the total bulk soil sample (see Attachment 1) This split will be sent to an EG&G-RF contract laboratory capable of performing EPA CLP or equivalent analyses

The samples that will be analyzed to determine the optimum operating conditions of the TRUclean Process will consist of samples collected during optimization testing of the individual unit operations. Optimization testing is described in detail in Section 7 3 The AWC operator(s) will collect and analyze representative samples Representative screening samples for the magnetic separation process will be collected from test runs and analyzed by LANL personnel

Samples will be collected following test runs at the optimum operating conditions to provide data to evaluate the effectiveness of the treatment technologies Samples for the TRUclean Process will be split. One split will remain with the treatment operator for in-house analyses, the other split will be sent to an EG&G-RF contract laboratory that is capable of performing analyses according to, or equivalent to, EPA CLP methods

5 3 2 Samplıng and Analysıs Qualıty Controls

The QAA for thıs Plutonıum ın Soıls Treatabılıty Studıes Work Plan addresses the qualıty controls that will be ımplemented to ensure the qualıty of the pre- and posttreatment data used to evaluate the effectıveness of the treatment technology process

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6 0 DATA MANAGEMENT

As specified in the TSP, records of observations and raw data generated in the field and laboratory must be managed Additionally, TSP requires that data tables presenting field and laboratory test data be verified against the original (raw) data sheets to verify the accuracy of transcription The Site-Wide Rocky Flats Quality Assurance Project Plan (QAPjP - EG&G, 1991) establishes data management requirements and methods for the generation, control, validation, maintenance, and disposition of QA Records. QA Records include documents that furnish evidence of the quality and completeness of the RFI/RI and Corrective Measures Study/Feasibility Study (CMS/FS) processes as well as field notebooks, field data collection forms, laboratory data reports, chain-of-custody forms, calibration records, field activity reports, photographs, and electronic formats. Management of the site characterization data is discussed below The data management requirements for the TRUclean and magnetic separation studies are discussed in Sections 7 4 and 8.4, respectively

6 1 Site (Bulk Sample) Characterization Data

Appropriate Environmental Management (EM) Standard Operating Procedures (SOPs) which relate to management of the characterization sample acquisition process and the associated QA Records generated will be identified in the QAA for the Plutonium in Soils Treatability Studies Work Plan More specifically EM SOP 1.14, Data Base Management, delineates the responsibilities and procedures that provide an orderly method by which field data will be recorded, entered into electronic form, validated, transferred, and filed The procedure encompasses the data handling process from the point of data collection by field personnel to the filing and transmission of the field data to EG&G-RF personnel.

The management of the analytical data generated (including the reporting format and electronic deliverables) by EG&G-RF contract laboratories is controlled contractually through the EG&G-RF ERP General Radiochemistry and Routine Analytical Services Protocol (GRRASP) Scope of Work and Procedures for Providing the Electronics Deliverable Lab Data to the Rocky Flats Environmental Data Tracking System (EG&G, 1991) The RFEDS module (electronic format) required for storage, use, and compilation of the treatability test data is under development by EM. The EM Data Management Plan, which will describe the EM policies and procedures for managing these data, is also under development along with supporting data management SOPs Until the RFEDS module and formal data management procedures are in place, data management will be the responsibility of the EG&G-RF Project Manager The Project Manager will store and secure electronic and hard copy deliverables from the site characterization and TRUclean and magnetic separation processes

6.2 Quality Control Procedures

Quality control procedures for the treatability testing include data review exercises to ensure accuracy of data transcription and transmission as well as validation exercises to evaluate data quality Verification and validation requirements are included in the following sections

6 2 1 Verification

QA Records

The correctness and completeness of the data contained on QA Records is the responsibility of the subcontractor performing the task Quality control procedures for the QA Records supporting field activities and associated electronic media are described in EM SOP 1 14, Data Base Management. This SOP describes the procedures for field data receipt and completeness check, data validation, and data entry Quality control checks on the analytical data and reports are prescribed in GRRASP. QA Records generated from the specific treatability tests will be checked for accuracy and completeness by the test contractor project manager prior to transmission to EG&G-RF. These records include all treatability operations data.

Database

The TSP states that data tables generated from the database system for both field and laboratory data will be checked against the source document. This verification exercise should be conducted prior to reporting or release of study information This requirement is necessary to verify the transcription accuracy of information from the original field and laboratory data against that contained in the RFEDS The field and laboratory data will be verified against source documents after upload into RFEDS in accordance with EM data management procedures The treatability test subcontractor will verify data entry into the selected electronic format prior to submittal to EG&G-RF After upload of the information to RFEDS, accuracy of the transmission will be verified by checking data tables against the original documentation provided by the test subcontractor

6 2 2 Validation

As stated in the QAPjP, the appropriate EM division or its subcontractor will validate field data prior to inclusion into the RFEDS database as specified in SOP 1 14, Data Base Management and the DQOs identified in Section 5 0 of this work plan Laboratory data are routinely reviewed and validated by the EM laboratory validation subcontractor. Results of data review and validation activities are documented in data validation reports The quality control measures implemented during the analysis of the bulk subsample and process characterization split samples are described in GRRASP The data generated from these analyses will be validated against the guidelines specified in the Site-wide QAPjP. Additional quality control procedures (i e , analysis of duplicate samples, reporting of standard results) were prescribed in Section 5 0, Data Quality Objectives These data will undergo a data review by the EM validation subcontractor to assess the overall quality of the laboratory screening results

7 0 TRUclean PROCESS

The TRUclean Process technology was selected during the development of the TSP for bench-scale treatability testing as a result of a screening process designed to identify candidate technologies for use in corrective/remedial actions at the RFP (DOE, 1991) **The following information on the TRUclean Process is proprietary to AWC-Lockheed**

7 1 Type of Treatability Study

The treatability study to be conducted with the TRUclean Process is considered "bench-scale" The equipment is located at NTS and will be operated by AWC Operators at AWC will attempt to optimize the performance of the TRUclean Process with untreated RFP soil by varying process parameters such as bed depth of the gravimetric separator (GS), solids/liquid ratio in the attrition scrubber, and pH of wash solution A detailed description of the TRUclean Process and its associated test procedures are included in following sections of this work plan

7.2 Technology Description

The key component of the TRUclean Process to be tested as part of this treatability study is a GS. A GS separates materials with different specific gravities by flowing a slurried material over a screen and screen bed subjected to a vertical hydraulic pulse The pulse is the result of a sudden upflow of water through the screen and screen bed with sufficient velocity to bring all particles momentarily into suspension so that the screen bed becomes fluidized At the completion of the pulse, the water drains back through the screen and screen bed and the pulse cycle is repeated The pulsing cycle allows heavy particles to settle through the screen bed and lighter particles to pass over the top of the screen bed Heavy particles that are small enough to pass through the screen are discharged continuously. Coarse, heavy particles not passing through the screen are withdrawn intermittently The lighter material flows over the top of the screen bed and out of the end of the GS.

There are three product streams from a GS: low density tailing which is skimmed over the weir; oversize dense particles which collect on the screen, and dense fines or "hutch product" which pass through the screen The oversize dense particle stream is not a continuously generated material, it is removed on a periodic basis Separation is accomplished by the different settling rates of the particles in a verticle pulse of water Figure 7.2-1 provides a simple diagram for the components and streams of a typical GS Figure 7.2-2 provides an actual size, visual representation of various particle sizes from coarse to fine

The ability of a GS to achieve fractionation by particle density and particle size is what provides an isolation of plutonium contamination Since plutonium (PuO_2) has a high specific gravity (Sp Gr = 11 5) and is associated with fines (DOE, 1982), it is expected that the plutonium contamination will be concentrated primarily in the hutch product stream

To enhance the performance of the TRUclean Process GS, several feed preparation steps have been added. These steps include an initial wet screening of the soil by a trommel screen, attrition scrubbing to promote separation of plutonium particulates from the soil aggregate, and particle size fractionation by hydrocyclones The hydrocyclones are optional and will be used if improvement is needed in effecting particle size cuts. Also, unit operations have been added to "polish" the tailing stream of the GS in an effort to further isolate the plutonium contamination. These unit operations include. particle size fractionation by spiral classifier and gravimetric separation by centrifugal concentrator.

Figure 7.2-3 presents a general flow diagram showing the typical arrangement of unit operations making up the TRUclean Process A detailed description of the operational procedures and equipment for the test process (with modifications to the general TRUclean Process flow) as applied to the RFP plutonium-contaminated soil is included in Section 7 3 4 of this work plan

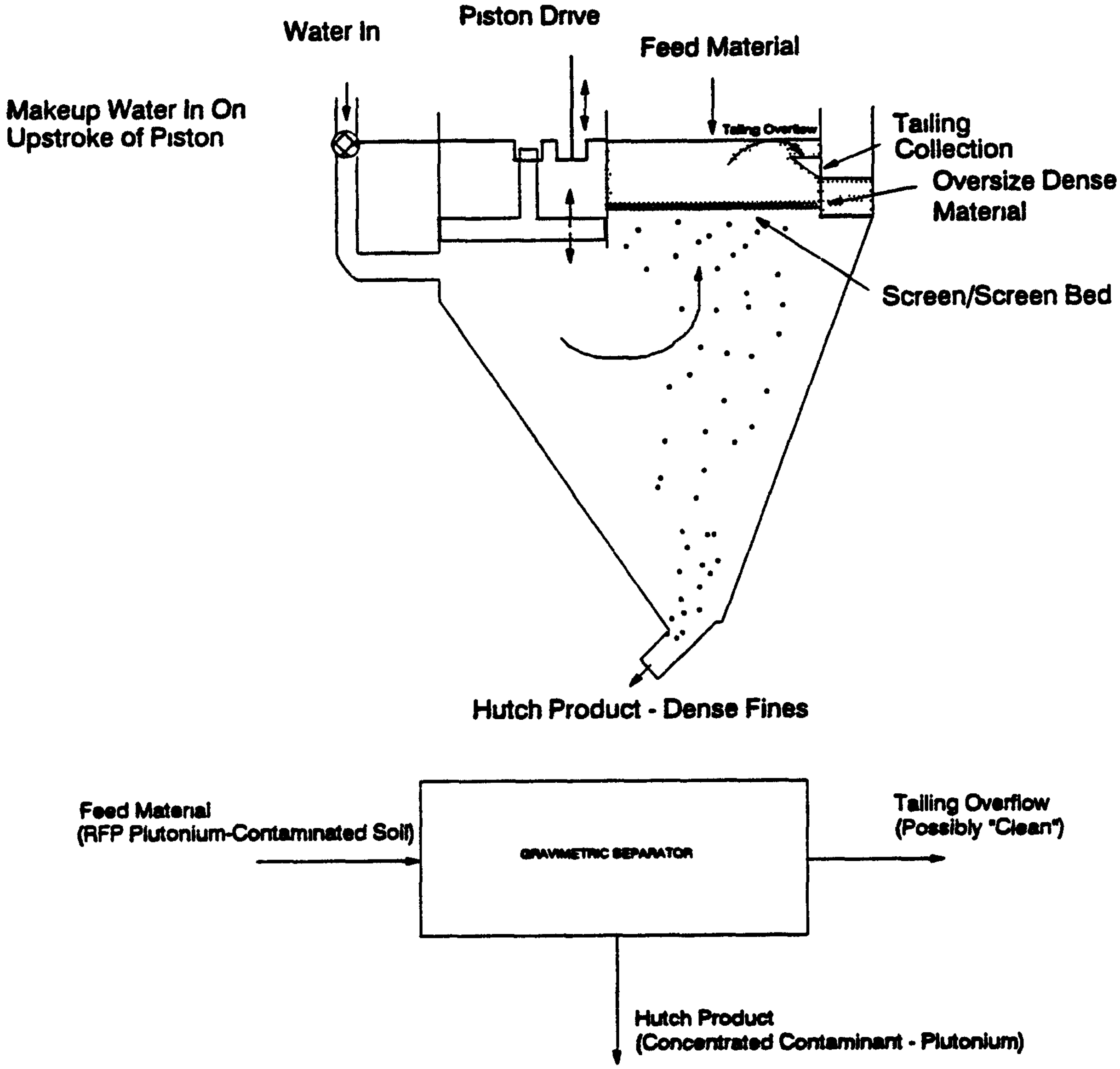

FIGURE 7.2-1

GENERAL CONFIGURATION AND FLOW FOR A GRAVIMETRIC SEPARATOR

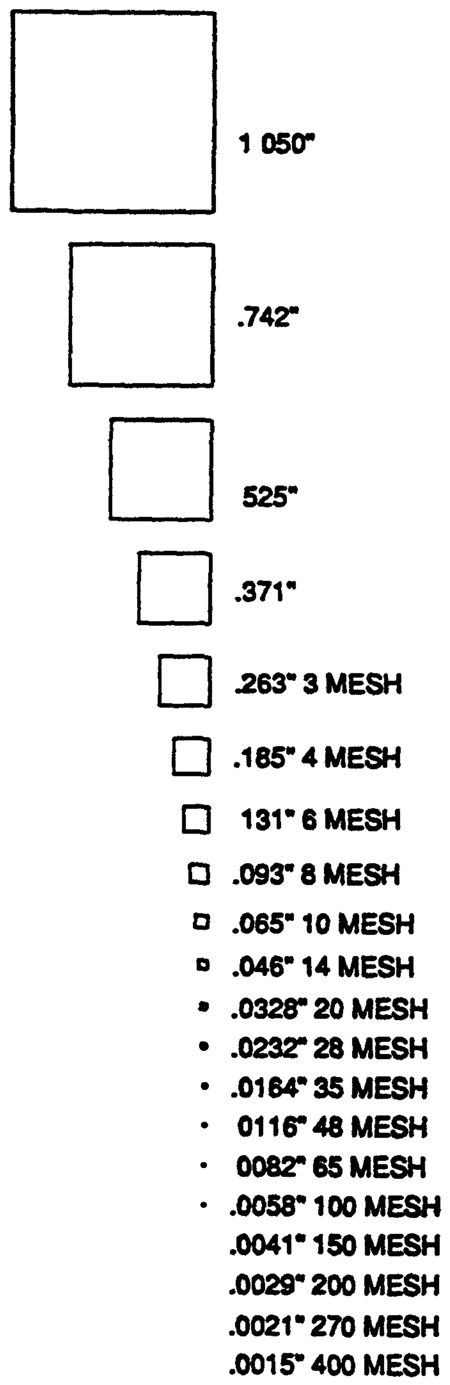

FIGURE 7.2-2

PARTICLE SIZE REPRESENTATION

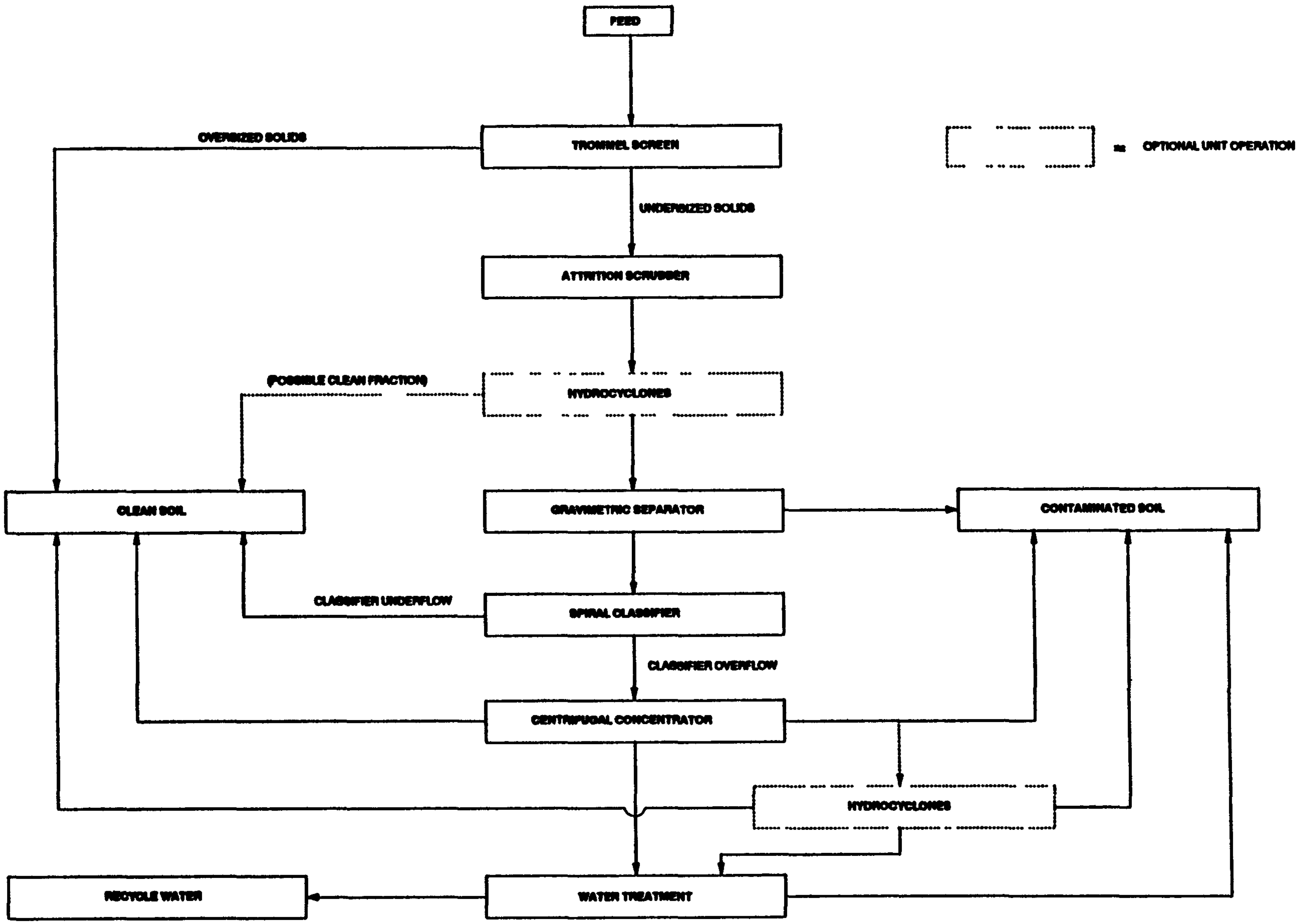

FIGURE 7.2-3
GENERAL FLOW DIAGRAM
TRUclean PROCESS

7.3 Experimental Procedures and Equipment

AWC will conduct a treatability test on RFP plutonium-contaminated soils The goal of the experimental procedures is to select the bench-scale process equipment (Phase I) and place that equipment in the most effective sequence (Phase II) to separate clean (less than 0 9 pCi/g Plutonium 239 plus Plutonium 240) soils from plutonium-contaminated soils

There are at least eight pieces or types of process equipment that will be tested There are at least five additional types of support equipment that will be used in conjunction with the process equipment. AWC has provided the following SOPs. The SOPs are included in Attachment 2

Process Equipment	SOP No.
Gravimetric Separator	SOP NTS 101
Centrifugal Gravimetric Separator	SOP NTS 102
Multi-Gravity Separator	SOP NTS 104
Trommel	SOP NTS 201
Attrition Scrubber	SOP NTS 203
Spiral Classifier	SOP NTS 301
Hydrocyclone Test Unit	SOP NTS 302
Thickener	

Support Equipment	SOP No.
Feed Auger	SOP NTS 202
Pump(s)	
Hopper(s)	
Tank(s)	
Homogenizer	
Agitator(s)	

7 3.1 Experimental Design

The experimental design for the AWC TRUclean Process and its expanded pieces of equipment, will be based upon two phases of tests Phase I will consist of testing individual pieces of process equipment selected by AWC in order to determine the following

- Effectiveness in separating clean soils from plutonium-contaminated soils
- Optimum size fraction(s) cleaned in the individual pieces of process equipment
- Optimum settings for the various physical variables for each piece of process equipment (e.g , incline angle and rpm)
- Optimum settings for the process variables for each piece of process equipment (e g , gallons per minute (gpm) of wash water, pulp density, and feed rate)

In order to determine the optimum conditions, AWC will select for their equipment, a 22 to 23 kilogram (approximately 50 lb) sample of contaminated soils which will be charged 10 to 15 times to the piece of equipment to determine the optimum physical and operating parameters for a particular unit operation. There will be flexibility in the procedures to make adjustments for optimizing performance results For example

- If optimum conditions can be achieved with fewer tests on a particular piece of process equipment, a smaller number of tests will be conducted If more tests are required, they will be conducted
- If 22 to 23 kilograms is insufficient for optimization tests on a particular piece of equipment, more contaminated soils will be added to the test run If 22 to 23 kilograms is an excess quantity, a smaller quantity will be used.

Once the Phase I data results are evaluated and the optimum design developed, EG&G-RF or its designated contractor will approve the design, the Phase II portion of testing will begin As part of Phase II, the process equipment units will be placed, based upon the Phase I evaluation, in the most effective sequence to separate clean soils from plutonium-contaminated soils The experimental design for Phase II will consist of three runs (the Final Record Runs) Each of these runs will test 90 to 91 kilograms (approximately 200 lb.) of contaminated soils to effect the separation of clean soils from plutonium-contaminated soils.

7.3.2 Testing Facility

The TRUclean Process treatability tests will include testing of both the TRUclean Process and additional physical separation equipment. Tests will be performed at NTS near Mercury, Nevada, within Area 25 at the ETL Facility, Building 3124

7.3.3 Characterization of Test Soil

The RFP contaminated soils will be split at the sample collection site (Attachment 1) One sample will be split for the RFP, which will conduct chemical and radiological testing RFP characterization data will be compared with AWC characterization data The characterization procedures discussed in this section are subject to change or modification based upon the final recommended protocols of the Protocol Committee for Soil Characterization These protocols are being developed as part of the Plutonium in Soil Integrated Demonstration

AWC will generate a characterization sample from the RFP contaminated soils sent to them in four 55-gallon Department of Transportation (DOT) 17H drums. AWC will place the contaminated soil from the four drums, approximately 1450 kilograms (3200 lb) into a 10-foot long by 10-foot wide tray "homogenizer". The contaminated soils will be mixed thoroughly by manual means

Once the RFP contaminated soils are thoroughly mixed, the mass will be split using the standard "cone and quartering" (Tyler, 1989) technique described below and shown in Figure 7.3-1·

> The sample will be piled in a cone, each shovelful going to the center of the cone and allowed to run down equally in all directions - this will mix the sample. Spread the pile out in a circle and walk around the pile gradually widening the circle with a shovel until the material is spread out to a uniform thickness.

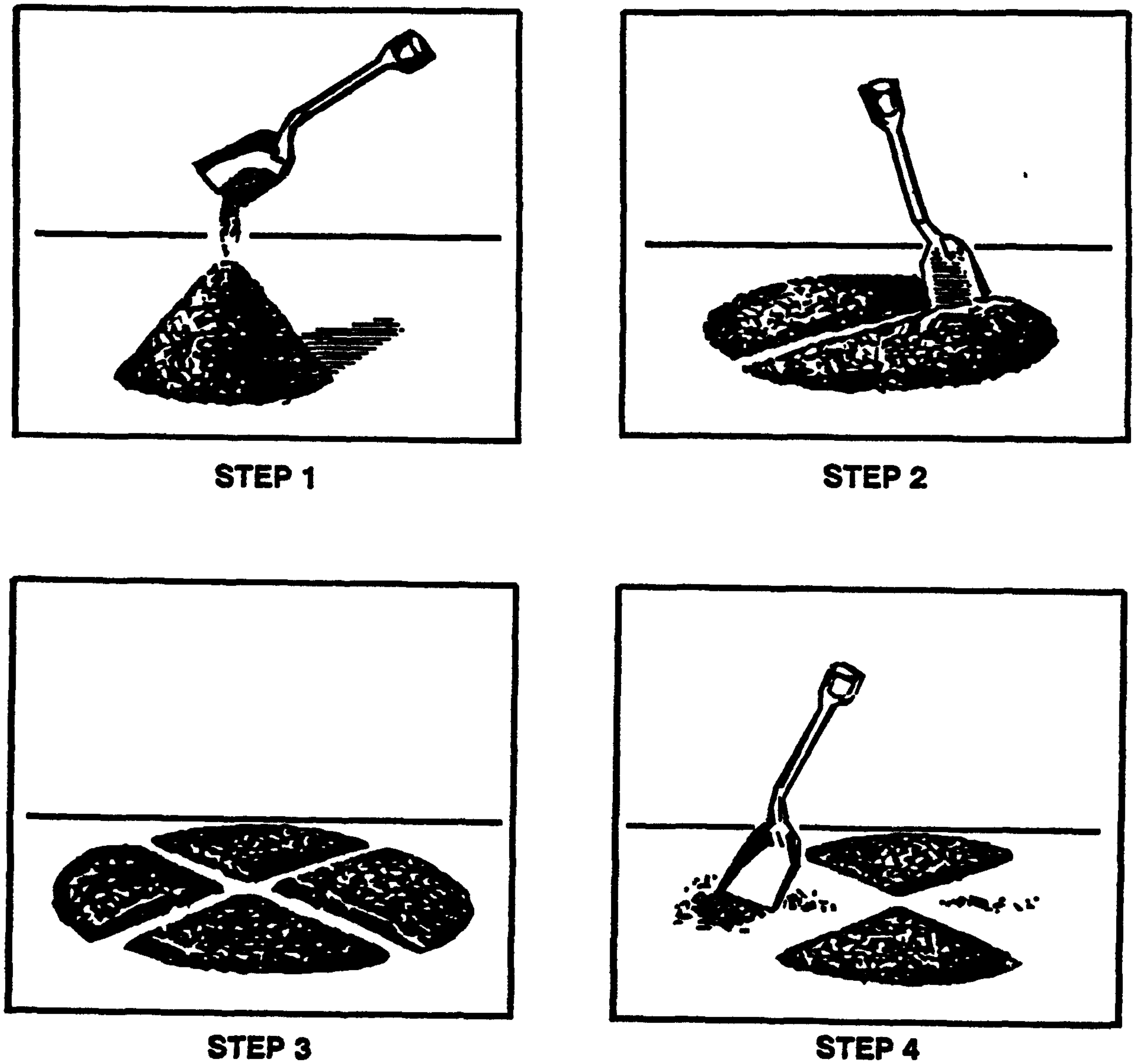

FIGURE 7.3-1
CONE AND QUARTERING

> Divide the flat pile into quarters and reject two opposite quarters Mix again by shoveling the material into a conical pile, taking alternate shovelfuls from the two quarters saved Continue the process of piling, flattening, and rejecting two quarters until the sample is reduced to the required size
>
> Surveys have shown that the greatest cause of inconsistencies in testing results have come from improper selection of a sample which is not truly representative of the entire lot of material Therefore, every care should be taken in the proper selection of the sample

This procedure will be repeated five times to reduce the initial 1450 kilograms to approximately 91 kilograms (200 lb) After the fifth repeat, the flattened pile will consist of four quarters of 22 to 23 kilograms Opposite quarters will be combined resulting in two samples One approximately 45 kilogram (100 lb) sample, will be the AWC characterization sample (AWC-CS) The other, approximately the same weight, will be the RFP check sample The RFP sample will be placed into a minimum 6 mil plastic bag, tie sealed, labeled, and placed into a 30-gallon DOT 17H drum. This drum will be used to send all RFP splits from the AWC treatability tests to the RFP

The approximate 45 kilogram AWC-CS will be characterized with the following tests The sample will be air dried after the bulk density determination sample is taken and prior to the other characterization tests.

- Bulk density determination

Air-dry sample prior to performing the remaining tests

- pH determination
- Particle size analysis
- Air-dry moisture determination
- Gross alpha determination
- Gross beta determination
- Plutonium 239 plus 240 determination

7.3.3.1 Bulk Density Determination

The bulk density will be obtained in accordance with Analytical Procedures AWC, AP No AWC 2, Bulk Density Determination, Rev 0, 05/02/91 The "volume filling" alternate should be used. The sample will be taken from the approximate 45 kilogram AWC-CS The bulk density sample will then be returned to the full sample The AWC Analytical Procedures are included in Attachment 2

7.3.3 2 Air Drying

The approximate 45 kilogram AWC-CS will be air dried prior to the remaining characterization tests being conducted The air drying procedure will be that described in Analytical Procedures, AWC, AP No AWC 5, Air Dry Moisture Determination, Rev 0, 05/02/91, Section 5 4, Sample Drying

7.3 3 3 pH Determination

The pH determination will be obtained in accordance with Analytical Procedures, AWC, AP No AWC 4, pH Determination, Rev. 0, 05/02/91. The sample will be a grab sample from the air dried AWC-CS

7.3 3 4 Particle Size Analysis

The RFP contaminated soil sample could contain 0 to 5 percent plus 3-inch size cobbles. In order to be prepared to properly handle these larger particle sizes, the Particle Size Analysis will consist of three discrete screening ranges plus 125 mm (+5-inch) to plus 19 mm (+3/4-inch), minus 19 mm (-3/4-inch) to plus 300 micron (+U S No 50), and minus 300 micron to minus 45 micron (-U.S. No 325)

125mm - 19mm

A Gilson Rocker Screen Set, SS-35, or equivalent, will be used to screen the entire AWC-CS, approximately 45 kilograms The screen (sieve) sizes to be used are as follows:

millimeters	U.S. Sieve No.
125	5-in.
100	4-in
75	3-in
50	2-in
37.5	1 1/2-in
25	1-in
19	3/4-in

First, the 125 mm opening screen will be used in the Rocker Screen Set. The AWC-CS will be placed onto the screen, and the box rocked to pass the minus 125 mm soils through the screen Obvious clumps which are not coarse solid material will be manually broken to pass through the screen. The plus 125 mm material will be removed from the screen, weighed, and retained separately The volume of the Rocker Screen Set box may require three repeats in order to screen/size the approximate 45 kilogram sample

Second, the 100 mm opening screen will replace the 125 mm opening screen and the cycle will be repeated The plus 100 mm material will be removed, weighed, and retained separately The minus 100 mm material will be feed material to repeat the cycle using the 75 mm screen

Once all of the AWC-CS has been dry screened through the sequence of sieve sizes to the 19 mm screen, the minus 19 mm contaminated soils will be set aside for later screening in the 19 mm to 300 micron sequence.

The separately retained size fractions, up to seven fractions if all sizes are present, will be subjected to wet screening in order to remove fine adhering particles The procedure to be followed will be that outlined in Analytical Procedures, AWC, AP No AWC 3, Particle Size Analysis, Rev. 0, 05/02/91, Section 5.5, Wet Sieving Method The screen oversize will be dried, weighed, and retained separately

Those materials separately retained in sizes plus 125 mm, plus 100 mm, plus 75 mm, and plus 50 mm will be split using the following sequence, by size

1) Place the material on a roll cloth and roll

2) Cone and quarter the material as described earlier

3) Select a grab sample from one quadrant for chemical testing (Sections 7.3 3 6, 7 3 3 7, and 7.3.3 8)

4) Select the entire opposite quadrant for the RFP sample

5) Retain all the remaining sample from all cone and quarter splits

Those materials separately retained in sizes minus 50 mm will be split using the following sequence, by size

1) Place the material into a Gilson Model SP-1 sample splitter or equivalent

2) Adjust the chute opening width to a minimum of twice the particle size, preferably three times (e g , for minus 50 mm use a 4-inch wide setting and for minus 37.5 mm use a 3-inch wide setting)

3) Each pass through the splitter will reduce the sample in half

4) Reduce the sample to the size required by AWC's internal laboratory procedures for chemical testing

5) When the final split size is selected, the other pan split in the sampler will be the RFP sample

6) Retain all the remaining samples from the pan splits

19mm - 300 micron

The minus 19 mm (-3/4-inch) contaminated soil from the dry screening and the oven dried fines from the wet screening will be combined These soils will then be split in a Gilson Model SP-1 Sample Splitter or equal, down to approximately 4 kilograms (8.8 lb). The sample will be split once more with half retained for the particle size analysis and half for the RFP sample Retain all the remaining sample from the pan splits.

The approximate 2 kilograms (4 4 lb) of AWC-CS particle size analysis sample fraction will be screened using the following sieve sizes

millimeters(microns)	U.S. Sieve No.
9 5	3/8-in
6 3	1/4-in.
4.0	5
2 0	10
(850)	20
(425)	40
(300)	50
PAN	

The particle size analysis will be obtained in accordance with Analytical Procedures, AWC, AP No. AWC 3, Particle Size Analysis, Rev 0, 05/02/91, except that the above sieve sizes will be used Both dry and wet sieving will be conducted

The minus 300 micron (-U S No 50) contaminated soil in the pan and the dried washed fines from wet sieving will be the feed material to the next set of sieve sizes The following sizes will be used.

microns	U.S. Sieve No.
212	70
150	100
106	140
75	200
45	325
PAN	

The particle size analysis will be obtained in accordance with AWC AP, No AWC 3, except that the above sieve sizes will be used

7.3 3.5 Air-DryMoisture Determination

The moisture determination will be obtained in accordance with Analytical Procedures, AWC, AP No AWC 5, Air-DryMoisture Determination, Rev 0, 05/02/91 The sample will be obtained from the retained portion of the minus 19 mm, plus 300 micron split. This sample will be reduced to the desired size required by AWC, AP No AWC 5 by reducing the sample in the Gilson Model SP-1 Sample Splitter or equal

7.3.3.6 Gross Alpha Determination

A gross alpha determination will be made on a sample of soil retained on every fraction (plus size) generated in the Particle Size Analysis as well as on the minus 45 micron sample This will be 20 determinations if particles are present in every sieve size

The gross alpha determination will be made according to the AWC internal laboratory procedures in a manner sufficient to meet the requirements outlined in Section 5 2

7 3 3 7 Gross Beta Determination

A gross beta determination will be made on a sample of soil retained on every fraction (plus size) generated in the Particle Size Analysis as well as on the minus 45 micron sample This will be 20 determinations if particles are present in every sieve size

The gross beta determination will be made according to the AWC internal laboratory procedures in a manner sufficient to meet the requirements outlined in Section 5.2

7.3.3.8 Plutonium 239 plus 240 Determination

A plutonium 239 plus 240 determination will be made on a sample of soil retained on every fraction (plus size) generated in the Particle Size Analysis as well as on the minus 45 micron sample This will be 20 determinations if particles are present in every sieve size

The plutonium 239 plus 240 determination will be made according to the AWC internal laboratory procedures in a manner sufficient to meet the requirements outlined in Section 5 2

7.3 4 Test Process

The TRUclean Process was specifically oriented to separate heavy contaminants from lighter non-contaminants The initial development effort centered around the GS Since the initial work, the TRUclean Process has grown into an assembly of physical scrubbing/classifying/separating pieces of equipment for segregating heavy contaminants from lighter non-contaminants

Once the RFP sample has been received (four 55-gallon DOT 17H drums), homogenized, and the AWC-CS removed, the treatability tests will begin The treatability tests to be conducted on the RFP plutonium-contaminated soils will utilize many, if not all, of the process equipment listed in the introduction to Section 7.3. The steps in the treatability study are as follows

1. Characterize the sample
2. Test individual pieces of process equipment using water as the liquid medium.
3. Optimize the settings of the variables on the individual pieces of process equipment.
4. Test individual pieces of process equipment at the optimum settings using a sodium hydroxide solution at a pH of 12 0 to 12 5 as the liquid medium
5 Evaluate the performance results from the individual pieces of process equipment.
6 Assemble the selected pieces of process equipment into a sequential flow system that provides an expected optimum performance

7. Test the optimum sequence system with water as the liquid medium.

8. Test the optimum sequence system with a sodium hydroxide solution at a pH of 12 0 to 12.5

The initial parts of the test process are depicted on Figure 7.3-2, Feed Blending and Trommel Scrub/Screen. Several of the more important pieces of support equipment are shown on this figure homogenizer, scale, and containers Once the AWC-CS has been removed as described in Section 7.3 3, the remaining sample, approximately 1360 kilograms (3000 lb) will be coned and flattened once (Section 7 3 3, Figure 7 3-1) Samples for testing will be withdrawn from this disc shaped pile as required. Using a hoe or similar rabbling tool, a segment of contaminated soil will be withdrawn from the disc weighing approximately 23 kilograms (50 lb) The sample will be withdrawn by placing the hoe at the center of the circle and withdrawing a thin segment. Additional samples for 23 kilogram tests will be withdrawn by selecting random radii and withdrawing soil from the center to the outer edge along the radii For Phase I testing (Section 7 3 1), the sample size will be generally 23 kilograms, however, the sample size can be varied For example, the trommel feed sample may need to be increased to 34 kilograms (75 lb.) in order to generate a 23 kilogram product for follow-on process equipment tests

Prior to beginning the Phase II testing (Section 7 3 1), the remaining sample will be coned, flattened and either quartered or divided into thirds This choice will depend on the amount of sample left. Phase II, the Final Record Runs, will consist of three runs, each consisting of approximately 90 kilograms of contaminated soil The sample could be increased up to 114 kilograms (250 lb) if a greater quantity of fine material is needed

7.3 4.1 Support Equipment

There are several pieces of support equipment which will be used in association with most of the pieces of process equipment These items include, but are not necessarily limited to the following homogenizer (Section 7.3 3), scale(s), feed hopper(s) with 3/4-inch opening screen deck, feed auger, collection containers, tank(s), and pump(s)

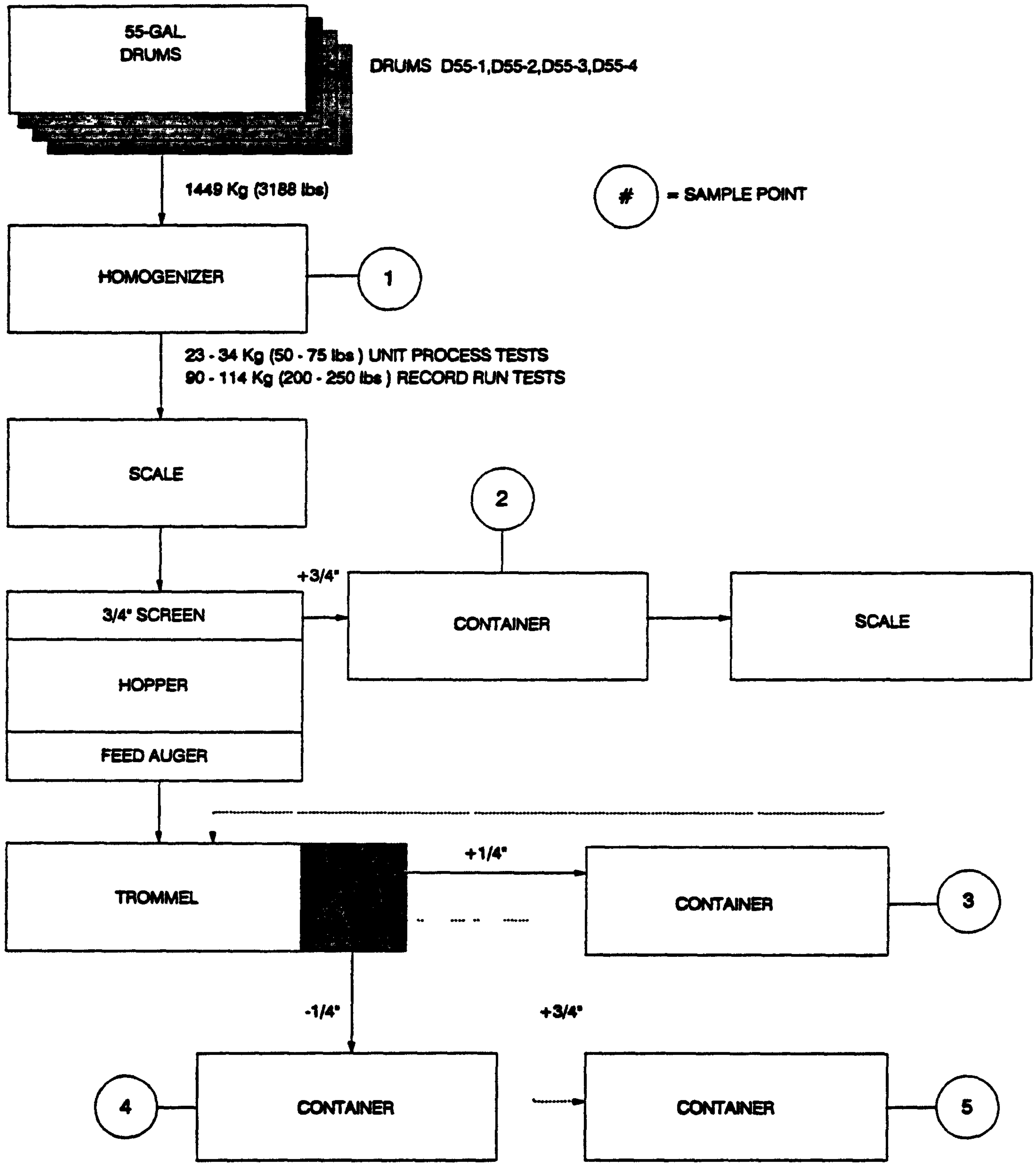

FIGURE 7.3-2
FEED BLEEDING AND
TROMMEL SCRUB/SCREEN

Scale(s)

All samples will be weighed prior to being tested and all products of the tests will be weighed A small portion of every fifth feed sample will have its moisture content determined (AP No AWC5, Air-Dry Moisture Determination)

Feed Hopper(s) with Screen Deck

The RFP plutonium-contaminated soil sample is expected to contain particles larger than 3/4-inch In order to protect the feed auger, the 3/4-inch material will be removed and saved in a container (Figure 7 3-2) The hopper's capacity is approximately five gallons (0 67 ft^3)

Feed Auger:

The feed auger will be used to control the rate (kg/hr, lb/hr) at which the sample is added to the process equipment The feed auger will be operated in accordance with AWC's Standard Operating Procedure, SOP NTS 202, Operation of feed auger, Rev 1, 7/1/91 The Auger Feed Rate table, page 7 of 7, is based upon a density of 2 65 g/cm^3 The rheostat setting calibration will need to be recalculated based upon the AWC-CS bulk density determination In general, the feed rate will be set to deliver a 23 kilogram sample to the process equipment in 10 minutes This is equivalent to 138 kilograms (300 lb) per hour The feed rate will be adjusted higher or lower as the test results indicate it is appropriate

Container(s).

Containers will be used to collect and accumulate the various products of each process equipment test during Phase I During Phase II, process equipment units will be assembled in sequence Containers will then be used for products at the end of the sequence

Products which are collected can be dry solids (+3/4-inch material from the hopper screen), wet solids (screw classifier underflow), or slurries (hydrocyclone overflow) The containers will be tared prior to use and they will be weighed after use

7.3 4 2 Process Equipment

The pieces of process equipment that will be tested as part of the treatability study program include the following trommel, spiral classifier, GS, attrition scrubber, centrifugal gravity separator, multi-gravity separator (MGS), hydrocyclone test units, thickener, and filter(s)

AWC will have considerable flexibility in executing the treatability studies within the parameters of the TRUclean Process This flexibility will include AWC's ability to choose items such as

- Number of tests in each piece of process equipment
- Weight of soil for each test
- Setting of process equipment variables
- Sequence of testing process equipment
- Choice of process equipment to receive products from earlier tests

AWC will be required in the performance of the treatability tests to meet specific criteria, including but not necessarily limited to the following

- Use water as the liquid medium to establish optimum operating conditions on each piece of process equipment to be tested
- Use a sodium hydroxide solution at a pH range of 12 0 to 12.5 to test the process equipment at the optimum settings
- Develop a plan for arranging the process equipment in sequence to generate the largest volume of clean (less than 0 9 pCi/g Plutonium 239 plus 240, Section 4.2) soils obtainable
- Obtain acceptance of the plan from EG&G-RF or its designated subcontractor
- Execute the plan at least three times using a minimum 91 kilograms (200 lb) of contaminated soil and using a sodium hydroxide solution at a pH range of 12 0 to 12 5 at least once.
- Collect, record, analyze and report all data in accordance with the requirements outlined in Section 5.2
- Conduct the six physical and chemical tests particle size analysis, pH determination, air-dry moisture determination, gross alpha determination, gross beta determination, and plutonium 239 plus 240 determination, on every sieve size of every product generated
- Conduct screen and sieve sizing to include millimeters - 125, 100, 75, 50, 37 5, 25, 19, 9.5, 6 3, 4 0, and 2.0 (U.S No 5",4",3",2",1-1/2", 1",3/4", 3/8", 1/4", 5, and 10), microns - 850, 425, 300, 212, 150, 106, 75, 45, and -45 (U S No 20, 40, 50, 70, 100, 140, 200, 325, and -325) on every product generated as appropriate for the particle sizes present.

Descriptions of parameters for the process equipment of the TRUclean Process follow

Trommel

The trommel is an inclined rotating cylinder with internal spray bars and a perforated (1/4-inch openings) discharge tube The rotation causes the larger soil particles to roll and tumble This action removes fine particles adhering to larger ones. The water sprays wash the fines off the coarser particles (+ 1/4-inch, 6 3 mm) The trommel is shown on Figure 7.3-2 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 201, Rev 1, 7/01/91 The trommel has four variables which can be adjusted to affect its operation angle of tilt, feed rate, spray bar water flow, discharge screen opening size The initial settings will be

Angle of tilt· The trommel will begin at zero setting which is approximately minus 10 degrees slope from horizontal To obtain greater retention time, which will increase the scrubbing/washing time, raise the discharge end of the trommel (decrease the minus 10 degree slope to a lower negative slope)

Feed rate The feed rate will be controlled by the feed auger (Section 7 3 4 2) The initial feed rate will always be set to deliver a 23 kilogram (50 lb.) test sample in 10 minutes Adjustments for ensuing tests will be made as required

For plus 3/4-inch contaminated soils the feed auger will be by-passed The feed rate will be controlled by the size of test sample and frequency of addition when by-passing the feed auger

Spray bar water flow. The initial spray bar water flow will always be set to deliver five gpm water Adjustments for ensuing tests will be made as required In general, the target pulp density inside the trommel is five to ten percent solids

Discharge screen opening size The discharge screen with the 1/4-inch (6 3 mm) openings will be used for all trommel tests

Spiral Classifier.

Based upon the precept that the soil contaminants are small, heavy particles mixed with or adhering to larger clean soil particles, the spiral classifier is anticipated to be the optimum second step in the contaminated soil cleaning sequence The spiral classifier can separate coarse particles (+150 micron, U S No 100) particles from finer particles (-150 micron) by controlling spiral rpm, weir depth, and pulp density. The spiral classifier is shown on Figure 7 3-3 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 301, Operation of the Spiral Classifier, Rev 1, 7/01/91. The spiral classifier has four variables which can be adjusted to affect its operation: auger speed (screw rpm), feed rate, pulp density, and weir height. The initial settings will be set to achieve a split of minus 1/4-inch, plus 70 U S No sieve (-6 3mm, +212 microns) in the underflow This size split is chosen as the initial starting

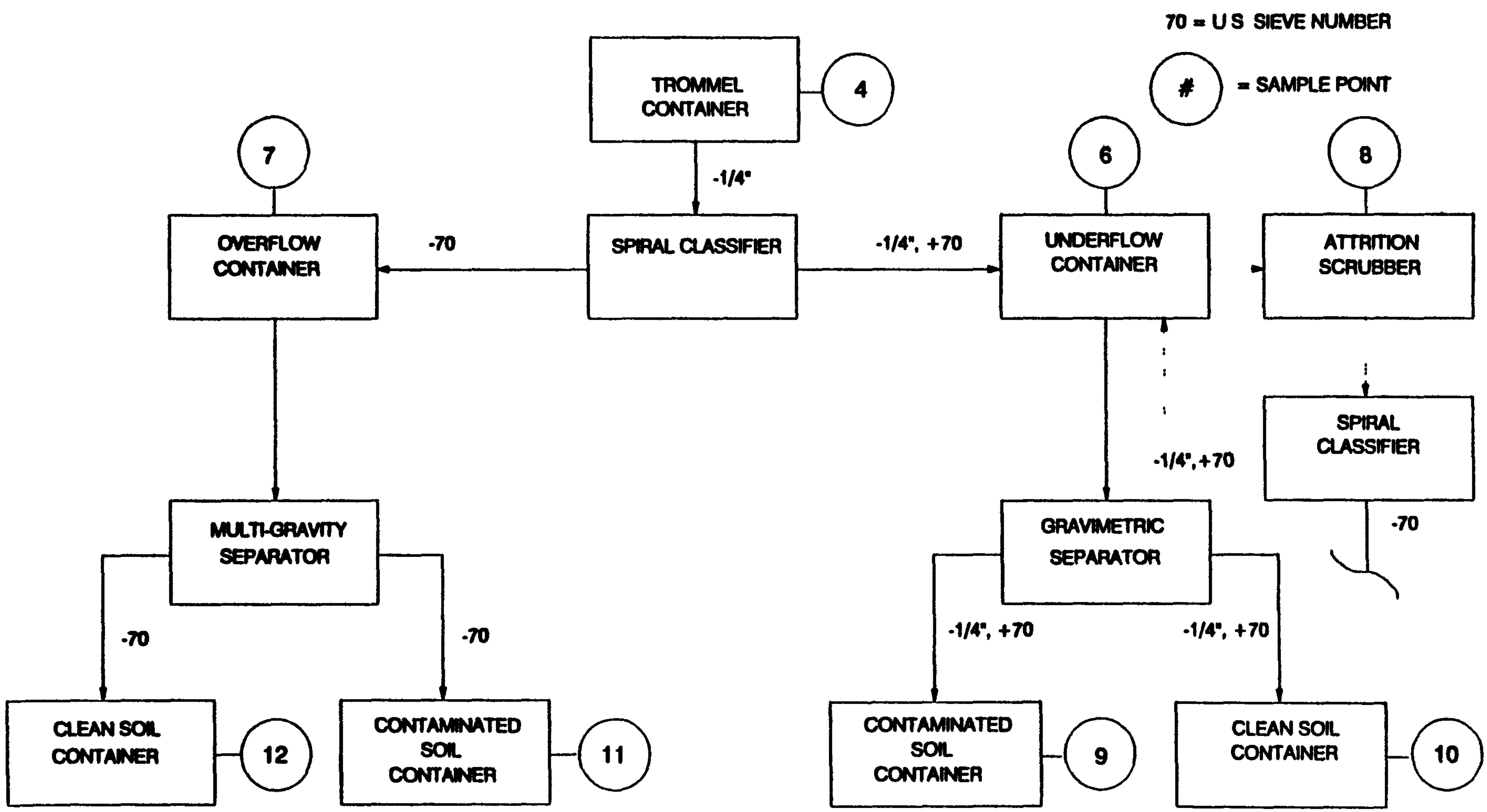

FIGURE 7.3-3
CLASSIFIER SIZING
AND GRAVITY SEPARATION

point because if the particles do not meet the "clean" requirements, they are in the preferred size range for the GS and/or the attrition scrubber

Auger speed: the auger speed will be set at 25 rpm for the initial test. Adjustments will be made to achieve a split between underflow and overflow at U S Sieve No 70

Feed rate· The feed rate will be controlled to deliver a 23 kilogram test sample in 10 minutes. Adjustments for ensuing tests will be made as required.

Pulp density. The pulp density will be adjusted as required to achieve the desired split at U S Sieve No 70 Water sprays will be used to wash fine particles off of the coarse particles being raised by the spiral (underflow) This volume of water will impact the pulp density

Weir height The initial weir height will be set at the maximum height. Adjustments will be made as required to achieve the desired size split

The spiral classifier underflow, Figure 7 3-3, item 6 will be sampled in order to conduct the six physical and chemical tests discussed in Section 7 3 6 These tests will indicate the effectiveness of the separation of contaminants from the clean soil If the spiral classifier underflow is not "clean", further treatment and/or adjustments to the split size will be required The underflow can be further treated by the GS or attrition scrubber

Attrition Scrubber:

The attrition scrubber is shown on Figure 7 3-3 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 203, Rev 1, 7/01/91. The attrition scrubber is an agitation device in which particles continually abrade each other This removes fine (-150 micron) particles from larger (500 to 150 microns) particles The attrition scrubber has four variables which can be adjusted to affect its operation pulp density, impeller speed, feed rate, and residence time The attrition scrubber is a two cell unit consisting of two approximately 1 $ft.^3$ cells The attrition scrubber operates in series with the first cell, discharging to the second AWC may have available a new two cell unit for the treatability tests The new unit's cells will operate in series and be smaller, approximately 0 33 $ft.^3$ to 0.5 $ft.^3$ cells

Pulp density: The pulp density will be set for 70 percent solids for the initial test. Adjustments will be made as required to effect better scrubbing

Impeller speed The initial impeller speed will be set according to the manufacturer's recommendation

Feed rate The feed rate will be controlled to deliver a 23 kilogram test sample in 10 minutes. Adjustments for ensuing tests will be made as required. Feed rate affects retention time

Residence time The longer the residence time, the greater the scrubbing contact Residence times are adjustable from 3 minutes to 30 minutes After the initial feed rate setting, adjustments to residence time will be made as required

A sample, Figure 7 3-3, item 8, will be obtained from the attrition scrubber in a manner similar to that described for the minus 1/4-inch fraction (-6.3 mm) in Section 7.3 6 The results of the six physical and chemical tests will indicate the effectiveness of the scrubbing and the sieve size to achieve a separation of "clean" and contaminated soils It is anticipated that the attrition scrubber product will be treated best by a return to the spiral classifier

Gravimetric Separator

The GS is shown on Figure 7.3-3 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 101, Rev 1, 7/01/91 The GS separates heavy (>7.0 Sp Gr) particles from lighter particles due to the faster settling rate of the heavy particles in a pulse of water The GS has six variables which can be adjusted to affect its operation stroke length, stroke frequency, bedding material, water flow rate, feed dilution water and feed rate The GS operates best in the particle size range of minus 3/8-inch, plus U S No 200 (-9.5 mm, +75 micron)

Stroke length Stroke length will be set at 1/2-inch for the initial test. Adjustments will be made as required

Stroke frequency The stroke frequency will be set a 125 strokes per minute for the initial test Adjustments will be made as required

Bedding material. The initial bedding material will consist of 3/16-inch steel balls placed to a thickness of 1-inch on the support screen The support screen openings are fixed at 1/8-inch

Water flow rate The initial water flow rate will be set at 5 gpm Adjustments will be made as required.

Feed dilution water. The initial feed dilution water will be set to produce a 30 percent solids by weight pulp density Adjustments will be made as required.

Feed rate The feed rate will be controlled to deliver a 23 kilogram test sample in 10 minutes Adjustments for ensuing tests will be made as required

Samples to determine the effectiveness of the GS will be taken from both the anticipated "clean" container (overflow) and the contaminated soil container(s) (hutch and bed) Samples will be obtained and analyzed as discussed in Section 7.3 6. As with all AWC analyses, a split sample will be taken for RFP

Multi-Gravity Separator.

The MGS is shown on Figure 7 3-3 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 104, Rev 1, 7/01/91. The MGS separates heavy (>4 0Sp Gr) particles from lighter particles via a combination of centrifugal and velocity forces, (e g , rotational speed and shaking frequency) The MGS has seven variables which can be adjusted to affect its operation rotational speed, shake frequency, amplitude, washwater flow rate, angle of tilt, feed rate, and pulp density The MGS operates best on liberated contaminants in the minus 250 micron (-60 U.S No), plus 1 micron range. The spiral classifier overflow will be targeted to be minus 250 microns which makes the MGS an appropriate piece of process equipment to test on spiral classifier overflow

Rotational speed The rotational speed will be set a 200 rpm for the initial test. Adjustments will be made as required Rotational speed settings are 160, 200, or 240 rpm

Shake frequency The shake frequency will be set at 4 8 cycles per second (cps) for the initial test Adjustments will be made as required. Shake frequency settings are 4 0, 4 8, or 5 7 cps

Amplitude The amplitude will be set at 19 0 mm for the initial test Adjustments will be made as required Amplitude settings are 12 7, 19.0, or 25 4 mm.

Washwater flow rate The washwater flow rate will be set at 5 liters per minute (lpm) for the initial test Adjustments will be made as required Flow rates are adjustable from 0 to 10 lpm

Angle of tilt The tilt angle will be set at 2 5 degrees for the initial test. Adjustments will be made as required Tilt angles are adjustable from 0 to 5 degrees

Feed rate the feed rate will be controlled to deliver a 23 kilogram test sample in 10 minutes. Adjustments for ensuing tests will be made as required.

Pulp density· The pulp density will be set at 30 percent solids by weight for the initial test. Adjustments will be made as required Pulp density is adjustable from 15 to 50 percent.

Samples to determine the effectiveness of the MGS will be taken from three locations, items 7, 11, and 12 as shown on Figure 7 3-3 Samples will be obtained and analyzed as discussed in Section 7.3 6 As with all samples taken for AWC analyses, a split will be taken for RFP.

Hydrocyclone.

The hydrocyclone is shown on Figure 7 3-4 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 302, Rev 1, 7/01/91 The hydrocyclone separates different particle sizes into a plus and minus size fractions Hydrocyclones can make good separations over wide particle size ranges For example, hydrocyclones can separate particles at plus and minus 1 millimeter or plus and minus 75 microns The hydrocyclone has four variables which can be adjusted to affect its operation pulp density, inlet pressure, vortex diameters, and unit size. The hydrocyclone has the capability to split the very fine particles away from the more coarse particles The hydrocyclone will be tested to determine two items

1) capability to separate contaminated soils from "clean" soils, items 13 and 14, respectively on Figure 7.3-4, and 2) capability to provide improved sized feed to the centrifugal gravity separator and the MGS

Pulp density The pulp density will be set at the optimum spiral classifier pulp density for the initial test. Adjustments will be made as required

Inlet pressure The inlet pressure will be set at 75 psi for the initial test Adjustments will be made as required Inlet pressure is adjustable from 50 to 100 psi

Vortex diameter: The vortex diameter for the initial test will be selected based upon the hydrocyclone manufacturer's recommendation to control the underflow at minus 70 U S No , plus 200 U S No with 5 percent or less (preferred) minus 200 U S No particles in the underflow

Unit size For the particle size separations discussed, the 10 mm hydrocyclone(s) will be used

The hydrocyclone overflow and underflow will be sampled and analyzed, items 13 and 14, Figure 7 3-4 Tests will be conducted to try to achieve a "clean" underflow If a clean underflow is not achieved, the underflow will be tested in the centrifugal gravity separator. In either case the hydrocyclone overflow will be tested in the MGS as described for treating spiral classifier Overflow.

Centrifugal Gravity Separator·

The centrifugal gravity separator (CGS) is shown on Figure 7.3-4 and its operation is covered by Standard Operating Procedure, AWC, SOP NTS 102, Rev 1, 7/01/91 The CGS separates heavy (>4 0 Sp Gr.) particles from lighter particles via a combination of centrifugal and velocity forces. The CGS works better on particles smaller than 212 microns. The CGS has five variables which can be adjusted to affect its operation· feed dilution, feed size, feed rate, bowl back pressure, and shaking screen vibration (frequency and amplitude)

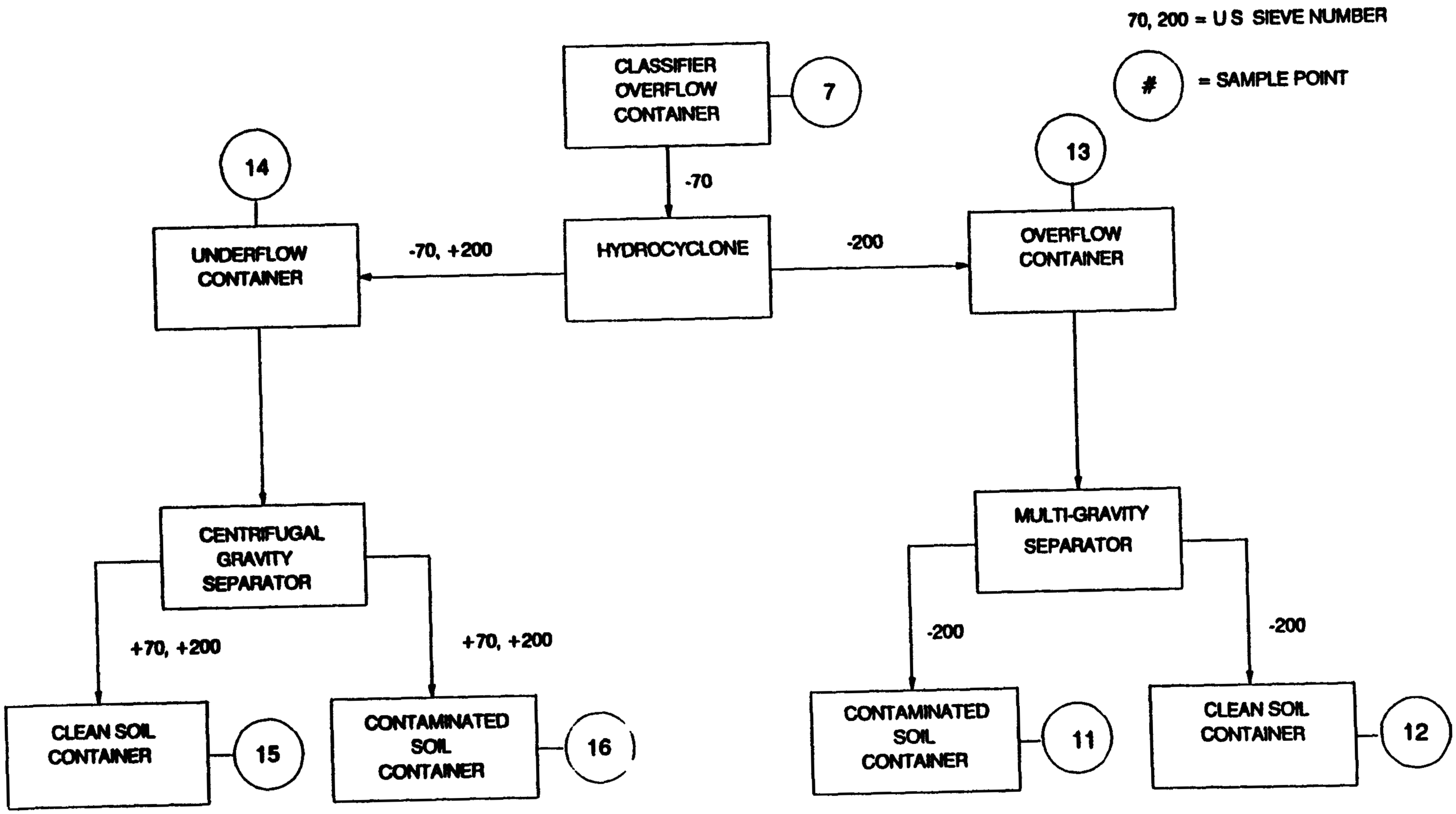

FIGURE 7.3-4
HYDROCYCLONE SIZING
AND GRAVITY SEPARATION

Feed dilution. The feed dilution will be set at 40 percent solids by weight for the initial test. Adjustments will be made as required The minimum feed dilution is 30 percent solids

Feed size. The feed size will be set at minus 70 U.S No., plus 200 U.S No (-212, +75 microns) for the initial test Adjustments will be made as required

Feed rate· The feed rate will be controlled to deliver a 23 kilogram test sample in 10 minutes. Adjustments for ensuing tests will be made as required

Bowl back pressure· The bowl back pressure will be set at 9 psi for the initial test Adjustments will be made as required The bowl back pressure is adjustable from 0 to 30 psi For minus 100 U.S No (-150 micron), normal pressures are in the 4 to 6 psi range

Shaking screen vibration The shaking screen vibration, frequency and amplitude, will be set at the mid-range setting for each one for the initial test Adjustments will be made as required

Samples to determine the effectiveness of CGS will be taken from three locations, items 14, 15 and 16 as shown on Figure 7.3-4. Samples will be obtained and analyzed as discussed in Section 7 3 6 As with all samples taken for AWC analyses, a split will be taken for RFP.

Thickener·

A center-well feed thickener will be used to test the recovery of scrub/wash/dilution water for recycle Flocculants and pH adjustments will be tested to obtain the cleanest possible thickener overflow It is critical that recycle water contain low enough levels of radionuclides so that they contribute less than half, ideally one-tenth, the radionuclide levels set in the "clean" definition before being recycled

7.3 5 Equipment, Materials and Reagents

The major pieces of equipment that will be utilized are in three areas Process Equipment, Support Equipment, and Sampling/Analytical Equipment.

7.3 5 1 Process Equipment

- Trommel
- Spiral Classifier
- Attrition Scrubber(s)

- Gravimetric Separator
- Hydrocyclones
- Centrifugal Gravity Separator
- Multi-Gravity Separator
- Thickener

7.3.5.2 Support Equipment

- Feed Auger(s)
- Hopper(s) with screen
- Containers tanks, drums
- Pumps
- Agitators
- Filter(s)
- Scale(s)

7.3 5.3 Sampling/Analytical Equipment

- Homogenizer
- Gilson, Rocker Screen Set, SS-35 or equivalent, U.S No Screens 5-, 4-, 3-, 2-, 1 1/2-, 1-, and 3/4-inch
- Gilson Model SP-1, Sample Splitter or equal with three pans, brushes
- Tyler Sample Reducer (16 1) or equivalent with three pans, brushes
- Hoe or rabble
- Laboratory sieve screen sets to cover sizes U S No (mm or microns)

3/8-inch	(9 5 mm)
1/4-inch	(6 3 mm)
U S No 5	(4 0 mm)
U S No 10	(2 0 mm)
U S No 20	(850 micron)
U S No 40	(425 micron)
U S No 50	(300 micron)
U S No 70	(212 micron)
U S No 100	(150 micron)
U S No 140	(106 micron)
U S No. 200	(75 micron)
U S No. 325	(45 micron)
PANS	

- Analytical equipment for pH, gross alpha, gross beta, and plutonium 239 plus 240 (gamma/alpha spectrometer)

7.3.5 4 Reagents

The only reagent that will be used as a treatability testing media will be sodium hydroxide Sodium hydroxide will be added to the water to achieve a solution pH of 12.0 to 12 5 which will be used in the process equipment for scrubbing, washing, and pulp density control Flocculants may be tested in the thickener to improve settling and filtering characteristics

7.3 6 Measurements and Sampling Requirements

As discussed in Section 7.3 4 1, containers will be used to collect and accumulate the various products of each process equipment test Each of these products will be sized according to the sizes described in Section 7.3 3 4, Particle Size Analysis Depending on the weight of the product, the product will be split to obtain a representative sample of less weight for physical and chemical testing to determine the effectiveness of the separation of contaminants from soil For example, the plus 3/4-inch (+19 mm) product material will be placed into a Gilson Rocker Screen set, SS-35 or equal containing a 50 mm (U S No 2-inch) screen The plus 50 mm material and the minus 50 mm will be split as described in Section 7 3 3 4, 125 - 19 mm If all size fractions are present, there will be seven fractions for which physical and chemical data will be collected In general, these are shown on Figure 7 3-2 as item 2 when the material is dry and as item 5 when the material is wet. The data to be collected will include.

- Moisture content if sample is from wet solids (Section 7 3 3 5)
- Particle size analysis (Section 7 3 3 4)
- pH determination (Section 7.3 3 3)
- Gross alpha determination (Section 7.3 3 6)
- Gross beta determination (Section 7.3.3 7)
- Plutonium 239 plus 240 determination (Section 7.3.3 8)

The minus 3/4-inch (-19 mm), plus 1/4-inch (+6 3 mm) fraction (Figure 7.3-2, Item 3) will be split down to the AWC standard sample size in the same manner as referred to above for the minus 50mm (-2-inch U S No) and described in Section 7 3 3 4 This product of the trommel will be wet. The above six physical and chemical tests will be performed on each size fraction present consistent with the screen and sieve designations in Section 7.3 3 4

During treatability testing observation and judgement will be required in the handling of the minus 1/4-inch (-6 3mm) soils (Figure 7 3-2, Item 4) In general, if the minus 1/4-inch fraction is coarse, settling will occur quickly and the scrubbing/wash solutions will become clear enough to decant When this occurs, the sample will be split down to the AWC standard sample size by use of a Tyler Sample Reducer (16 1 sample reducer) or equivalent The Tyler Sample Reducer will be especially helpful in splitting samples from the spiral classifier underflow (Figure 7 3-3, Item 6) The sample reducer is limited to a maximum particle size of 1/2-inch (12 5mm) Once the proper sample is obtained, the above mentioned six physical and chemical tests will be performed on each sieve fraction present consistent with Section 7.3.3 4

If the minus 1/4-inch fraction is primarily fine soils, then settling will be slow In order to collect the sample in this circumstance the container contents will be highly agitated with a portable agitator for at least 15 minutes. The agitated container contents then will be poured into the 16 1 sample reducer to obtain the sample. The sample will be subjected to the six physical and chemical tests described above and consistent with the sieve separations in Section 7 3 3 4

Decant solutions and suspensions of fine solids will be put into the thickener for settling characteristic testing A split of all samples will be taken and retained for RFP analysis

All measurements and determinations will be made as outlined in Section 7.3 subsections and according to AWC internal laboratory procedures in a manner sufficient to meet the requirements outlined in Section 5 2 Where AWC internal procedures and work plan directions conflict, the work plan will take precedence unless resolved in writing by EG&G-RF or its designated subcontractor

7.4 Field and Laboratory Documentation and Management

Management of the QA Records and data generated in support of the TRUclean treatability test is addressed in the Quality Assurance Project Plan for Land Surface Cleanup of Plutonium Project (AWC) and AWC SOPs included in Attachment 2 Records of the operating conditions for the test equipment during treatability testing include project logbooks and equipment specific run sheets

AWC deliverables at the completion of the treatability tests include the following

- performance evaluation report
  - project logbook containing results of physical and chemical tests, weights, temperatures, and other pertinent information
  - process equipment run sheets
- originals (or legible copies) of all QA Records produced throughout the treatability testing, organized by test run number (e g , 1 through 5)
- test parameters and analytical results in either Lotus or dBase format, organized by test run number

The EG&G-RF project manager will receive the deliverables supporting the treatability test from the test subcontractor. The project manager will manage these data according to the EM data management procedures which are presently being developed It is noted that some technical data specifications and documents are considered proprietary to AWC and will be handled accordingly. EG&G-RF will provide the test data and results to their feasibility study subcontractor for interpretation and analysis. The subcontractor is required to manage these data in accordance with a standardized document inventory and filing system. Data interpretation and analysis results will be documented to allow independent verification of the conclusions drawn

7.5 Data Evaluation

Data evaluation will be a critical component of the TRUclean Process treatability test program. Data evaluation will be performed on the physical and chemical results from three areas AWC-CS, individual process equipment tests (Phase I), and sequential process equipment tests (Phase II) After all the treatability tests are complete and the data evaluated, an overall project data evaluation will be made

7.5.1 AWC Characterization Sample

Prior to individual process equipment testing being undertaken, the AWC-CS data will be reviewed and evaluated Since the objective of the treatability test program is the separation of contaminated soils into clean (less than 0.9 pCi/g plutonium 239 plus 240, Section 4 2) and contaminated soils, evaluation of the contaminated soil starting material is a key element

The items to be evaluated will include, but are not necessarily limited to, bulk density, moisture content, pH, particle size analysis, gross alpha, gross beta, and plutonium 239 plus 240 Each plus screen fraction and the minus 45 micron (-325 U S No) fraction data will be reviewed If all particle sizes are present (Section 7.3 3 4) there will be 20 fractions to evaluate Data will be presented in a tabular format (e g , tests as column titles and screen fractions as the vertical column items)

The data will be reviewed with the prime effort being expended on the alpha, beta, and plutonium concentrations of each size fraction Comparisons will be made between activities of dry screened soils and wet screened soils These differences will be indicative of the adherence of fine contaminated particles to larger clean soil particles Evaluations will determine whether the "clean" condition is achieved.

These evaluations will be starting point for the individual process equipment tests For example, evaluation of the data will indicate whether the plus 3/4-inch soils will be clean and not need to be treatability tested, or whether they will be contaminated and will need to be treatability tested.

7.5.2 Individual Process Equipment Tests

Individual pieces of process equipment will be tested to determine the equipment's effectiveness in separating clean soils from contaminated soils In addition to the items to be evaluated as described for the AWC-CS, a material balance around each piece of process equipment will be required. To accomplish the material balance, weights and moisture contents become important data along with the alpha, beta, and plutonium determinations

The trommel feed will be based upon the AWC-CS results If the material balance around the trommel (feed +3/4-inch, +1/4-inch, and -1/4-inch products) does not balance, it will be necessary to select a larger trommel feed quantity, split out a representative sample, and characterize the sample

In general, the trommel products, plus 1/4-inch soils and minus 1/4-inch soils will be characterized sufficiently well to use that characterization data as the feed data for the next piece of process equipment. For each piece of process equipment, data on that piece of equipment's variables will be collected, recorded, tabulated, and compared to see the impact on the physical and chemical data For example, if the initial trommel settings do not produce a clean plus 1/4-inch soil, the data will be evaluated by reviewing the screen fractions to determine

1 Plus 1/4-inch particles that are still contaminated

2. Plus 1/4-inch particles that are contaminated by minus 1/4-inch carry-over with the plus 1/4-inch soils

Based upon this type of data evaluation it may be determined that trommel variables should be changed, one at a time For example, the incline angle may be reduced to provide longer retention time in the perforated discharge tube to allow better washing of the plus 1/4-inch particles to remove fines

Evaluations will be made for each piece of process equipment by tabulating the characterization type data. and comparing it against different variable settings for that piece of process equipment. A written description will be provided to record the interpretation of the data the rationale for the change in the process equipment variable(s), and the results of the change

When the best results are achieved using a water media, then one or more tests will be run using a water/sodium hydroxide solution at pH 12 0 to 12.5 The high pH solution results will be compared to the water only results

Once all the pieces of process equipment chosen by AWC for treatability testing have been tested and evaluated, AWC will develop a plan for the sequence testing of process equipment, Phase II The Phase II plan will be supported by summarizing collected data from individual tests The plan will be presented to EG&G-RF or their designated subcontractor for approval

7 5 3 Sequential Process Equipment Tests

Once the sequence of process equipment has been approved, this portion of testing can begin During this Phase II portion of the treatability testing, the process equipment variables will not be changed Their optimum setting will have been determined by Phase I testing

The data collected will be as delineated in the previous two sections This data will encompass the trommel feed and the final products of the TRUclean Process unit operations This data will be evaluated to provide input for the overall TRUclean Process evaluation For example, spiral classifier underflow, which is expected to be clean, would be a final product Spiral classifier overflow, which will be contaminated is not a final product. The overflow is fed to another piece of process equipment, as such, its characterization will not be part of the sequential process equipment evaluation

Samples will be collected and characterized at all process equipment discharge points. The data from those intermediate discharge points, although not part of the final data evaluation, will be retained to interpret what occurred if the sequential systems cannot produce either clean soil or a sufficient quantity of clean soil

7.5.4 Overall Data Evaluation

The overall data evaluation will follow the same procedures as described earlier Figure 7.5-1 is presented as a hypothetical example of the data evaluation procedure which is the input to the decision process.

7 6 Regulatory Requirements

Off-site treatability studies on RFP plutonium-contaminated soil require conformance to applicable DOT regulations. These regulations address the handling and shipping requirements for radioactive materials It is expected that the soil will be exempt from the requirements of 40 CFR 261 - Identification and Listing of Hazardous Waste, therefore, the soil will not be subject to the requirements of 40 CFR 262 - Standards Applicable to Generators of Hazardous Waste

The TRUclean Process tests on RFP plutonium-contaminated soil will be performed at the NTS Soil samples will be shipped to the NTS as normal form radioactive material (49 CFR 173 401) and will be packaged in Type A (or equivalent) containers. The sampling methodology and specifications for containers are included as Attachment 1, Field Sampling Procedure for Sampling Plutonium-Contaminated Soils to Support Treatability Tests at Nevada Test Site and Los Alamos National Laboratory The weight limitation of untreated soil for each Type A package shipped to the NTS is based on the normal form (A_2) limit for plutonium 239 and 240 (Note The A_2 limits for plutonium 239 and plutonium 240 are each equal to 0.002 Curie as per 49 CFR 173), and the expectation that the total plutonium concentration in the soil to be sampled is approximately 10 pCi/g Thus, the estimated package weight limit is calculated as follows

Plutonium Concentration in Soil	10 pCi/g
A_2 Limit for Plutonium 239 and 240.	0 002 Curie (Ci)

$$\text{Weight Limit} = 0.002 \text{ Ci Pu} \times \frac{1\times10^{12} \text{ pCiPu}}{1 \text{ CiPu}} \times \frac{1 \text{ g Soil}}{10 \text{ pCi Pu}} \times \frac{1 \text{ kg Soil}}{1000 \text{g Soil}} = 2 \times 10^{5} \text{ kg Soil}$$

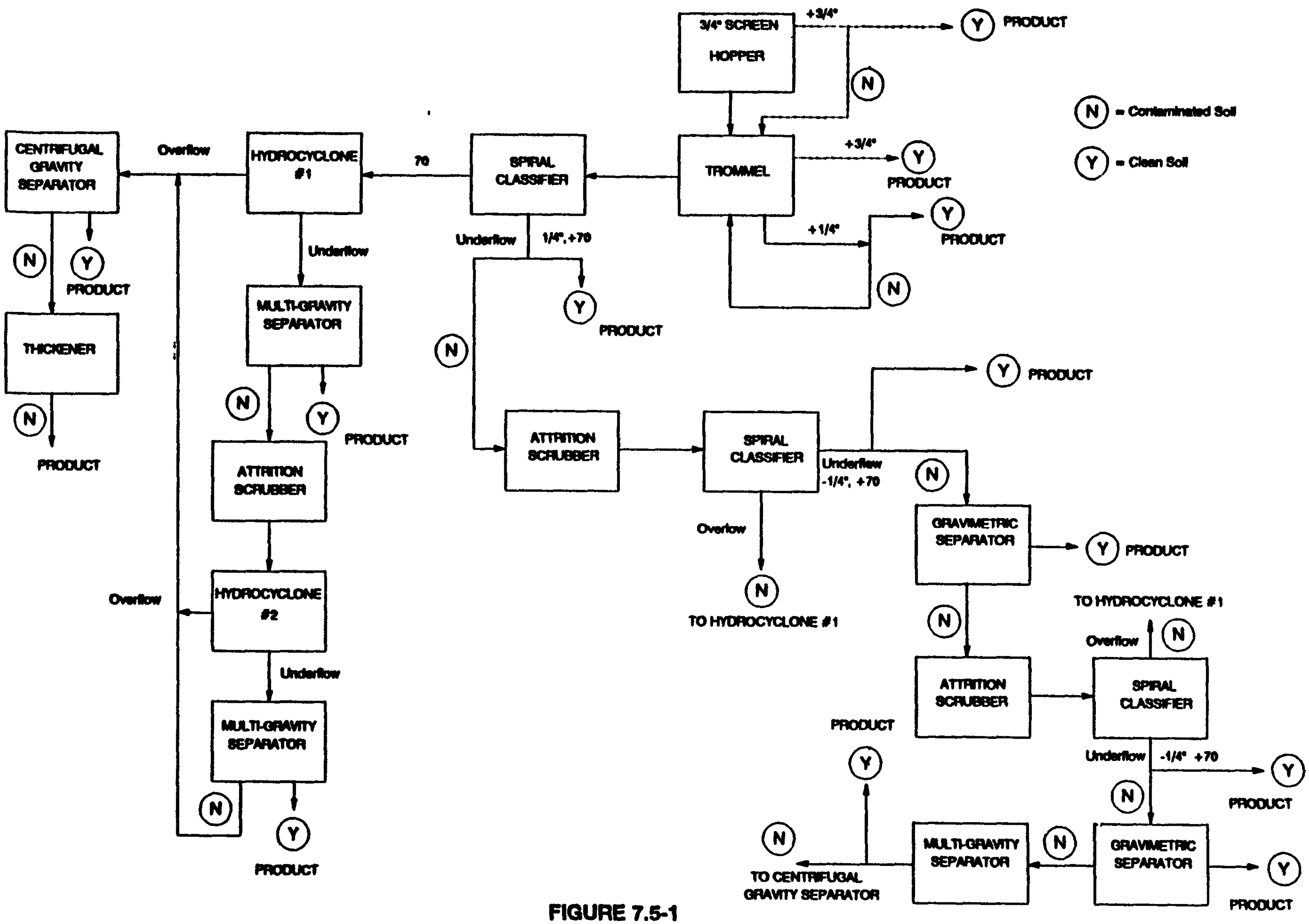

FIGURE 7.5-1
HYPOTHETICAL DECISION TREE
TRUclean PROCESS

Based on a typical DOT 17H 55-gallon drum, which exceeds Type A package requirements, and an assumed soil density of 100 lb/ft^3 (1 6 g/cm^3), the estimated soil sample weight per package to be shipped to the NTS is approximately

$$55 \text{ gallon} \times \frac{3785 \text{ cm}^3}{\text{gal}} \times \frac{1.60 \text{ g Soil}}{\text{cm}^3} \times \frac{1 \text{ kg Soil}}{1000\text{g Soil}} = 333 \text{ kg Soil}$$

This is well below the weight limit calculated for the untreated soil

The weight limitation of treated soil for Type A packages returning to the RFP from the NTS is estimated under the assumption that the TRUclean Process produces a "clean" soil stream that meets the meets the cleanup goal of 0 9 pCi/g plutonium and comprises 90 percent of the original feed mass for the entire RFP bulk soil sample This assumption leads to a material balance around the TRUclean Process as represented in Figure 7 6-1 The plutonium concentration in the "contaminated material" stream provides a conservative basis for estimating the Type A package weight limit. This estimate is calculated as follows

Plutonium Concentration in Contaminated Material (CM)	92 pCi/g
A_2 Limit for Plutonium 239 and 240·	0 002 Ci

$$\text{Weight Limit} = 0\ 002 \text{ Ci Pu} \times \frac{1\text{x}10^{12} \text{ pCi Pu}}{1 \text{ Ci Pu}} \times \frac{1 \text{ g CM}}{92 \text{ pCi Pu}} \times \frac{1 \text{ kg CM}}{1000\text{g CM}} = 2 \times 10^4 \text{ kg CM}$$

As previously estimated, the weight of a soil-filled 55-gallon drum will be approximately 333 kg, which is well below the weight limit calculated for a package with contaminated material

7.7 Residuals Management

It is anticipated that at the end of the test program there will be the following residuals

1) RFP soils, unused

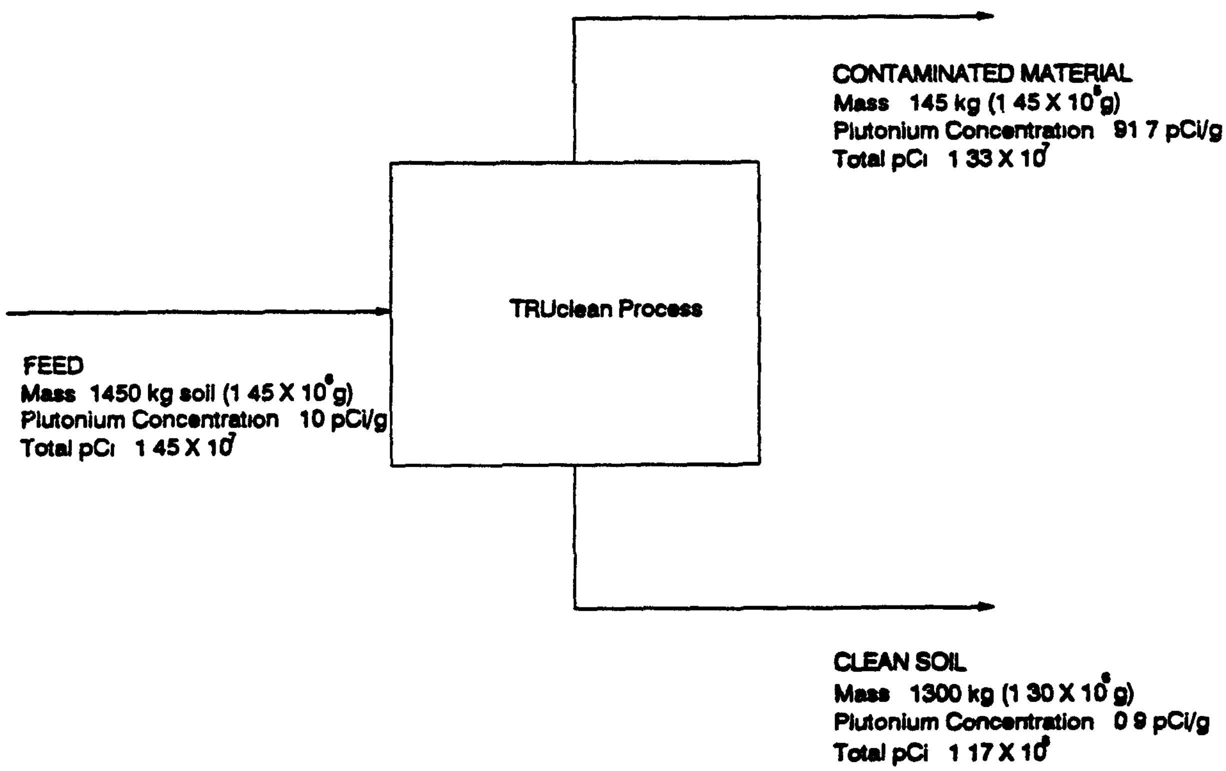

FIGURE 7.6-1

ASSUMED OVERALL MATERIAL BALANCE

TRUclean PROCESS

2) Dry solids including a) "clean" soils (Pu 239 plus 240 less than 0 9 pCi/g), b) contaminated soils with Pu 239 and 240 in concentrations equal to or less than the original RFP soils, and c) contaminated soils with Pu 239 and 240 in concentrations higher than the original RFP soils

3) Wet solids including a) "clean" soils (Pu 239 plus 240 less than 0 9 pCi/g), b) contaminated soils with Pu 239 and 240 in concentrations equal to or less than the original RFP soils, and c) contaminated soils with Pu 239 and 240 in concentrations higher than the original RFP soils

4) Sludges/slurries including a) "clean" soils (Pu 239 plus 240 less than 0 9 pCi/g), b) contaminated soils with Pu 239 and 240 in concentrations equal to or less than the original RFP soils, and c) contaminated soils with Pu 239 and 240 in concentrations higher than the original RFP soils

5) Water solutions including a) solutions sufficiently clean to be disposed of within AWC's permit for non-hazardous/non-radioactive liquid disposal, b) contaminated solution not requiring radioactive placarding for shipment under DOT 49 CFR regulations, c) contaminated solutions requiring placarding under DOT 49 CFR

6) Sodium Hydroxide solutions including a) solutions "radioactively" clean and neutralized to be disposed of within AWC's permit for non-hazardous/non-radioactive liquid disposal, b) contaminated solutions not requiring radioactive placarding and neutralized for shipment under DOT 49 CFR, c) contaminated solutions requiring radioactive placarding and high pH classification under DOT 49 CFR

All materials and solutions, except items 5 a and 6.a, will be returned to the RFP. All materials and solutions in items 1, 2 a, 2 b, 3.a, 3 b, 4 a, 4 b, 5 b, and 6 b will be returned to the RFP in DOT 17H 55-gallon drums All materials and solutions in items 2 c, 3 c, 4 c, 5 c, and 6.c will be returned to RFP in DOT-specified and approved drums based upon the criteria set forth in 49 CFR

AWC will be responsible for preparing all residuals for return shipment to RFP. EG&G-RF will be responsible for the handling and disposition of residuals upon receipt at RFP.

7.8 Health and Safety

Activities conducted at the AWC facility will be performed in accordance with the Environment Safety and Health Plan for the Land Surface Clean-Up of Plutonium Project (LSCOPP) dated April 22,

1991. Specific procedures have been established for nonradiological and radiological hazards These procedures, as referenced above, have been written in accordance with the applicable DOE Orders

A complete set of the applicable EG&G-RF/EM procedures should be reviewed by the operators Particular attention should be applied to the following areas

- Radioactive Airborne Contamination Monitoring
- Contamination Surveys - Personnel and Equipment
- Internal/External Dosimetry Requirements
- Decontamination and Equipment Release Surveys
- Personnel Training in Radiation Safety and Contamination Reduction Techniques
- Nonradiological Hazards, i e , electrical, mechanical, fire

The primary hazard is from the low levels of plutonium that will be concentrated, increasing the exposure potential to the worker Through the proper execution of the procedures listed in the ES&H LSCOPP Plan no additional exposure is anticipated

7 9 Schedule for TRUclean Tests

A bar chart schedule of the TRUclean treatability tests is included as Figure 7 9-1

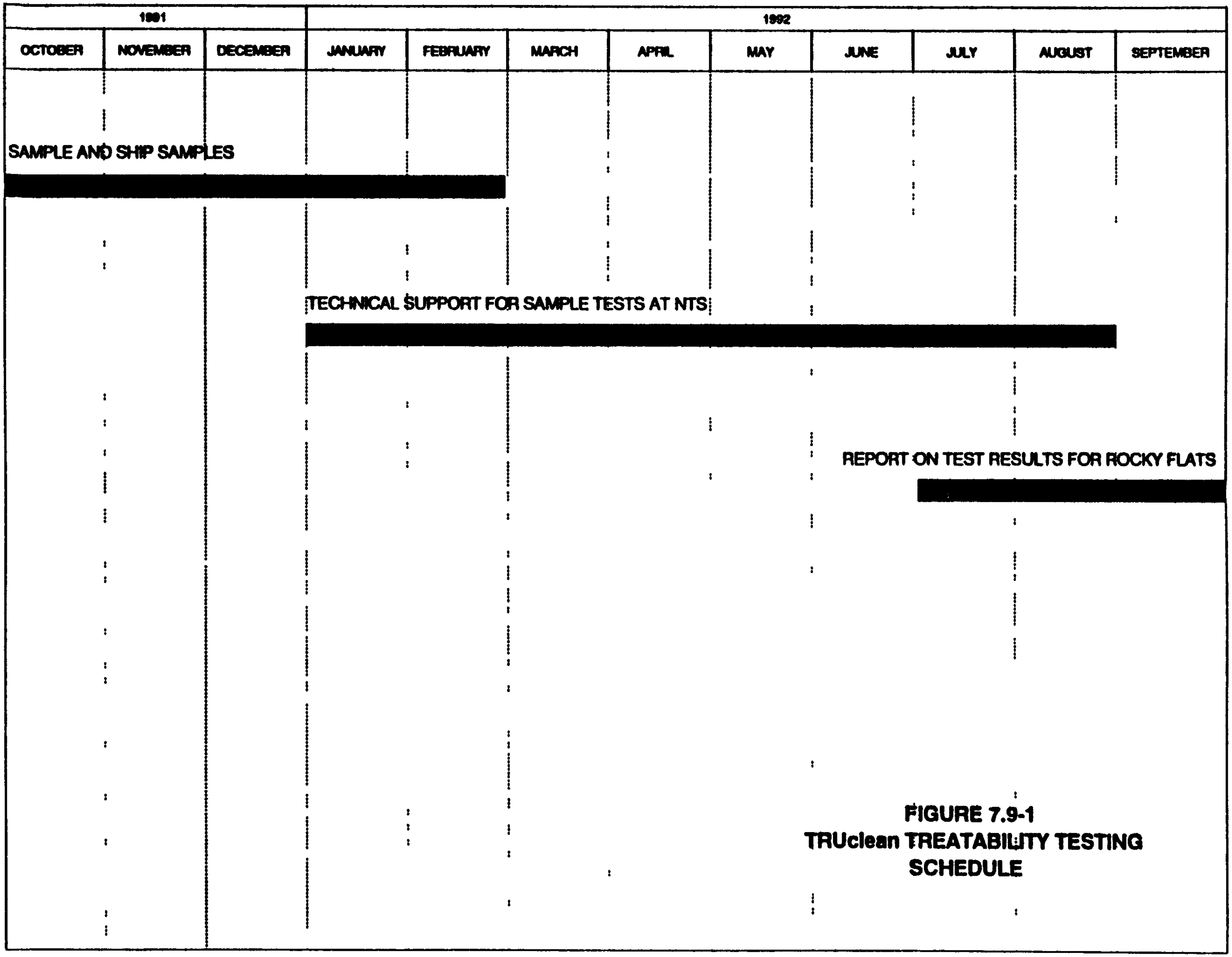

FIGURE 7.9-1
TRUclean TREATABILITY TESTING SCHEDULE

8 0 MAGNETIC SEPARATION

8.1 Type of Treatability Study

The magnetic separation treatability study will provide a "laboratory" level of screening for this technology The equipment for conducting magnetic separation tests is located at LANL. LANL operators will attempt to optimize the performance of the magnetic separator (Model PEM 1" Crossfield Separator) with untreated RFP soil A detailed description of the magnetic separation process and its associated test procedures are included in following sections of this work plan

8 2 Technology Description

Magnetic separation was selected for laboratory treatability testing during the development of the TSP as a result of a screening process designed to identify candidate technologies for use in corrective/remedial actions at the RFP

Magnetic separation segregates solid materials based on differences in magnetic susceptibility Solids may be classified as diamagnetic or paramagnetic Diamagnetic solids have a negative (-) magnetic susceptibility and repel a magnetic field Paramagnetic solids have a positive magnetic susceptibility and are attracted by a magnetic field Paramagnetic solids are typically categorized into one of the following groups·

- Strongly magnetic (ferromagnetic)
- Weakly magnetic
- Non-magnetic

Plutonium and plutonium compounds, such as PuO_2, exhibit paramagnetic properties and could be considered strongly magnetic (magnetic susceptibility of 730 x 10^{-6} cgs units - CRC, 1982) relative to other components of RFP soil Magnetic susceptibility is the basis for evaluating the potential effectiveness of magnetic separation

On a large scale, several types of magnetic separators are available for the concentration and/or purification of solids It is anticipated that the application of magnetic separation to the plutonium-contaminated soils at RFP will be a purification process (i e , the general goal is to remove small amounts of magnetic plutonium particles from the bulk non-magnetic soils) Magnetic separators are available to accommodate purification needs on either wet (slurried) solids or dry solids.

At the current level of technology screening, a laboratory scale system is appropriate for testing the applicability of magnetic separation to RFP soils Figure 8 2-1 provides a simple flow diagram that represents typical magnetic separation processes Details on the specific application of magnetic separation to RFP soils are included in Section 8 3

8 3 Experimental Procedures and Equipment

The magnetic separation treatability study will focus on high gradient magnetic separation, which will involve processing samples of RFP plutonium-contaminated soil through a high gradient magnetic separator (HGMS) model PEM 1" Crossfield Separator (or equivalent) The following procedures and descriptions are intended to provide the methodology by which the treatability tests with magnetic separation (hereinafter referred to as HGMS) will be conducted

8 3 1 Experimental Design

The HGMS treatability test is designed to provide performance data that enables EG&G-RF to evaluate HGMS as a treatment technology for possible integration into feasibility studies as an alternative for treatment of plutonium-contaminated soils Key elements of the experimental design include the following:

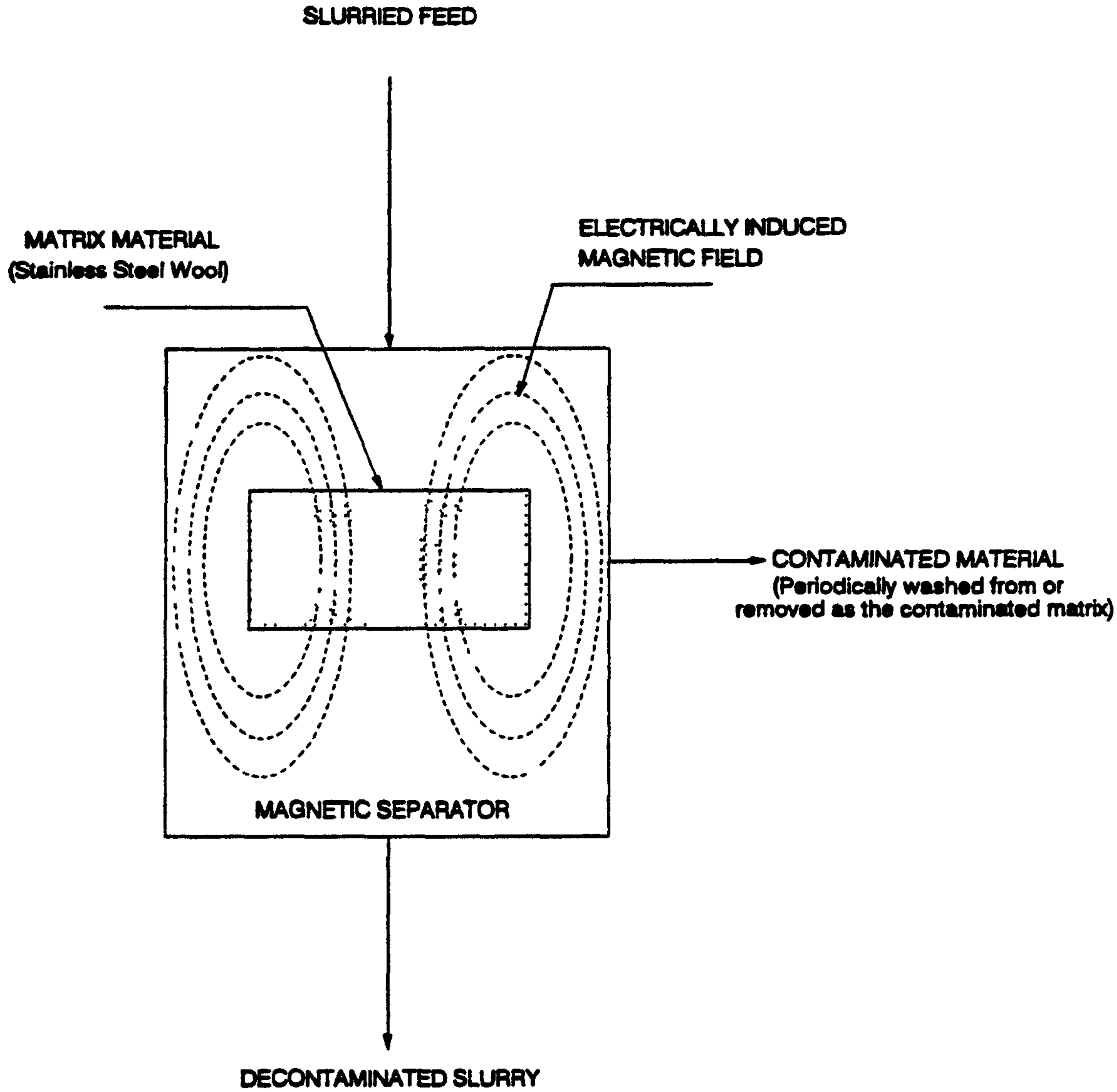

FIGURE 8.2-1

FLOW DIAGRAM

TYPICAL MAGNETIC SEPARATION PROCESS

- Adjustment and optimization of process control and configuration parameters
- Replication
- Mass of contaminated soil to be tested

The HGMS treatability test will be structured as represented in Figure 8 3-1 This figure shows a progression that includes process optimization through surrogate tests, model runs, and final tests It is important to note that the procedures associated with the HGMS process optimization are intended to be general (i e provide a baseline methodology for conducting optimization of HGMS). Minor variations of or changes to the procedures are expected Critical parameters of the HGMS to be optimized include the following:

- Magnetic field strength
- Flowrate of slurried soil through the HGMS
- Solid/Liquid ratio
- Matrix type

Magnetic field strength is a function of the amperage setting for the HGMS Increases in field strength lead to a greater removal efficiency of particles that are susceptible to magnetic fields Ideally, an optimum field strength will isolate plutonium without affecting other magnetically susceptible constituents in the RFP soil The flowrate through the HGMS determines the soil's residence time within the matrix. The solid/liquid ratio will be optimized to allow for uninterrupted flow through the matrix The matrix refers to the area where magnetically susceptible particles collect. A typical matrix is very porous and is made of stainless steel, namely steel wool

A preliminary optimization of the above parameters will be accomplished through HGMS tests performed on RFP soil spiked with a surrogate contaminant such as copper oxide, nickel oxide, or palladium. The surrogate materials exhibit paramagnetic susceptibilities that are similar to plutonium oxide, the dominant form of plutonium contamination found in RFP soil These paramagnetic susceptibilities are listed in Table 8-1 (Weast, 1982)

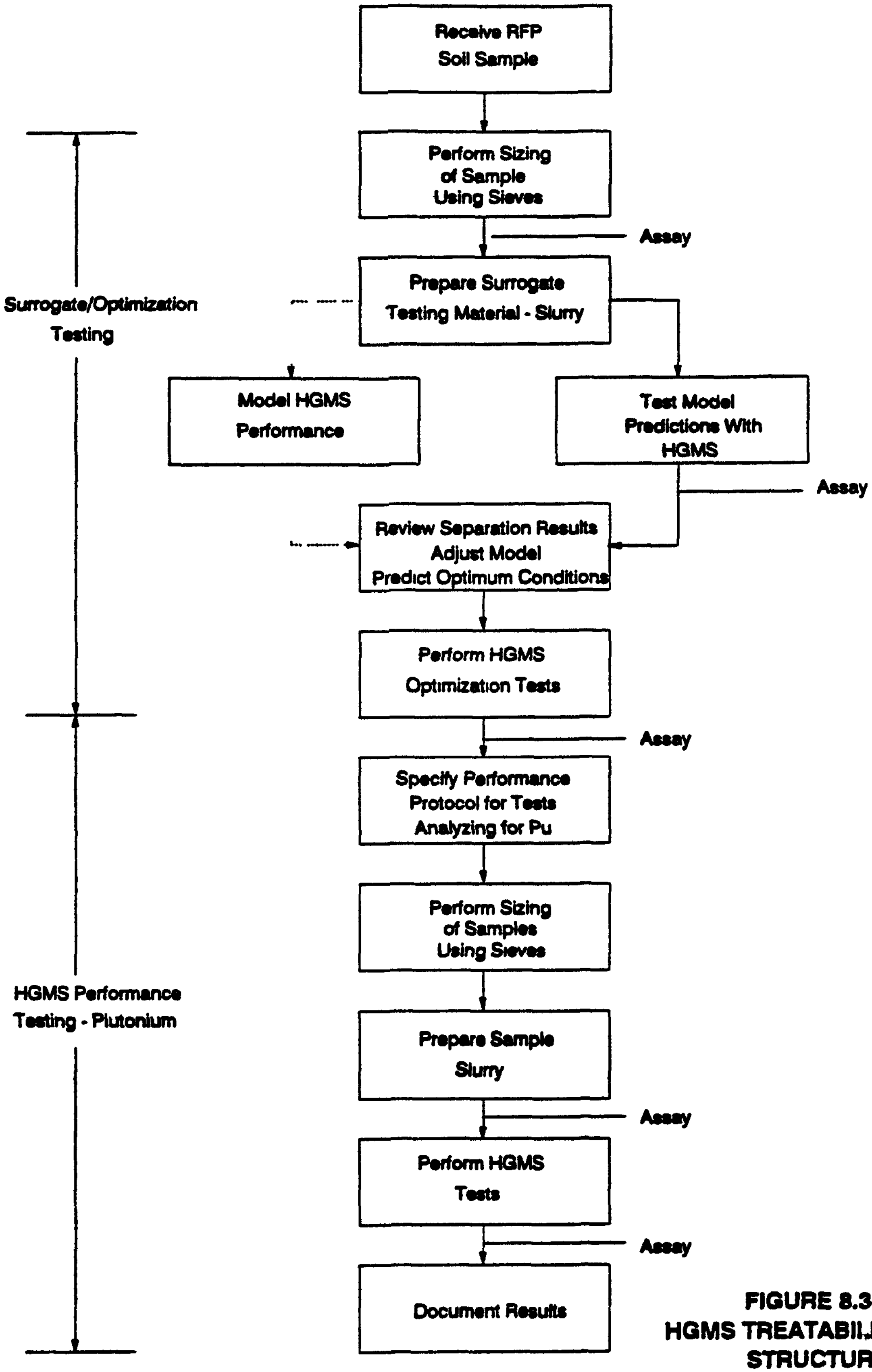

FIGURE 8.3-1
HGMS TREATABILITY TEST
STRUCTURE

TABLE 8-1
Magnetic Susceptibilities

COMPOUND	MAGNETIC SUSCEPTIBILITY (10^{-6} cgs)
plutonium oxide (PuO_2)	730
copper oxide (CuO)	240
nickel oxide (NiO)	660
palladium (Pd)	570

CuO is the preferred surrogate because of its availability, cost, and ease to detect Also, having the lowest magnetic susceptibility relative to the PuO_2 and the other surrogates, CuO should provide conservative data regarding performance of the HGMS (i e , it is expected that the optimized parameters of the HGMS will lead to an equivalent or greater performance on PuO_2 with regard to its removal from soil)

The HGMS optimization procedure will be supplemented through the use of a LANL-developed computer model This procedure for the CuO surrogate will incorporate the following sequence of general steps, and will involve reviews by the appropriate LANL technical managers and the designated EG&G-RF technical manager:

1) Based on properties of the surrogate contaminant (assumed to be CuO hereinafter) and the soil matrix, performance of the HGMS shall be predicted with the computer model at various levels of the critical parameters.

2) Performance predictions will be checked against actual tests with the HGMS using the same levels of critical parameters as modelled

3) The model predictions and the actual performance data will be compared. The computer model will be adjusted to match actual performance data.

4) The adjusted model will be used to optimize the HGMS system by determining optimum levels of the critical parameters Also, as part of this optimization stage, the critical parameters having the greatest impact on performance will be identified.

5) The predicted optimum conditions will be checked with the magnetic separator using the same levels of critical parameters as modelled

6) The model predictions and the actual performance data will be compared The computer model will be adjusted to match actual performance data.

Once the critical parameters have been optimized based on CuO and ranked in terms of their impact on the HGMS performance, a phased testing program will be implemented with the focus being on PuO_2. The phased approach will involve testing the HGMS with three to five settings of each of the four critical parameters, one parameter at a time, beginning with the critical parameter determined to have the greatest impact on performance during the optimization procedure The remaining critical parameters will be maintained at prescribed optimum levels Of the three to five settings tested, the setting that produces an optimum performance becomes the new optimum level for that parameter This type of adjustment to the optimum levels will be repeated for each parameter

8.3 2 Testing Facility

The magnetic treatability tests will be performed at LANL in Los Alamos, New Mexico Specifically, the tests will be conducted within area TA-46 at Building 25 or at a building or area deemed more appropriate for the HGMS treatability work

8 3 3 Characterization of Test Soil

Prior to performing treatability tests with the HGMS, chemical and radiological assays will be performed on the bulk soil sample from RFP The assay procedure will require that the received sample be completely homogenized before a subsample is taken. Chemical analysis will be for EPA TAL metals; radiological analyses will be for plutonium 239 plus 240, gross alpha, and gross beta. The required analytical levels and associated types of analyses are discussed in Section 5.2. The reported values for TAL metals and the radionuclides will be based on dry soil This initial characterization of the test soil will serve as a basis for evaluating the performance of the HGMS throughout the treatability study. It is important to note that the RFP bulk soil sample must be maintained as a homogenous source from which all subsamples will be taken to support the treatability study efforts

8.3 4 Test Process

Utilizing results of initial HGMS optimization testing of RFP soil with surrogate CuO contamination (Section 8 3 1), testing will shift to focus on removal of plutonium from the RFP soil Initial characterization of the plutonium-contaminated soil as received at LANL is described in Section 8.3.3. After characterization, HGMS testing will proceed with the following elements.

- Sieving and prepared sample slurrying
- Phased HGMS testing in plutonium removal
- Processing of treated slurry

These three stages are depicted on Figure 8 3-2 and described in the following subsections along with examples to demonstrate expected material flow

8 3 4.1 Sieving and Prepared Sample Slurrying

Because the bulk plutonium-contaminated soil sample will be homogenized, the wet sieving process should produce consistent results throughout the treatability program and thus not require any particular attention or characterization work while the HGMS tests are underway However, initial evaluation of the sieving process is needed to allow for an accurate curie-balance on the entire treatment process and determine the fraction of the 500 gram whole soil sample passing the sieve for slurry preparation This initial characterization will be replicated at least once during the course of the phased HGMS testing to verify the material split on the sieve and the plutonium activity of the oversize reject stream.

Sieving procedures and example calculations where pertinent include the following

1) Remove more than 500 grams of homogenized plutonium-contaminated soil from storage drum, dry and weight out 500 grams $\pm$ 5 grams and place on the sieve assembly, return excess soil to the storage drum.

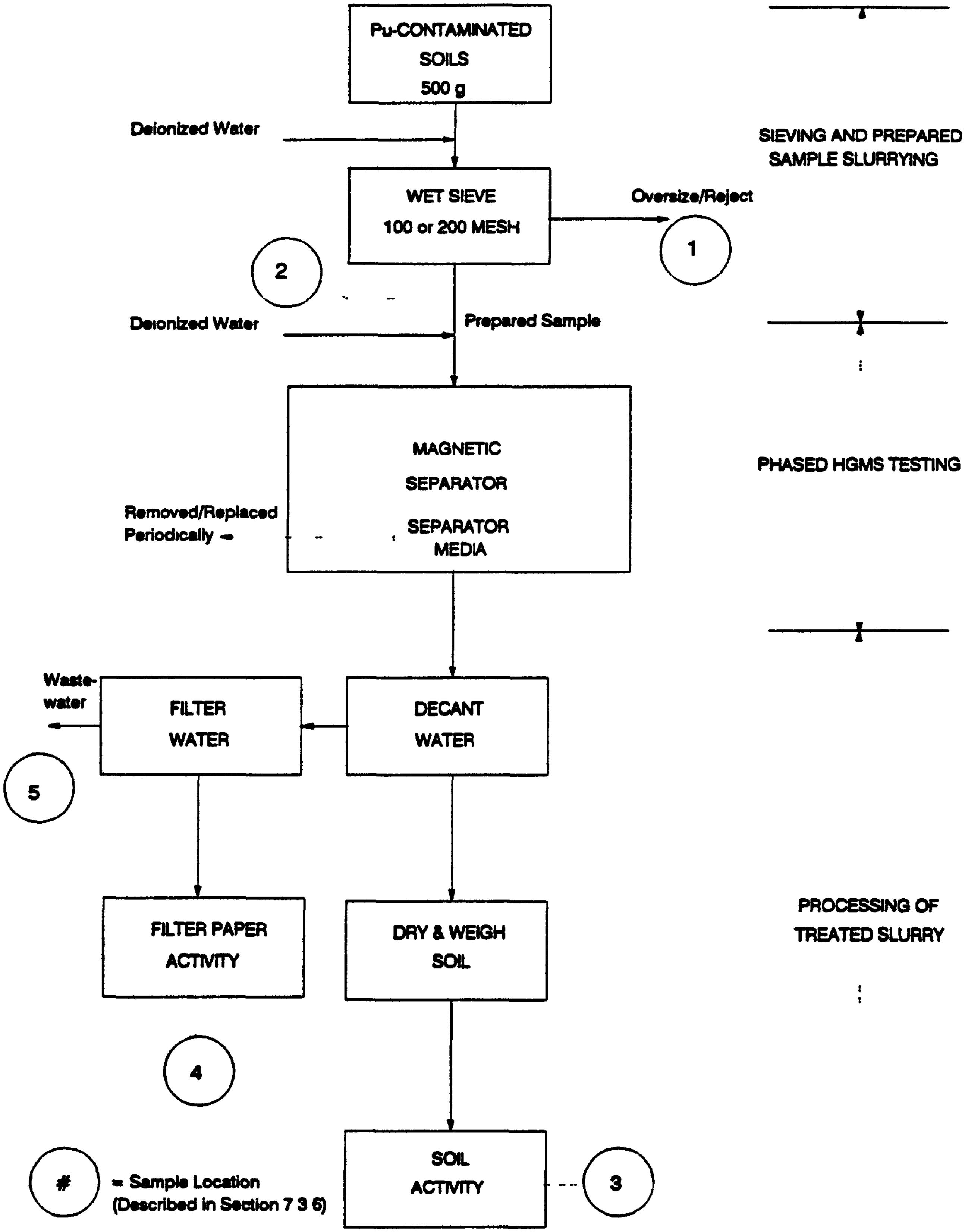

FIGURE 8.3-2

STAGES OF HGMS

2) Measure out up to 1.0 liter of deionized water using a graduated cylinder for use in sieving

3) Conduct wet sieving on the 100 or 200 mesh sieve in accordance with ASTM D422 and record the volume of water used (Vsw-100 and Vsw-200, respectively)

4) Transfer oversize/reject fraction to a tare-weighed dish, weigh wet, dry the material and reweigh

Using.

ORD-100	=	Mass of Oversize/Reject - 100 mesh, g (dry)
ORD-200	=	Mass of Oversize/Reject - 200 mesh, g (dry)
ORW-100	=	Mass of Oversize/Reject - 100 mesh, g (wet)
ORW-200	=	Mass of Oversize/Reject - 200 mesh, g (wet)
Vorw-100	=	Volume of Water in ORW-100, ml
Vorw-200	=	Volume of Water in ORW-200, ml
MC	=	Moisture Content, percent

Assume

Oversize/reject on 100 mesh = 5 percent by weight
Oversize/reject on 200 mesh = 15 percent by weight
ORD - 100 = .05 x 500 grams = 25 grams
ORD - 200 = 15 x 500 grams = 75 grams

Moisture content (MC) = 50 percent after wet sieving

From the above assumptions, it follows that

$$MC = \frac{(ORW\text{-}100) - (ORD\text{-}100)}{ORD\text{-}100} \times 100 = 50 \text{ percent}$$

Weight of water in ORW-100 = 0.5 x 25 grams = 12.5 grams

Volume of water (Vorw-100) = 12.5 ml

Similarly,

Vorw-200 = 37.5 ml.

5) Retain dried oversize/reject materials for activity analysis.

6) Process the materials passing sieve (known as Prepared Sample PS) as described in Section 8.3.4 3 for activity analysis

PS-100 = 500 - 25 = 475 grams

PS-200 = 500 - 75 = 425 grams

7) Replicate steps 1 - 6 at least once during the phased HGMS testing program on both 100 and 200 mesh sieves immediately after the bulk sample has been rehomogenized

After the initial sieving runs on 100 and 200 mesh sieves, the data on actual prepared sample weights (PS-100 and PS-200) together with the recorded sieving water volumes (Vsw-100 and Vsw-200) and oversize reject water volumes (Vorw-100 and Vorw-200) will be used to prepare HGMS test slurries as discussed in Section 8 3 1 The slurry solids fractions (SSF) which will be used range from 0.2 to 0 3 (20 to 30 percent solids, by weight) The volumes of water which must be added to the prepared samples to make up the test slurries for HGMS testing are calculated using the following equations

$$SSF = \frac{PS}{PS + Vt}$$

where, Vt = total volume, ml (= weight in grams), of water needed to make desired slurry)

and, $Vt = Vsw - Vorw + Va$

or, $Va = Vt - (Vsw - Vorw)$

where, Va = Volume (in ml) which must be added to prepared sample after sieving to make desired slurry

Using the examples initiated in the sieving procedures, above, the following deionized water volumes must be added to make test slurries having 20 and 30 percent solids.

<u>PS-100</u>

Assume the volume of sieving water, Vsw = 1000 ml

To achieve a 20 percent slurry (SSF = 0.2)

$$0.2 = \frac{475 \text{ grams}}{475 \text{ grams} + Vt}$$

$$Vt = \frac{475}{0.2} - 475 = 1900 \text{ grams (or ml)}$$

$$Va = 1900 \text{ ml} - (1000 \text{ ml} - 13 \text{ ml})$$
$$= 913 \text{ ml}$$

Therefore, add 913 ml of deionized water to PS-100 to make up a 20 percent slurry

To achieve a 30 percent slurry (SSF = 0.3),

$$0.3 = \frac{475 \text{ grams}}{475 \text{ grams} + Vt}$$

$$Vt = \frac{475}{0.3} - 475 = 1108 \text{ grams (or ml)}$$

$$Va = 1108 \text{ ml} - (1000 \text{ ml} - 13 \text{ ml})$$

$$= 121 \text{ ml}$$

Therefore, add 121 ml of deionized water to PS-100 to make up a 30 percent slurry

PS-200

Assume the volume of sieving water, Vsw-200 = 700 ml

To achieve a 20 percent slurry (SSF = 0.2),

$$0.2 = \frac{425 \text{ grams}}{425 \text{ grams} + Vt}$$

$$Vt = \frac{425}{0.2} - 425 = 1700 \text{ grams (or ml)}$$

$$Va = 1700 \text{ ml} - (700 \text{ ml} - 38 \text{ ml})$$
$$= 1038 \text{ ml}$$

Therefore, add 1038 ml of deionized water to PS-200 to make up a 20 percent slurry

To achieve a 30 percent slurry (SSF = 0.3),

$$0.3 = \frac{425 \text{ grams}}{425 \text{ grams} + Vt}$$

Vt = $\frac{425}{0.3}$ - 425 = 992 grams (or ml)

Va = 992 ml - (700 ml - 38 ml)
= 330 ml

Therefore, add 330 ml of deionized water to PS-200 to make up a 30 percent slurry

Figures 8 3-3 and 8 3-4 summarize the material balance for the Sieving and Sampling Process for the PS-100 and PS-200 samples

For the accuracy needed in the HGMS testing analysis and data evaluation, ORD-100, ORD-200, Vorw-100 and Vorw-200 can be determined initially (and replicated) per the above procedures and used in slurry make-up calculations throughout the HGMS testing, while Vsw-100 and Vsw-200 should be recorded each time a 500 gram sample is sieved for a HGMS run

8 3 4.2 Phased HGMS Testing - Plutonium Removal

A phased program of HGMS testing will be conducted on the sieved, slurried, prepared samples The phased program will include a test series run in which the critical process control and configuration parameters will be evaluated with a period of treated sample processing (Section 8 3 4.3), activity analysis, and data evaluation (Section 8 5)

Critical process parameters will have been determined by surrogate contaminant testing and varied in accordance with their influence on HGMS efficiency In addition to the four parameters identified in 8 3.1, slurry pH may influence separation efficiency for plutonium in the RFP soil, especially in view of the high clay content of the soil More alkaline slurry pH, as opposed to the expected near natural pH (6.0 to 8 0) of the soil-deionized water slurries, may improve dispersion of plutonium particles and increase plutonium removal. After the critical parameters have been determined by the surrogate testing and are evaluated, an additional phase of testing may be conducted using a more alkaline slurry pH in the 10 to 12 range The HGMS equipment manufacturer will be consulted to identify equipment limitations on pH.

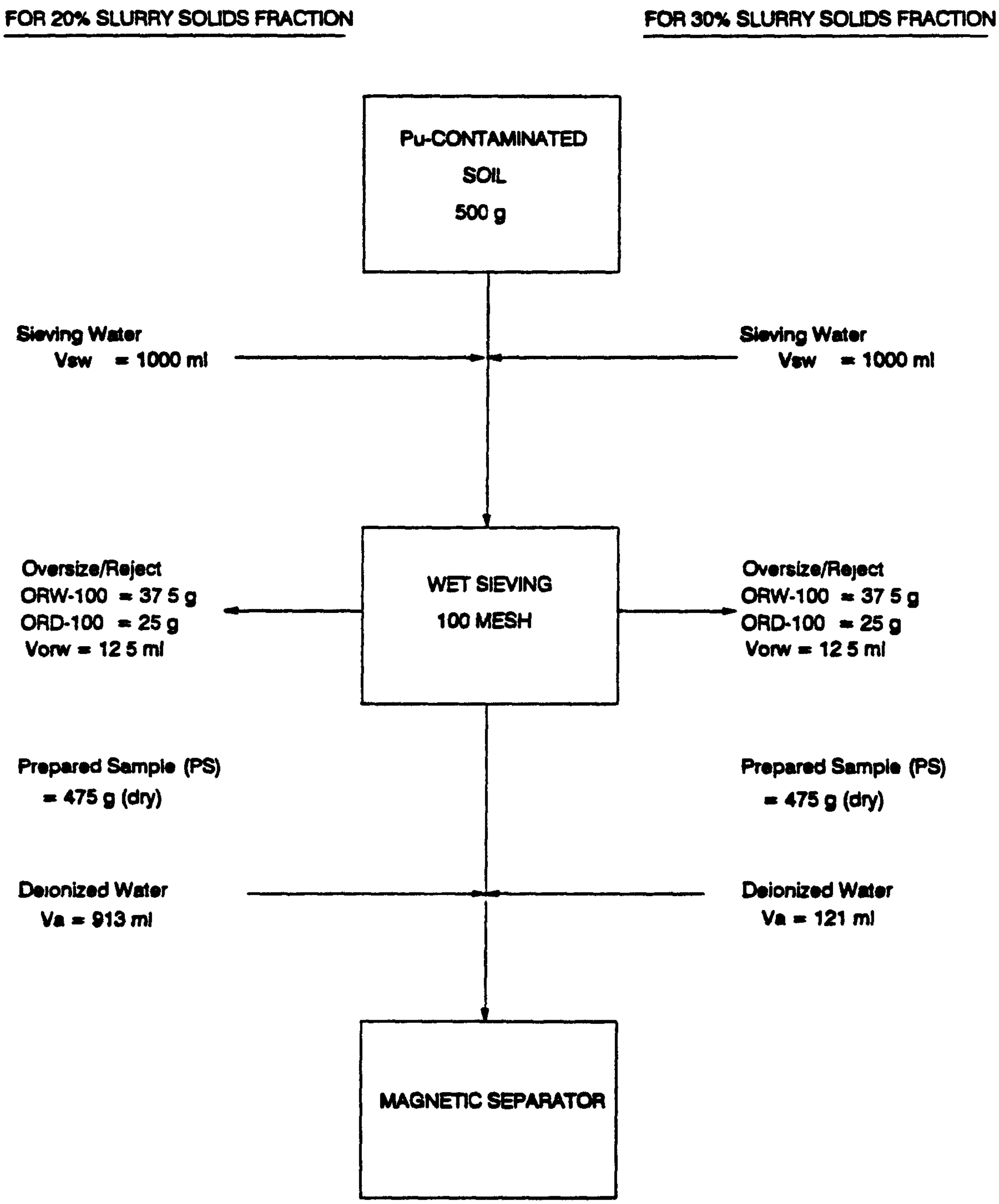

FIGURE 8.3-3
SIEVING/PREPARED SAMPLE
100 MESH SIEVE

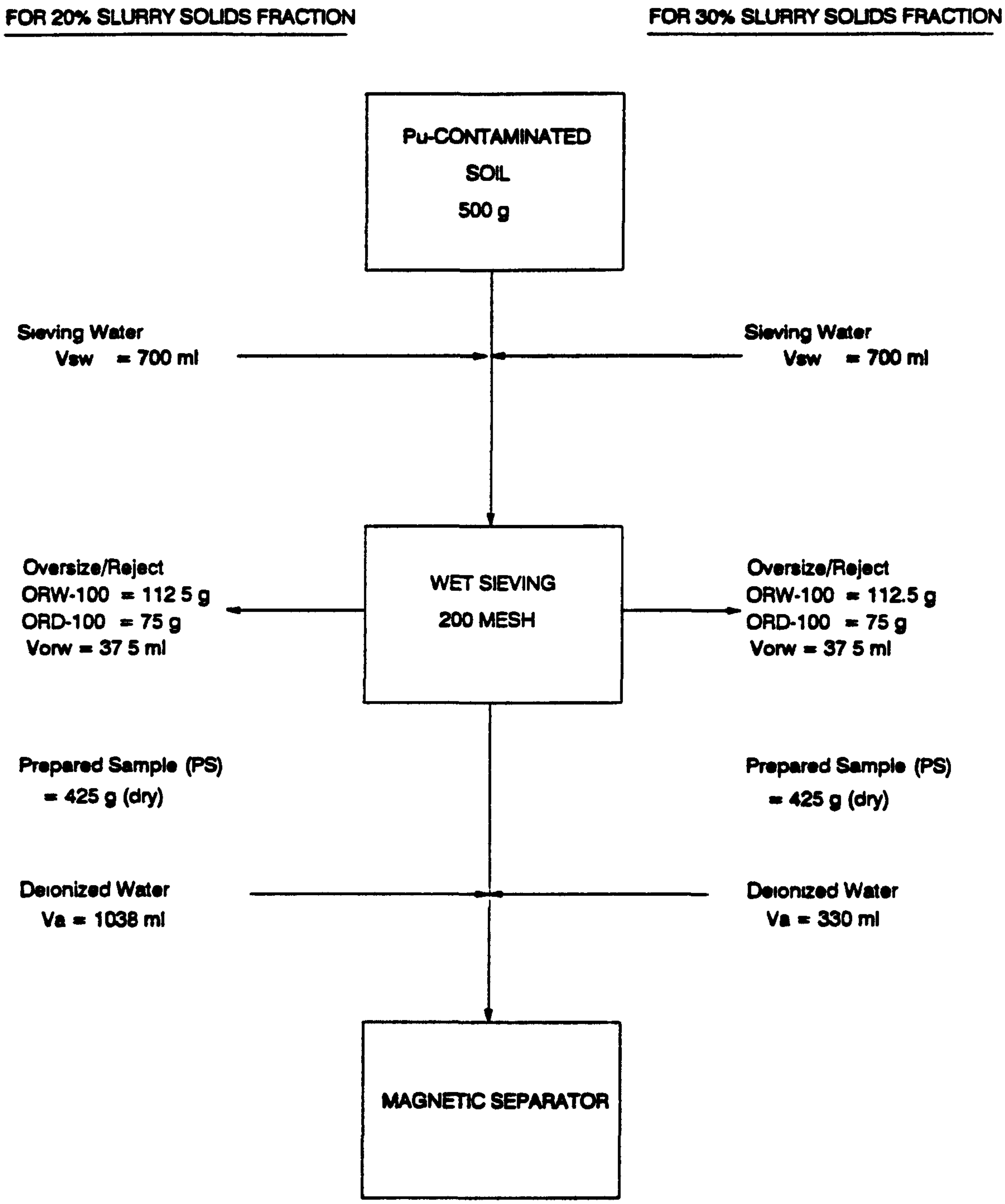

FIGURE 8.3-4
SIEVING/PREPARED SAMPLE
200 MESH SIEVE

The high slurry pH will be achieved by adding a measured volume of 50 percent sodium hydroxide (NaOH) solution to the slurry The slurry will be continuously rapid mixed during NaOH addition to dispersion The slurry pH will be monitored using a pH meter (calibrated for the alkaline pH range) during NaOH addition and for a minimum of 15 minutes after the prescribed pH (± 0.2 units) is achieved and maintained.

The phased program will generally be configured as follows

- Phase I Prepared Samples, PS-100 and PS-200
- Phase I HGMS Testing - First Rank Process Parameter (see Section 8 3 1)
  - Three to five first parameter settings
  - Other parameters set to prescribed optimum levels
  - Two replicates at each setting, PS-100 and PS-200, and at each pH (assumed to be two levels)
- Process 24 to 40 Treated Phase I Samples for Analysis
- Laboratory Analysis (Section 5 2)
- Phase I - Data Evaluation (Section 8 5)
  - Compare to select optimum setting(s) first parameter
- Prepared Samples, PS-100 and PS-200
  - Replicate sieving characterization (Section 8 3 4 1)
- Phase II - HGMS Testing - Second Rank Process Parameter
  - Three to five second parameter settings
  - First parameter at optimum setting
  - Other parameters set to prescribed optimum levels
  - Two replicates at each setting, PS-100 and PS-200, and at each pH (assumed to be two levels)
- Process 24 to 40 Treated Phase II Samples for Analysis
- Laboratory Analysis (Section 5 2)
- Phase II - Data Evaluation (Section 8 5)
  - Select optimum setting(s) - second parameter

This phased testing program will be continued for additional critical process control parameters identified in surrogate testing (Section 8 3 1) Additional replication of the sieving and oversizing-reject characterization procedures of Section 8 3 4 1 will be optional in the later phases with the need for additional replicates dependent on variation in results of the first two replicates

Specific procedures and protocols for initiation, operation, and monitoring of HGMS test runs will be based on the operation and maintenance manual for the PEM 1" Crossfield Separator (Attachment 3) and the standard protocols developed by the LANL treatability team during the surrogate testing

8 3 4 3 Processing of Treated Slurry

Treated slurries generated by HGMS testing of RFP plutonium-contaminated soils will be processed to facilitate a curie balance in the sieving and treatment processes, allow estimation of soil mass deposition on the separation matrix in the HGMS canister, and separate the slurry water for storage and eventual disposal.

Procedures for treated slurry processing are the following

1) Discharge the treated slurry into a 2-liter beaker and allow time for settling of the soil particles

2) Decant free water using a vacuum flask and transfer soil layer to dish for drying, use a spray bottle filled with deionized water to sluice visible solids into the dish

3) Using a spray bottle filled with pH 12 NaOH solution, the 2-liter beaker walls and base will be washed and the wash solution combined with the free water using a vacuum. Additional NaOH solution will be used to rinse the vacuum flask and tubing

4) Vacuum or pressure filter the decanted water through a 0 45 micron membrane filter and rinse down the walls of the filter chamber with NaOH solution at the end of the filter process, filter the NaOH solution

5) Retain the loaded filter paper for laboratory analysis (Section 8 3.6)

6) Dry and weigh the soil for laboratory analysis (Section 8.3 6)

8 3 5 Equipment, Materials, and Reagents

The major pieces of equipment, materials and reagents needed to conduct the HGMS tests include

- PEM (Pacific Electric Motor) 1" Crossfield Separator
- Solids (soil) homogenizer
- Laboratory sieve screens to cover U S Numbers 100 and 200, 150 and 75 micron, respectively
- Analytical equipment for pH, gross alpha, gross beta and plutonium 239 and 240 (gamma/alpha spectrometer)
- 0 45 micron filter paper and filtering apparatus to filter up to two liters of solution (low suspended solids)
- Miscellaneous glass beakers (one and two liter)
- Containers. six mil plastic bags, 30-gallon DOT 17H drums (2)
- Deionized water, 50 percent Sodium Hydroxide (approximately 4 liter), copper oxide (CuO)

8 3 6 Documentation of Critical Parameters and Sampling Requirements

This section addresses the documentation of critical test parameters and the sampling requirements for tests performed with the HGMS after completion of the optimization procedure by LANL personnel

The critical test parameters of the magnetic separator include the following

- Magnetic field strength
- Flowrate of slurried soil through the HGMS
- Solid/Liquid ratio
- Matrix type

These parameters will be documented in the Magnetic Separation Run Sheet (Figure 8 3-5) for each test run The format for the test run number will be AA - BBB - CC - D, where:

Magnetic Separation Run Sheet

TEST NUMBER	SOLIDS % (SP)	FIELD STRENGTH - amps (FS)	FLOW RATE - l/min (FR)	MATRIX TYPE (MT)

Figure 8.3-5

AA = Critical parameter being varied Use the following abbreviations Solids Percentage (SP), Field Strength (FS), Flowrate (FR), and Matrix Type (MT)

BBB = Particle size fraction (i.e., 100 or 200)

CC = pH value (e g , 08, 12, etc)

D = replicate number (e g , 1,2,3, .)

As an example, a test run number for a field strength replicate at a pH of 8 on the -100 particle size fraction is FS - 100 - 08 - 1. Each magnetic separation run sheet should only include data for runs completed on one of the critical parameters using the two particle sizes and two pH levels (assumed)

Samples from the effluent streams of both the sieving and prepared sample slurrying and the phased HGMS testing will be required in order to evaluate the performance of each There are five sample locations identified in Figure 8 3-2 and are described below

Sample Location 1: A sample will be taken periodically at this location to determine the activity (plutonium 239 and 240, gross alpha, and gross beta) concentration in the particle size fraction rejected by wet sieving at a particular pH The size fraction will be either +100 or +200 mesh The concentration should be relatively constant for a particular pH and size fraction for all tests performed on the homogenized RFP soil sample.

Sample Location 2 A sample will be taken periodically at this location for each pH level and size fraction in order to provide an activity balance around the sieving process This also provides a verification of the level of activity present in the soil being fed to the HGMS.

Sample Location 3: A sample will be taken from this location for each test run to determine the activity in the effluent (soil portion) of the HGMS.

Sample Location 4: This sample consists of the 0 45 μm filter paper used to filter water decanted from the magnetic separator's effluent slurry. The filter paper will be taken as a sample for each test run Loose solids that may collect on the filter paper and affect an activity screening of the paper should be carefully removed and combined (mixed) with the effluent solids of the HGMS prior to sampling at Location 3.

Sample Location 5 A water sample will be taken periodically to monitor activity in wastewater generated as part of the HGMS separation treatability study

Note **Samples taken at locations 3 and 4 will be labelled with the appropriate test run number as described for the Magnetic Separation Run Sheet**

Soil samples will be analyzed in accordance with the requirements outlined in Section 5.2. Water will be analyzed for plutonium 239 plus 240, gross alpha and gross beta in accordance with LANL procedures

8 4 Field and Laboratory Data Management

Data generated from implementation of the magnetic separation laboratory screening will be documented as described in Section 8 3 6 The data produced from the tests will primarily be recorded on the Magnetic Separation Run Sheet Analytical data will be recorded and managed according to LANL APs. Deliverables for the magnetic separation test are the following

- Performance evaluation report which includes at a minimum
  - Magnetic Separation run sheets
  - Analytical logs for optimization and performance tests, including activity analyses results, temperatures, pH, etc
  - Sieving/Prepared Sample procedure notes
- Originals (or legible copies) of all QA Records produced throughout the treatability testing, organized by test run number
- Test parameters and analytical results in either Lotus or dBase format, organized by test run number

The EG&G-RF project manager will receive the deliverables supporting the treatability test from the test subcontractor. EG&G-RF will manage these data according to the EM data management procedures EG&G-RF will provide the test data and results to its feasibility study subcontractor for interpretation and analysis The subcontractor is required to manage these data in accordance with a standardized document inventory and filing system Data interpretation and analysis results will be documented to allow independent verification of the conclusions

8 5 Data Evaluation

Data evaluation will be conducted in stages coupled with surrogate contamination tests, plutonium-contaminated soil sieving, and the various phases of HGMS testing of plutonium-contaminated soil. Calculations and statistical analyses will be produced, checked, and coded for inclusion in treatability study report appendices in accordance with good engineering practices and standard procedures for RFP Evaluation of laboratory reports and related QA/QC information is addressed in Section 6 2

8 5.1 Surrogate Testing Data

The LANL treatability laboratory team will evaluate the surrogate test data, and the RFP plutonium-contaminated soil treatability team will review them prior to initiation of the treatability testing program on RFP plutonium-contaminated soil

Surrogate testing data evaluation will include the following components

- The separation process simulation model developed at LANL will be calibrated using data on copper oxide (CuO) removal
- Critical process control and configuration parameters will be identified and ranked according to their degree of influence on CuO removal efficiency
- A standard protocol will be developed for use in the RFP soil testing program.
- Optimum ranges of the critical parameters will be determined.

8.5 2 Sample Characterization and Preparation

Data from initial characterization of the bulk RFP plutonium-contaminated soil sample (Section 8 3 3) and from preparation for HGMS testing by wet sieving (Section 8 3 4 1) will be evaluated prior to initiation of the phased HGMS testing (Section 8 3 4.2) Grain size distribution data for the bulk sample will be compared with the 100- to 200-mesh sieving results for mass in the prepared (-100 and -200 mesh) samples Also activity (plutonium 239 plus 240, gross alpha, and gross beta) in the oversize-reject material will be compared with the clean soil criteria (Section 4 2) Mass and Curie balances will be prepared for 100- to 200-mesh sieving using data on feed soil, oversize-reject, and prepared sample characteristics Replicates will be compared to evaluate test procedure reproductivity and to confirm average and extreme values for soil sample particle size gradations and activity levels

8 5 3 Phase HGMS Testing

Data evaluation for the HGMS testing program (including processing of treated samples) on plutonium-contaminated soils will include interim data reviews by the LANL treatability laboratory team and the RFP plutonium-contaminated soil team to establish test run configurations for succeeding phases of testing (Section 8 3 4 2) These interim reviews will begin the evaluation of data which is later completed in evaluation of the entire data set at the end of the test program, including the following components

- Comparison of plutonium-removal efficiencies for the various sample preparations and settings of process control parameters
  - Assess effects of grain size by comparing results from PS-100 runs against PS-200 runs
  - Assess effects of the various critical parameters by comparing results for each phase against the other phases in terms of average and peak removal efficiencies.
  - Evaluate which parameters generate the greatest sensitivity in plutonium-removal efficiency by comparing results for runs with the same phase of testing
  - Identify optimum settings for each parameter and evaluate whether additional test runs are needed to explore optimum combinations for the process parameters
  - Compare plutonium-removal in pH neutral slurry test runs against high pH slurry test runs having the same settings for critical process parameters

- Compare replicated test results
  - Reproducibility of results
  - Average and 15 percent confidence limits on achievable efficiency

- Achievement of test objectives
  - calculation of curie and mass balances for most efficient configurations
  - compare clean soil criteria with optimum efficiency results
  - Estimate HGMS average and range of residuals including matrix and slurry water

- Assess Technical Feasibility of HGMS
  - Efficiency, ability to meet objectives
  - Practical limitations on efficiency
  - Technical operating problems
  - Residuals generation and reagent usage

8.6 Regulatory Requirements

Off-site treatability studies on RFP plutonium-contaminated soil will require conformance to applicable DOT regulations These regulations address the handling and shipping requirements for radioactive materials It is expected that the soil will be exempt from the requirements of 40 CFR 261 - Identification and Listing of Hazardous Waste, therefore, the soil will not be subject to the requirements of 40 CRF 262 - Standards Applicable to Generation of Hazardous Waste

RFP soil samples will be shipped to LANL as normal form radioactive material (49 CFR 173.401) and will be packaged in Type A (or equivalent) containers The sampling methodology and specifications for containers are included as Attachment 1 - Field Sampling Procedure for Sampling Plutonium-Contaminated Soils to Support Treatability Studies at Nevada Test Site and Los Alamos National Laboratory

The weight limitation of untreated soil for each Type A package shipped to the NTS is based on the normal form (A_2) limit for plutonium 239 and 240 (Note the A_2 limits for plutonium 239 and 240 are each equal to 0 002 curie as per 49 CFR 173), and the expectation that the total plutonium concentration in the soil to be sampled is no greater than approximately 10 pCi/g Thus, the estimated package weight limit is calculated as follows

Plutonium Concentration in Soil.	10 pCi/g
A_2 Limit for Plutonium 239.	0.002 Curie (Ci)

$$\text{Weight Limit} = 0.002 \text{ Ci Pu} \times \frac{1\times10^{12} \text{ pCi}}{1 \text{ Ci}} \times \frac{1 \text{ g Soil}}{10 \text{ pCi Pu}} \times \frac{1 \text{ kg Soil}}{1000\text{g Soil}} = 2 \times 10^{5} \text{ kg Soil}$$

Based on a typical DOT 17H 30-gallon drum, which exceeds Type A package requirements, and an assumed soil density of 100 lbs/ft^3 (1.6 g/cm^3), the estimated soil sample weight per package to be shipped to LANL is approximately

$$30 \text{ gallon} \times \frac{3785 \text{ cm}^3}{\text{gal}} \times \frac{1.60 \text{ g Soil}}{\text{cm}^3} \times \frac{1 \text{ kg Soil}}{1000\text{g Soil}} = 180 \text{ kg Soil}$$

This is well below the weight limit calculated for untreated soil

The weight limitation of treated soil for Type A packages returning to RFP from LANL is estimated under the assumption that the HGMS process produces a "clean" soil stream (meets clean-up goal of 0.9 pCi/g plutonium) that comprises approximately 95 percent of the original feed mass. This assumption leads to a material balance around the HGMS process as represented in Figure 8 6-1 A basis of 100 g of feed was chosen because of uncertainty associated with the number of test runs that will be made throughout the optimization and performance tests The plutonium concentration in the "matrix/contaminated material" (MCM) stream provides a conservative basis for estimating the Type A package weight limit. This estimate is calculated as follows

Plutonium Concentration in Soil	10 pCi/g
A_2 Limit for Plutonium 239	0 002 Ci

$$\text{Weight Limit} = 0\ 002 \text{ Ci Pu} \times \frac{1\times10^{12} \text{ pCi}}{1 \text{ Ci}} \times \frac{1 \text{ g MCM}}{183 \text{ pCi}} \times \frac{1 \text{ kg MCM}}{1000\text{g MCM}} = 1 \times 10^{4} \text{ kg MCM}$$

As previously calculated, the expected weight of a 30-gallon package of material will be approximately 180 kilograms, therefore, the weight limit will not be exceeded

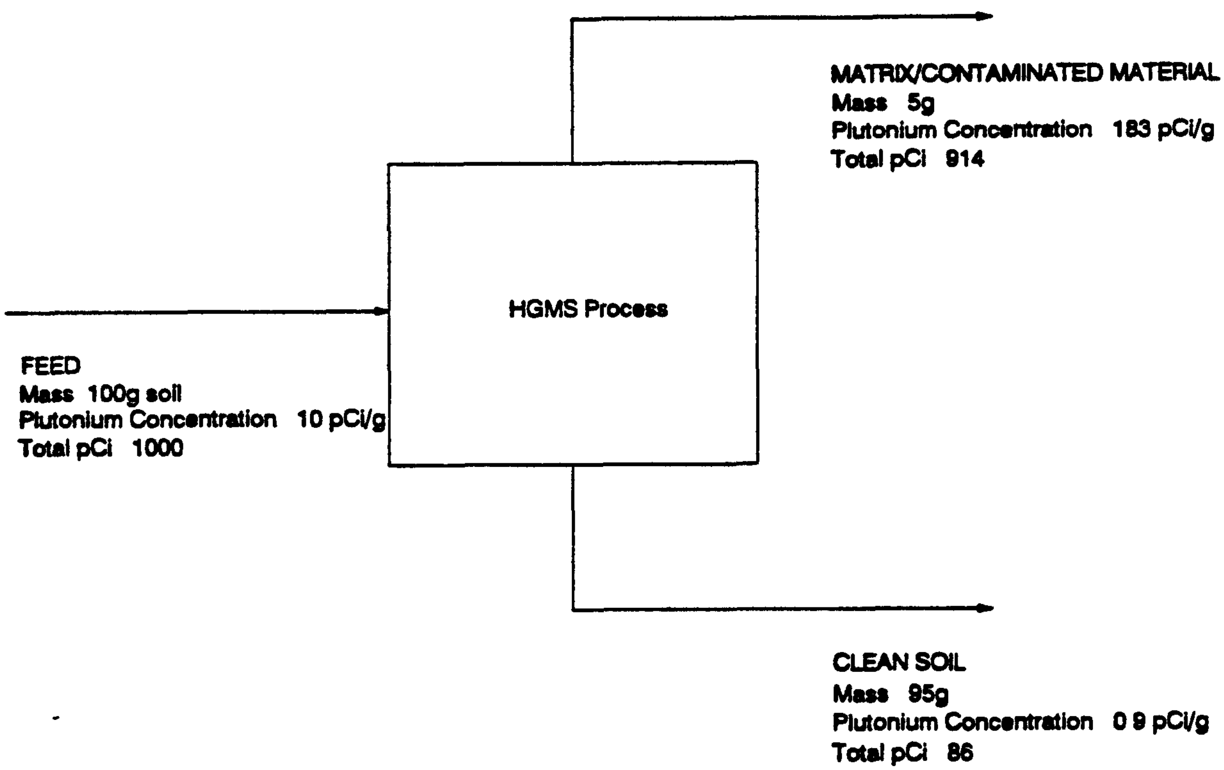

FIGURE 8.6-1

ASSUMED OVERALL MATERIAL BALANCE

HGMS PROCESS

8 7 Residuals Management

There will be four residuals generated as a result of the sieving/sample preparation and HGMS processes for both the optimization tests and the tests to be conducted to evaluate HGMS performance in removing plutonium. Each of the test's residuals are summarized in Table 8-1.

Table 8-1
Residuals with Expected Amounts

Residual	Expected Mass (volume)
Magnetic separation effluent	170 kg
Sieve reject material	30 kg
Matrix material	<10 g
Wastewater	(<100 l)

The solid residuals generated from the optimization tests will be combined and packaged into one DOT 17H 30-gallon drum Wastewater generated during the optimization tests will be collected in a drum, sampled, and analyzed for activity (plutonium 239 plus 240, gross alpha, and gross beta) The measured activity levels will be compared to the de minimus levels for plutonium, gross alpha, and gross beta. If the de minimus values are exceeded, the wastewater will undergo processing at LANL Water that meets de minimus values will be discharged according to LANL procedures

Solid residuals generated during the HGMS performance tests will be kept segregated The magnetic separation effluent and filter paper for each test run will be packaged in an unbreakable container which is labeled with the appropriate test run number (Section 8.3 6) All test run packages will then be combined in a Type A container such as a DOT 17H 30-gallon drum. The sieve reject and matrix material will be consolidated into one Type A container.

Wastewater generated during the HGMS performance tests will be handled as discussed above for optimization test wastewater

LANL personnel will be responsible for preparing all residuals for return shipment to RFP EG&G-RF will be responsible for the handling and disposition of residuals upon receipt at RFP

8 8 Health and Safety

When energized, a magnetic field exists around the HGMS exerting a pull on all magnetic objects All personnel working in the vicinity should have removed wrist watches, magnetically imprinted credit cards, and other magnetically susceptible items prior to energizing Personnel not involved with the treatability tests should not be permitted in the field, especially those who may be equipped with any type of medical equipment that may be affected by a magnetic field (e g suture staples, aneurism clips, prostheses, etc.)

According to American Conference of Governmental Industrial Hygienists (ACGIH) Biological Exposure Indices (ACGIH, 1990) routine occupational exposures should not exceed 60 millitesIas (600 Gauss) whole body or 600 millitesIas (6000 Gauss) to the extremities on a daily, time weighted average basis. A flux density of 2 Teslas is recommended as a ceiling value. Safety hazards may exist from the mechanical forces exerted by the magnetic field upon ferromagnetic tools and medical implants Workers having implanted cardiac pacemakers should not be exposed above 1 0 millitesla (10 Gauss) Perceptible or adverse effects may also be produced at higher flux densities resulting from forces upon other implanted ferromagnetic medical devices

The radiological concerns regarding the operation of the magnetic separator are similar to other radioactive material handling procedures Specific Health and Safety Plans (HSPs) are in existence at LANL which include SOPs for handling, storing and monitoring environmental and employee exposures These HSPs include SOPs which fulfill the requirements of DOE Orders Some of the more relevant DOE Orders which have been incorporated into the HSP development include the following

5480 11	Radiation Protection for Occupational Workers
5480 4	Environmental Protection, Safety and Health Protection Standards

5483.1 Occupational Safety and Health for Government Owned Contractor Operated Facilities

5400 5 Radiation Protection of the Public and the Environment

The specific protocols required for radiation protection during the magnetic separation will focus on the following·

- Radioactive Airborne Contamination Monitoring
- Contamination Surveys - Personnel and Equipment
- Internal/External Dosimetry Requirements
- Decontamination and Equipment Release Surveys
- Personnel Training in Radiation Safety and Contamination Reduction Techniques

8.9 Schedule for HGMS Tests

A bar chart schedule of the HGMS treatability tests is included as Figure 8 9-1

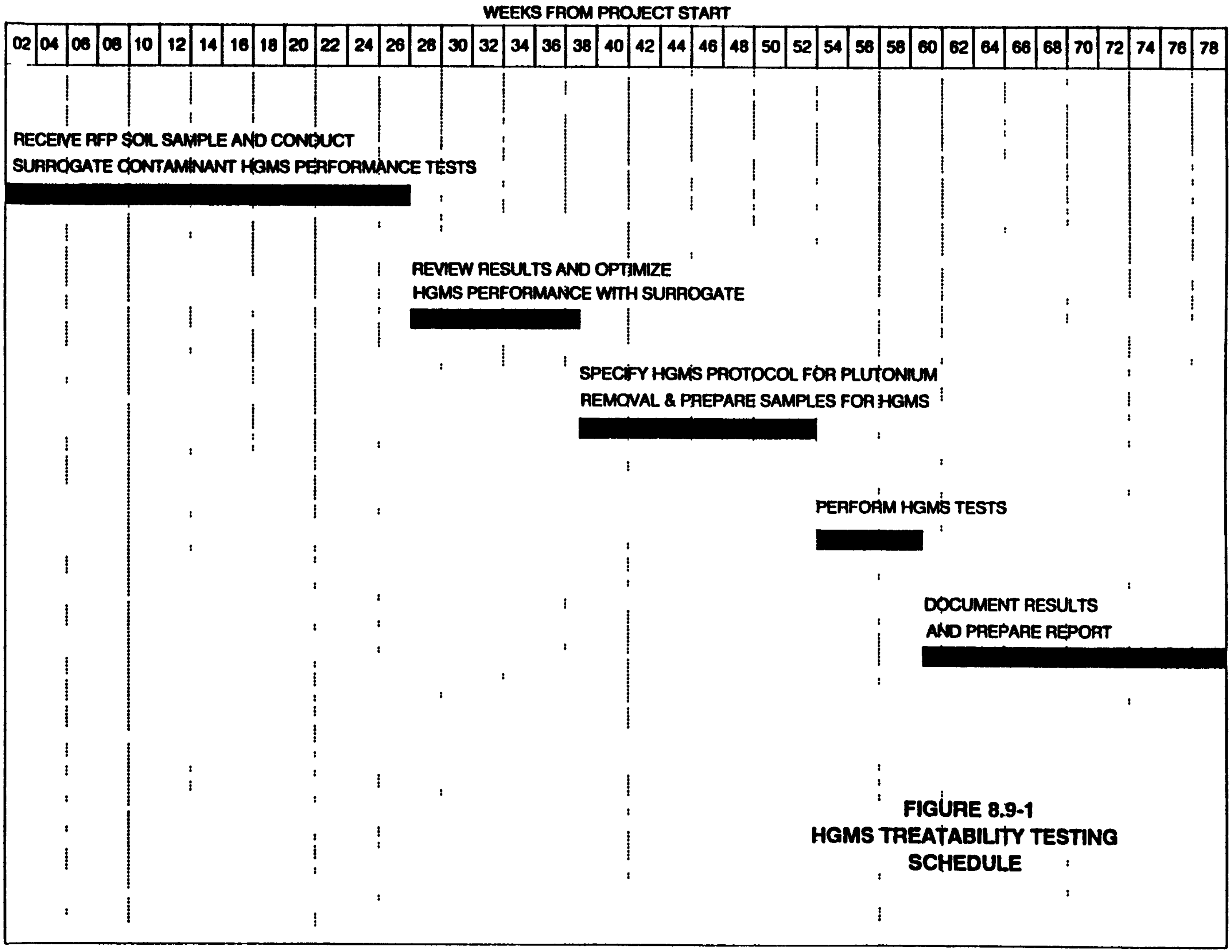

FIGURE 8.9-1
HGMS TREATABILITY TESTING SCHEDULE

9 0 SOIL CHAIN-OF-CUSTODY

Responsibility for RFP plutonium-contaminated soil samples will vary as indicated by Figure 9 0-1 From sampling at RFP, the soil samples will be transported to three locations an EG&G-RF designated laboratory for characterization, the AWC facility at NTS for TRUclean tests, and LANL for HGMS tests Upon completion of the characterization and treatability tests, residual materials will be returned to RFP for final disposition

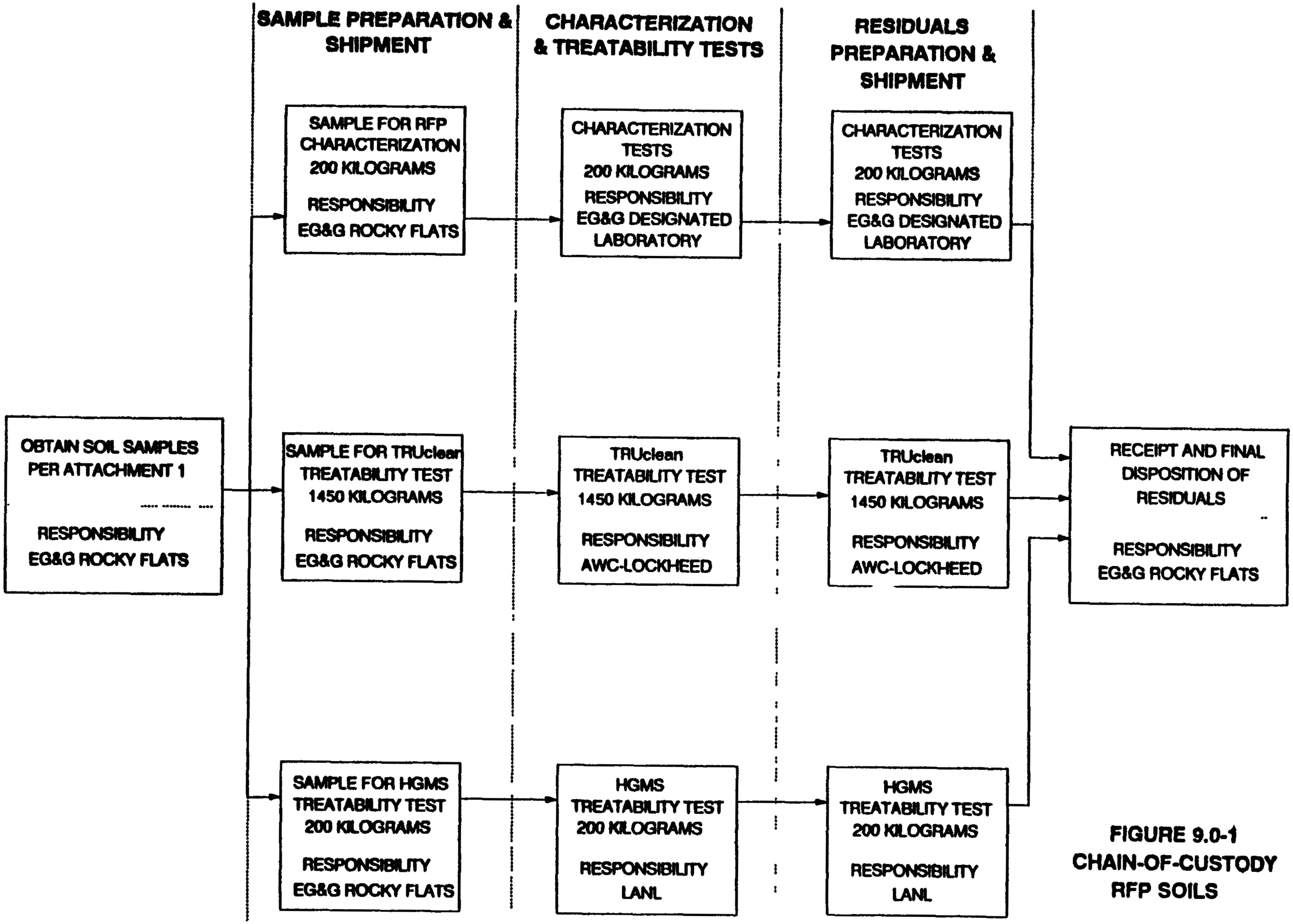

FIGURE 9.0-1
CHAIN-OF-CUSTODY
RFP SOILS

Approved By

TITLE:
Plutonium in Soils - Treatability Studies Work Plan

_______________ __/__/__
Name (Date)

10 0 REFERENCES

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TLE	DATE	PCN NUMBER
Field Sampling Procedure for Sampling Plutonium-Contaminated Soils to Support Treatability Tests at Nevada Test Site and Los Alamos Nat'l Lab		GT.08

RGENT Expires: N/A

PORARY Expires: N/A

Item umber	Page	Step or Paragraph	Changes (Use PCN CONTINUATION SHEET for additional space)
			Procedure is addendum to Final Field Sampling Plan for Sampling Plutonium-Contaminated Soils from Operable Unit 2, Rocky Flats Plant, EG&G, 1991.

fication (Reason for change - Provide numbers to reference corresponding items above.)

Addendum addresses specific sampling procedure to support treatability studies at the Nevada Test Site and the Los Alamos National Laboratory.

Concurrence	Organization	Req	Date	Concurrence	Organization	Req.	Date

Approval of Responsible Manager	14 Date	15. Is Posting Required	16. If Yes, by what date	17 Date Posted

FIELD SAMPLING PROCEDURE FOR SAMPLING PLUTONIUM-CONTAMINATED SOILS TO SUPPORT TREATABILITY TESTS AT NEVADA TEST SITE AND LOS ALAMOS NATIONAL LABORATORY

EG&G ROCKY FLATS, INC

TABLE OF CONTENTS

FIELD SAMPLING PROCEDURE FOR SAMPLING PLUTONIUM-CONTAMINATED SOILS TO SUPPORT TREATABILITY TESTS AT NEVADA TEST SITE AND LOS ALAMOS NATIONAL LABORATORY

1 0 SAMPLE PROGRAM

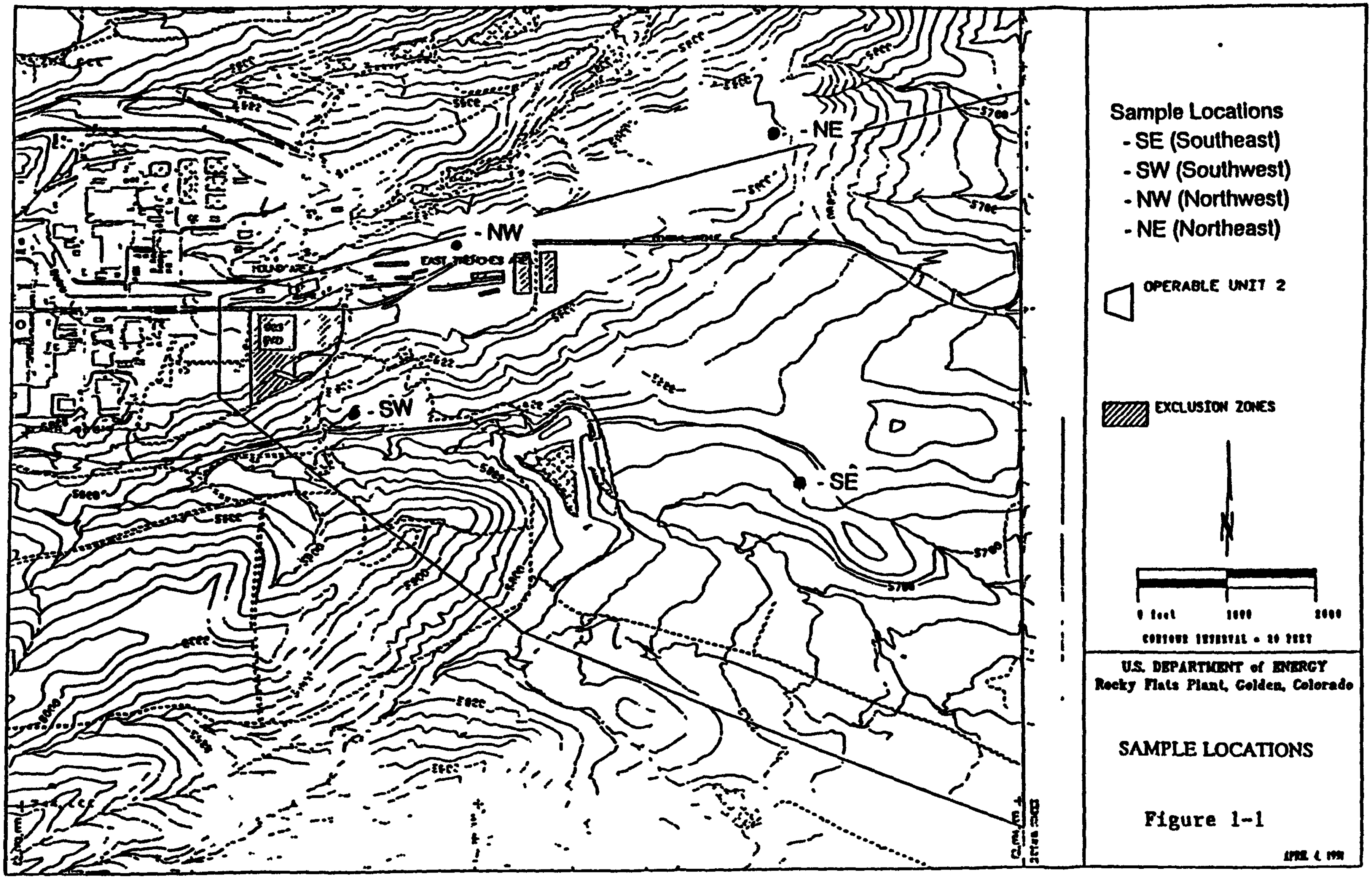
The Final Field Sampling Plan for Sampling Plutonium-Contaminated Soils from Operable Unit 2, Rocky Flats Plant (see Volume II of this work plan) locates the soil sampling areas within Operable Unit 2 that will support plutonium in soil treatability studies Figure 1-1 of this procedure identifies the four sampling areas The southeast sampling area will provide the soil to support the TRUclean and magnetic separation treatability tests at the Nevada Test Site and Los Alamos National Laboratory This sampling procedure delineates where to take the sample in that area and the procedure for taking the sample The sample procedure will result in a sample of approximately 1660 kilograms (3660 lbs) that will be divided between Nevada Test Site (87 5%), Los Alamos National Laboratory (6 25%), and Rocky Flats Plant (6 25%)

The sample procedure will require splitting the collected soils, therefore, the soils should not be wet or muddy A soil moisture content less than 10 percent, preferably 4 to 6 percent, should be satisfactory This requirement will need to be considered when scheduling the sample time A portable moisture analyzer could be used to correlate the soil moisture content with the splitting ease of the soil sample

1 1 Sample Plan

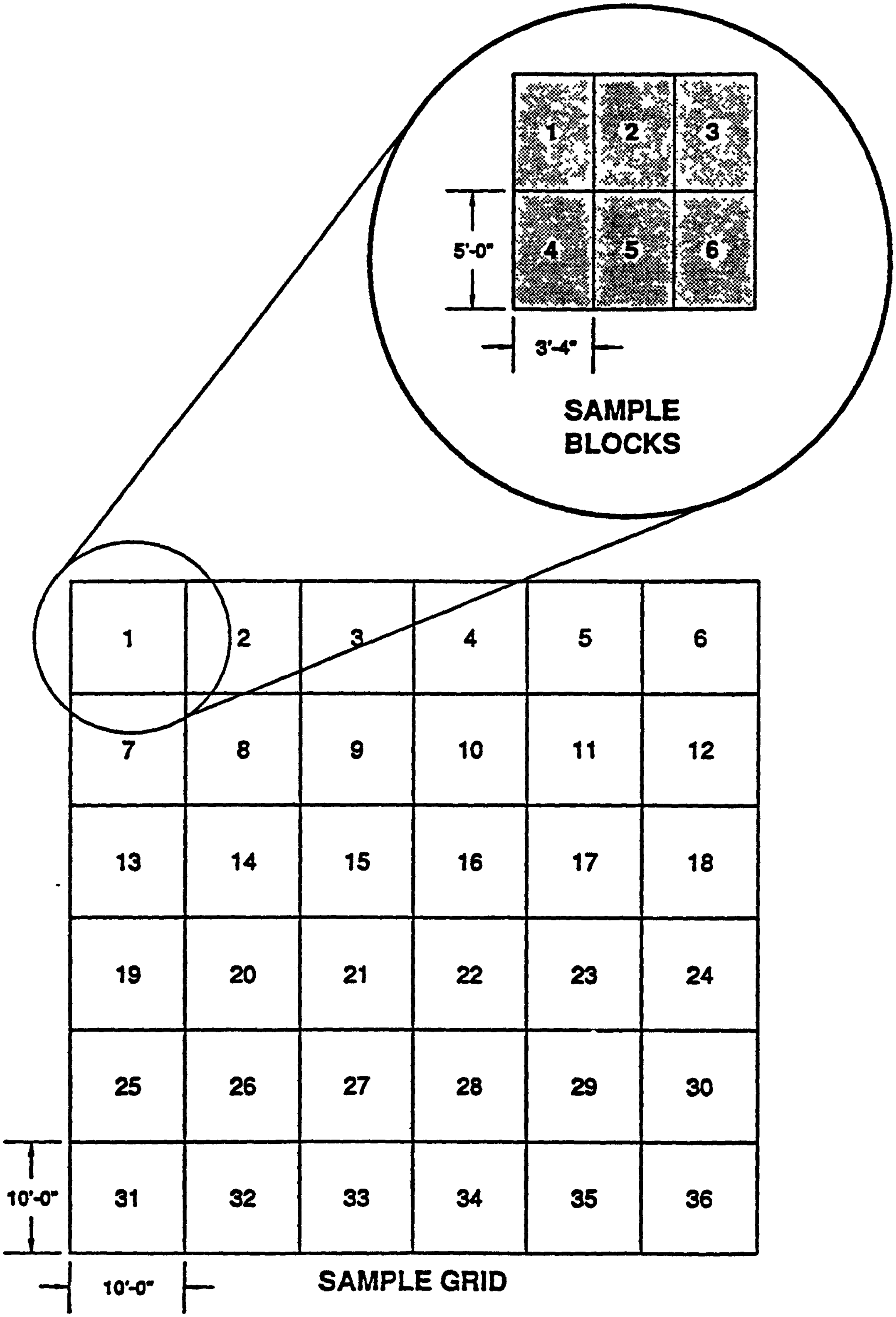
The area to be sampled will be 60 feet long by 60 feet wide (18 3 m x 18 3 m) and will be divided into 10-foot by 10-foot (3 05 m x 3 05 m) squares, resulting in 36 grids Each grid corner will be identified with a flagged stake The grids will be numbered numerically as shown on Figure 1-2, with number 1 in the northwest corner

A 10-foot by 10-foot grid pattern will be made out of rope. The grid pattern will be subdivided into six equal rectangles (sample blocks) with each rectangle or sample block being 3 feet, 4 inches wide by 5 feet high (1 02 m x 1 52 m) Each rectangle sample block will be considered to have a number, 1 through 6, as shown on the Figure 1-2 detail Number 1 will begin in the northwest corner There will be one sample taken from one of the sample blocks in each grid This will result in 36 discrete random samples being taken to provide the bulk sample



SAMPLE LOCATIONS

Figure 1-1



SAMPLE LOCATION AREA

Figure 1-2

1.2 Documentation

To document and track sampling activities and resultant data, the following record keeping procedures will be followed

1 2 1 Field Log

Each sampling team will keep a log of all sampling activities The information will be recorded in a bound, page-numbered journal This journal should contain a description of all activities related to sampling (equipment, decontamination, field tests, etc), as well as sample locations, sample identification, dates, times, weather conditions, and identification of individuals present

1.2 2 Sampling Record Form

To avoid incomplete field logs and to aid in sample source tracking, a sampling form requiring specific information on sample collection, field conditions, and sample distribution will be completed for each sampling event (Figure 1-3) At the end of each sampling day, the sampling forms will be compared with information recorded in the field log, organized sequentially by grid number, and placed in a three-ring binder Samples will be referenced by grid number (two digits), block number (one digit), month (two digits), day (two digits), and year (two digits) e g 21-5-09-11-91

A separate, bound journal will be kept for logging and tracking the samples This log will record the sample location by the project sample identification number An example of the sample log format is shown in Figure 1-4

SOLID SUBSTANCES SAMPLING FORM

Date ______________________________

Project ______________________________ Time ______________________________

Task No ______________________________ Sampling Team Members ____________

Site ______________________________ Location ______________________

Sample ID ______________________________ Quantity ______________________

SUBSTANCE DESCRIPTION

Sample Type [ ] Soils ____

[ ] Sediments ____

[ ] Other ____

Sampling Procedures/Methods (describe)

____

____

____

____

Sample Containers	Comments
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

General Comments

____

____

____

____

FIGURE 1-3

Project ____________

Page ____ of ____________

SAMPLE LOG

Date	Time	Sample Collection Location		Sample Identification Number	Quantity/Type	Logged By
		Grid No	Block No			
		1				
		2				
		3				
		4				
		5				
		6				
		7				
		8				
		9				
		10				
		11				
		12				
		13				
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		34				
		35				
		36				

FIGURE 1-4

2.0 SAMPLING PROCEDURE

A modified, stratified random sampling method will be utilized to provide a representative composite sample for a sampling site. The procedure involves the division of the site into 36 equal grid areas. Each area will then be subdivided into six subarea rectangles to form sampling blocks (Figure 1-2). Within each grid area, a subarea block will be selected randomly for sample collection. The following procedures will be utilized.

1. Define and mark the site as described in Section 1.1, Sample Plan.

2. Starting with grid number 1, roll a die and record the result next to the grid number in the block number column of the sample log (Figure 1-3). In this manner, a random number 1 to 6 will be generated for each of the 36 grid areas.

Grid Number	Die Roll Result, Block Number
1	3
2	2
3	5

3. Take the 10-foot by 10-foot rope pattern (Section 1.1) to the grid area to be sampled. Spread the pattern using the four corner stakes.

4. Go to the grid block selected by the die roll. In the approximate center of the block, excavate a 12-inch wide, 18-inch long, 8-inch deep (1 cubic foot, 30.5 cm x 45.7 cm x 20.3 cm, 0.0283 m^3) section of soil with a stainless steel shovel. Shift the sample location to avoid heavy vegetation, such as small bushes, tumbleweeds, etc. Grass-type vegetation is to go with the sample.
5. Once the soil sample is removed, the small excavation will be filled by using the shovel to grade the sides down into the excavation. This will result in a small depression with native soils to enhance revegetation.

6. Place the soil into a portable sieve box with a 2-inch opening screen. Using the stainless steel shovel, break clumps such that only rocks larger than 2 inches (>50 mm) remain on the screen.

7. Put the minus 2-inch (<50 mm) material into one of two 8-gallon DOT 17H drums and the plus 2-inch rock (>50 mm) into a third 8-gallon DOT 17H drum. After each 8-gallon drum of minus 2-inch contains about 22 to 23 kilograms (50 lbs), take it to the splitters for sample splitting.

8. An overview of the sample splitting procedure is shown on Figure 2-1. The overview follows one block sample from excavation through division into material for the Nevada Test Site (NTS) TRUclean test, the Los Alamos National Laboratory (LANL) Magnetic Separation test, and the Rocky Flats Plant (RFP) chemical and radiological tests. The procedure to accomplish the sample splitting is as follows.

   Note: After every use of the splitting equipment, the pans used to collect the sample splits and the drums containing the samples will be brushed clean. The particulate from the equipment will be brushed into the next item downstream (e.g., splitter particles are brushed into the pans before dumping the pans).

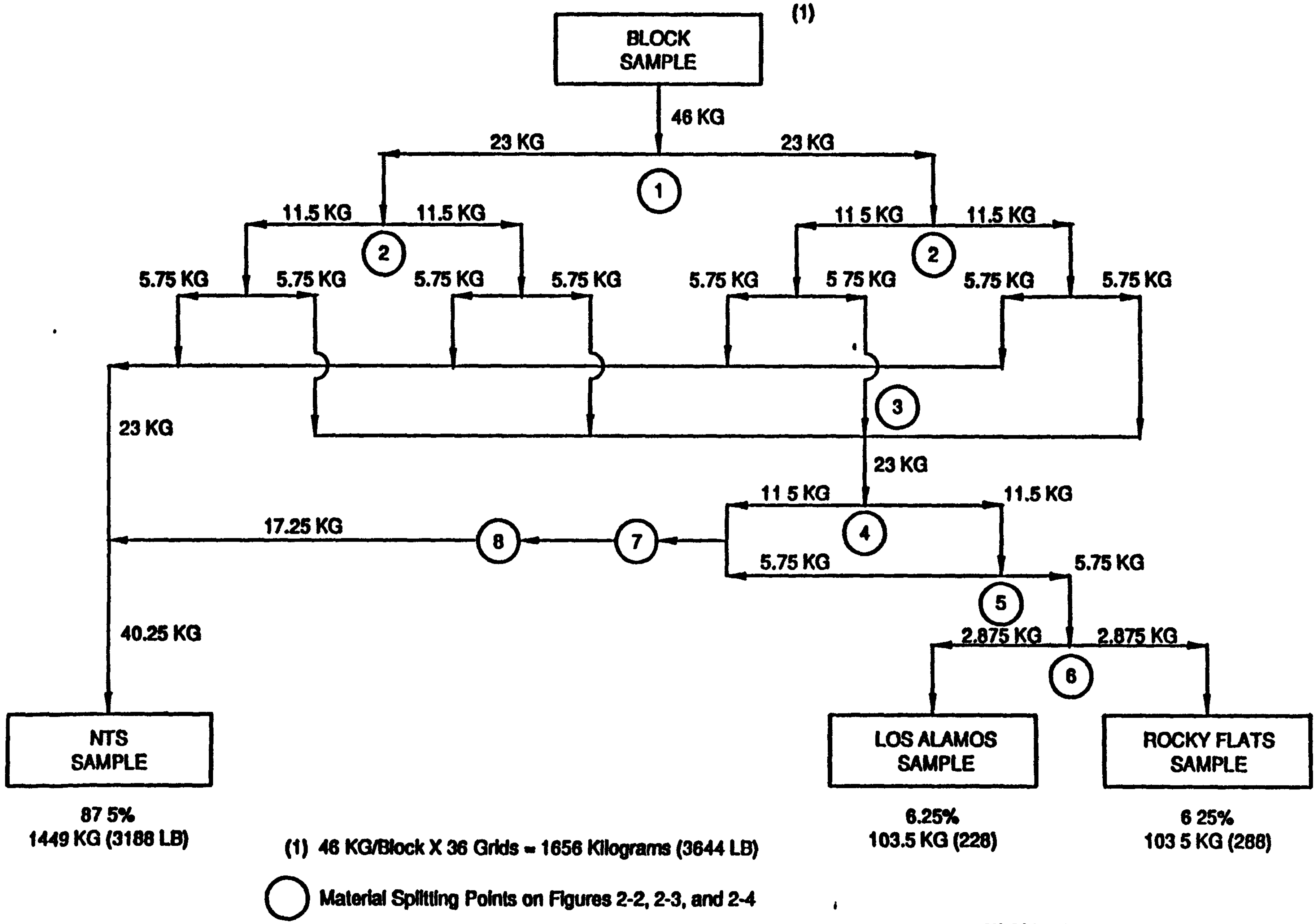

FIGURE 2-1
OVERVIEW SAMPLE SPLITTING

8.1 The two 8-gallon drums (Drums 8-1, 8-2), containing about 22-23 kilograms (48-50 lb) are placed into the hopper of a Gilson Model SP-O Mass Splitter or equal, splitter #1, as shown on Figure 2-2 Splitter chute width settings are chosen to be two or three times the largest particle size, e g for minus 2-inch material use either a 4-inch or 6-inch setting The soil is leveled in the hopper, then released into the splitter, item ①, on Figure 2-2

8.2 The sample is split in half with each half falling into two separate pans, one-half flows into pan #1 and pan #2 and the other half into pan #3 and pan #4 Each half (two pans) must be split again to provide identical material for each of the four 55-gallon DOT 17H drums (Drums 55-1, 55-2, 55-3, 55-4) for NTS and material for LANL and RFP, item ② Note **The 55-gallon drums for NTS are optional, however, the type of containers used must meet the requirements of a type A container as described in 49 CFR 173**

8.3 The splitting is done in sequence Pans #1 and #2 are combined in the splitter #1 hopper, leveled, and released into four other, clean pans (#5, #6, #7, and #8) Pan #5 material goes to Drum 55-1, #7 to 55-2, and the remaining two (#6, #8) to an 8-gallon, DOT 17H drum (Drum 8-4), item ③ The cycle is repeated with pans #3 and #4 This time pan #5 material goes to Drum 55-3, #7 to 55-4, and the other two (#6,#8) are added to Drum 8-4

8.4 At this point there are five drums (55-1 55-2, 55-3, 55-4, 8-4) containing basically identical sample material The material in Drum 8-4, item ③, must be split into smaller quantities as shown on Figure 2-3, item ④ The Drum 8-4 soil sample is placed into the hopper of a Gilson Model SP-1 Sample Splitter or equal, splitter #2 Splitter chute width settings are chosen as described in 7 1, e g 3-inch, 4-inch, or 6-inch Splitter #2 splits the sample in half and discharges into pans #9 and #10

8.5 Pan #9 soil is put into an 8-gallon, DOT 17H Drum (Drum 8-5), and pan #10 soil is split in half using splitter #2 a second time, item ⑤ Pan #9 soil is again put into Drum 8-5

8.6 Pan #10 soil is split a third time, item ⑥, in splitter #2 Pan #9's contents are placed into a 30-gallon DOT 17H drum (Drum 30-1) for collection of the LANL magnetic test materials Pan #10's contents are placed in another 30-gallon, DOT 17H drum (Drum 30-2) for collection of the RFP chemical and radiological test materials Note **The 30-gallon drums for LANL and RFP are optional, however the type of container used must meet the requirements of a type A container as described in 49 CFR 173**

8.7 Soil samples collected in Drum 8-5 are rejects from the LANL and RFP soil samples In order to properly divide this material (and to have virtually identical material in all four 55-gallon NTS drums) additional splitting is required, item ⑦

8.8 The Reject Return Split Pattern, Figure 2-4, shows the method to divide the rejects into four 55-gallon drums Drum 8-5 soils are placed into the hopper of splitter #1, leveled, then released, item ⑦ The contents of pans #1 and #2 are combined in the hopper of splitter #2, item ⑧ The soils are leveled released, and split in half Pan #9's contents are added to Drum 55-1, and pan #10's contents are added to Drum 55-2 The contents of pans #3 and #4, item ⑦, are split in the same manner, item ⑧ This time pan #9's contents are added to Drum 55-3 and pan #10's to 55-4

8.9 Plus 2-inch material collected in Drum 8-3 will be treated identical to the minus 2-inch material described above with sample splits going to NTS, LANL, and RFP

9 The above procedures delineate in detail the distribution of a soil sample from one selected block in a one grid area Extra 8-gallon DOT 17H drums will be provided This will allow field personnel to accumulate larger samples before splitting if they choose to do so For example, Figure 2-3, item ⑤, Pan #10 contents

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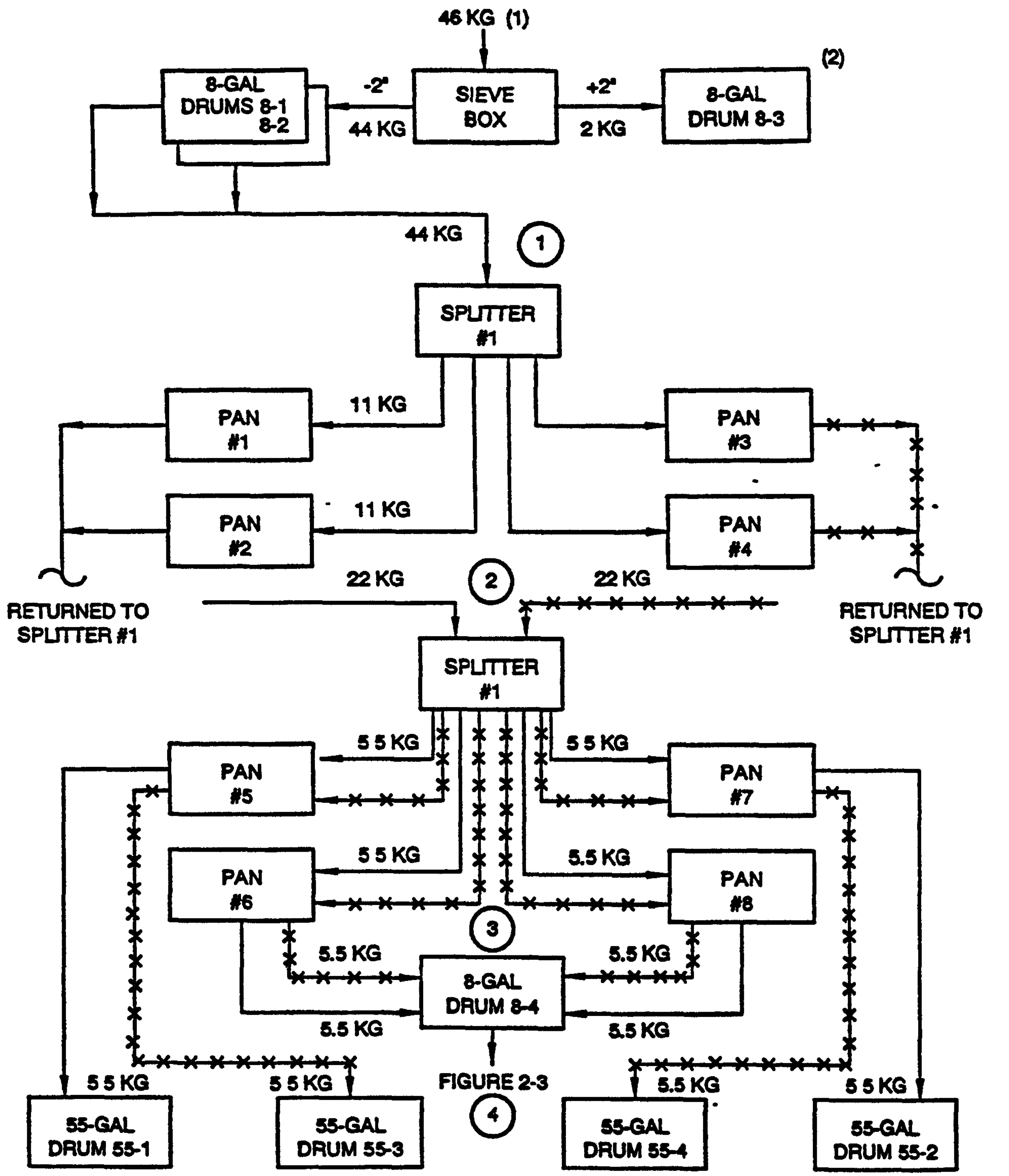

NOTES

1 For the example 46 kilograms is used. This is approximately the weight of sample from one block. The plus 2-inch is assumed to be approximately 4 3 percent.

2. When approximately 22 kilograms of plus 2-inch material is accumulated, Drum 8-3 is put through the same splitting process.

(2)— Represents the splitting of pan 1 & 2 material into 55-gal. drums

—x— Represents the splitting of pan 3 & 4 material into two other 55-gal drums. *Splitter #1 is used two different times, e.g. sequentially*

FIGURE 2-2
SAMPLE SPLIT PATTERN

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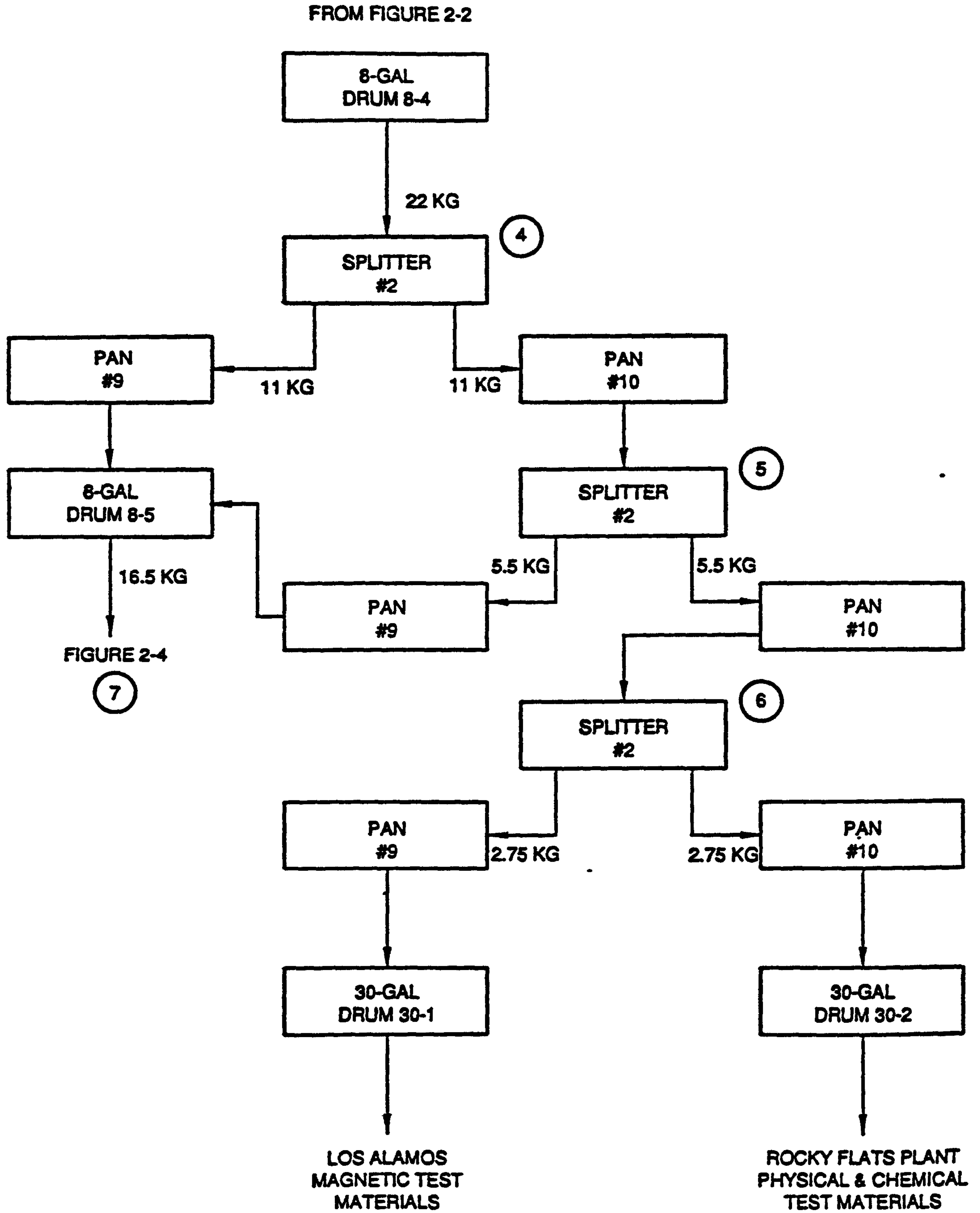

FIGURE 2-3
FINAL SAMPLE SPLIT PATTERN

rejrsp dwg

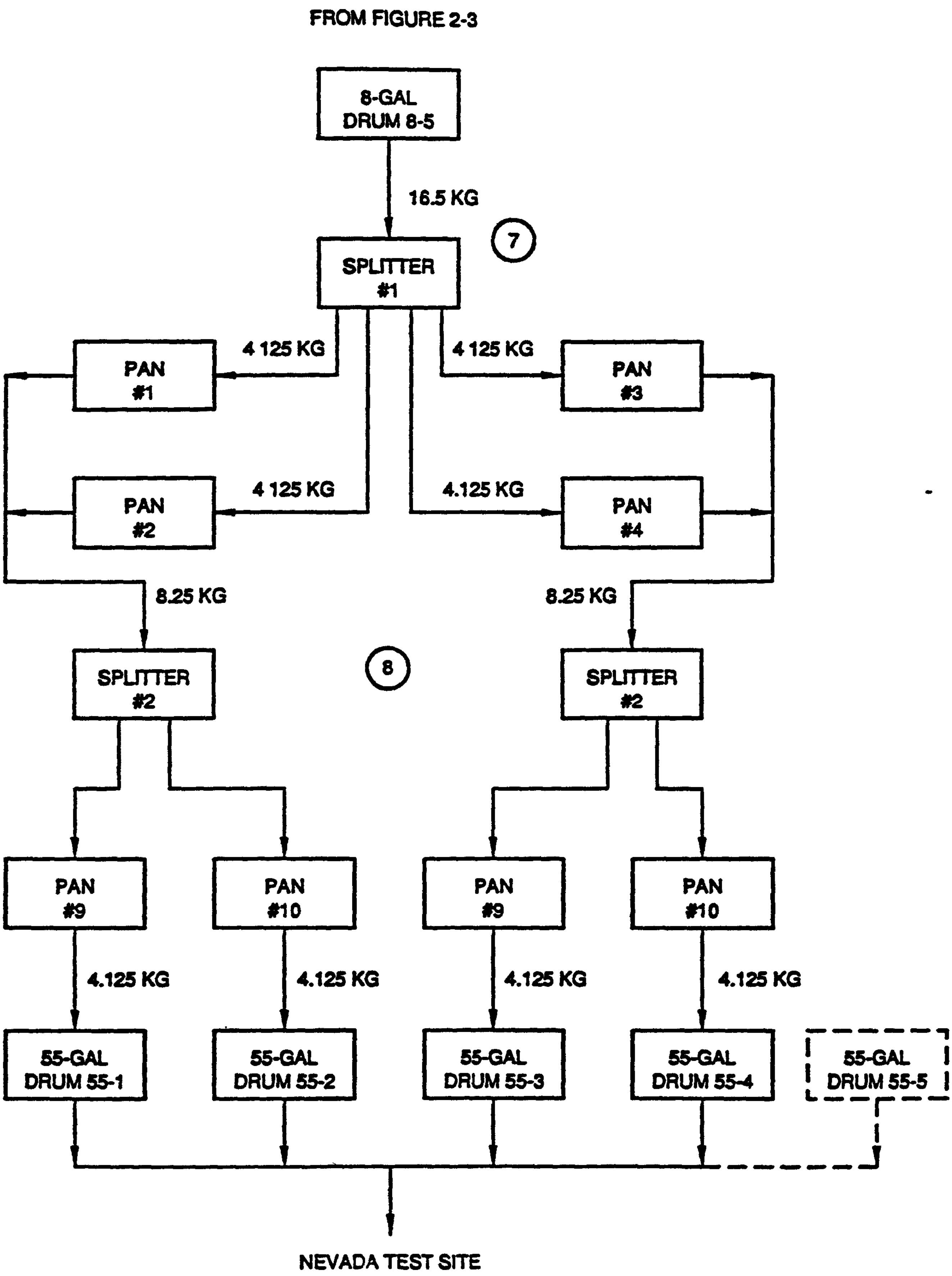

FIGURE 2-4
REJECT RETURN SPLIT PATTERN

could be accumulated in an 8-gallon drum Then splitter #2, item ⑥, could be fed 22 kilograms rather than 5 5 kilograms four times

10 A sample is required for volatile organic compounds (VOCs) using EPA Method 8240 Six samples will be taken for VOCs in the following manner

10 1 The sample area is divided into 36 10-foot by 10-foot grids There are six grids in a row and six rows, Figure 1-1

10 2 Each grid row will be considered to have numbers from 1 to 6 counting left to right

10 3 A die will be cast and one grid block will be selected for a VOC sample in each row The selected grid will be marked with an asterisk on Figure 1-3

10 4 When the soil sample is taken from the selected sample block a portion of the sample will be placed in a 40-milliliter vial The vial will be numbered as described in Section 1 2 2 and placed in a cooler at 4°C

11 The Final Sample Split Pattern, Figure 2-3, shows the generation of the final samples to be sent to LANL (Drum 30-1) for magnetic tests and to RFP (Drum 30-2) for physical and chemical tests The contents of each of these drums must be thoroughly mixed before any samples are taken The RFP drum should be kept cool (4°C)

Standard laboratory mixing, size reduction, and splitting procedures should be followed Mixing would best take place in a cube blender Spreading the sample out on a stainless steel plate and manually mixing the drum contents followed by cone and quartering is acceptable The RFP will need to extract an "as is"sample for determining a total particle size distribution before any size reduction is made to obtain analytical samples

3 0 EQUIPMENT REQUIREMENTS

The equipment requirements to execute the Section 2 0, Sampling Procedure, include the following items

1 One flat-bed truck, minimum 5-ton capacity, 1-ton jib hoist, and bed levelers

2 One Gilson Company, Inc , Model SP-O Mass Splitter or equal with nine pans

3 One Gilson Company, Inc , Model SP-1 Sample Splitter or equal with four pans

4 One Gilson Company, Inc , Rocker Screen Set or equal with 1-inch, 2-inch, and 3-inch wire cloth squares

5 Drums, DOT 17H

5 1 Five 55-gallon
5 2 Two 30-gallon
5 3 Eight 8-gallon

6 Two 10-foot by 10-foot rope grid patterns Each rope pattern will be subdivided into six equal rectangles, 3-feet 4-inches by 5-feet

7 Four shovels with stainless steel pointed blades

8 Two 25-foot tape measures

9 Four brushes to clean the splitters and pans after each use

4 0 SAMPLE SHIPMENT

4 1 Analytical and Radiological Screening Requirements

Each sample drum will require a radiological screening per RFP procedures (Environmental Management - Standard Operating Procedure No 1 13) prior to shipment offsite The packages must meet the requirements of 49 CFR 173 for shipment of normal form radioactive material in a type A container The primary contaminant of concern is plutonium which has a normal form limit (A_2 value) of 0 002 Ci

4 2 Shipping Destinations

At least four 55-gallon drums (drums 55-1, 55-2, 55-3, and 55-4) will be shipped to the Nevada Test Site near Las Vegas, Nevada Chuck Rosenberry should be contacted at 702-295-7090 prior to shipping drums to the Nevada Test Site The actual shipping address is

Attention Chuck Rosenberry
Building 180 - Radioactive Materials Control
Nevada Test Site
Mercury, NV 89023

One 30-gallon drum (drum 30-1) will be shipped to the Los Alamos National Laboratory, Los Alamos, New Mexico Larry Avens should be contacted at 505-667-2320 prior to shipping drums to the Los Alamos National Laboratory The actual shipping address is

Samples - Attn Larry Avens MSE-510
Receiving Department
Building SM-30 Bikini Road
Los Alamos, NM 87545

5 0 ANALYTICAL RECOMMENDATIONS

Each DOE laboratory will have specific analytical procedures for evaluating radioactive and hazardous constituents It is suggested that these procedures coincide with the EPA methodology An example would be radionuclide anlysis of plutonium, the EPA recommneded methods are radiochemistry Alpha Spectrometry using electro disposition techniques or by coprecipitation on a very small amount of carrier, such as laitranium fluroide - ALPHA - 605(2), ASTM-D-3972(13)

6 0 HEALTH AND SAFETY REQUIREMENTS

The following EMAD field procedures are to be followed in executing this SOP

SOP 3 8	Surface Soil Sampling
SOP 1 13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
SOP 1 16	Field Radiological Measurements

In addition to the specific requirements of each of the procedures listed above, particular attention should be made in equipment decontamination and container surveys prior to leaving an operable unit in order to prevent inadvertent spreading of contamination

7 0 REFERENCES

EG&G Rocky Flats, Inc , Final Field Sampling Plan for Sampling Plutonium-Contaminated Soils from Operable Unit 2, Rocky Flats Plant, U S Department of Energy, Golden, Colorado, July, 1991

TABLE OF CONTENTS
STANDARD OPERATING PROCEDURES
AWC

STANDARD OPERATING PROCEDURES
OPERATION OF GRAVIMETRIC SEPARATOR

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Approvals

Terry Wenehard	7/1/91	Gregory Gladie	7/1/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory Gladie	7/1/91	Gregory Gladie	7/1/91
QA Manager	Date	E,S&H Coordinator	Date

1.0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the Gravimetric Separator (GS)

1.2 The following procedure was developed to standardize testing of different soil types and optimize gravimetric separator settings to obtain the highest level of soil decontamination.

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests to optimize GS settings

2.2 The Gravimetric Separator operates most effectively on feed material less than 3/8 inch and separates heavy contaminants with particle sizes above 75 microns The Gravimetric Separator accepts feed rates up to 0.25 cubic yards per hour

3.0 Definitions

None

4 0 Responsibilities

4 1 The Laboratory Supervisor is responsible for assuring that all personnel assigned the task of G S operation are familiar with this SOP, that they have been trained in this SOP, and that a controlled copy of this SOP is available to them.

4 2 All personnel operating the G S on soil samples are responsible for following this SOP.

5 0 Procedure

5 1 Equipment and Supplies

1. Gravimetric Separator
2. 35 gpm Centrifugal Pump
3 2 - concentrate containers
4 Receiver tank
5 Water supply tank
6 Feed Auger
7. Miscellaneous piping and fittings
8 Stop watch
9 Ruler
10. Concentrate receiver tank

NOTE Some experiments may require other pieces of equipment to size the tails or scrub the feed Experiment configuration will be determined by the laboratory supervisor

5.2 Gravimetric Separator Operations

1 A description of the operational theory and operating variables is found in Attachment 10 1

2. Refer to G S Run Sheet (Attachment 10 2) and position G S in the experiment configuration. The G S Run Sheet contains supervisory instructions on system configuration and all G S settings to be used in the test run.

3 Position remaining system components as specified in the Run Sheet and connect system piping and fittings The operator will verify system configuration and settings by initialing G.S Run Sheet.

4 Set G.S stroke length as specified on G.S. Run Sheet. The stroke length is measured from the minimum and maximum travel of the rocker arm at the center of the hutch.

5 Set G S stroke frequency as specified on the Run Sheet by adjusting motor rheostat. The stroke speed is measured by counting the rocker arm cycles, using a stop watch.

6 Install bedding material of specified size and thickness

7 Add water to water supply tank

8 Start water supply pump and set Cell 1, Cell 2, hutch water, and dilution water to specified values on Run Sheet. The cell flows can be observed on the flowmeters or by collecting GS discharge in a measuring container

9 Position concentrate collection container under hutch discharge valves and open each valve to allow small trickle of water from the discharge valve (≈ 1/4 gpm) This verifies discharge lines and hutch core is free of solids.

10 Stop water supply pump.

11. Weigh specified quantity of feed material and place in feed hopper

Note The laboratory supervisor may elect to place feed in a feed supply tank and mix to a specified pulp density

12. Start GS

13 Start water supply tank (or feed supply pump)

14 Start feed at specified rate and record time on G S Run Sheet and dilution water.

15 Watch collection of water and concentrate in collection container and change containers as required While second container is filling, carefully decant water from first container into receiver tank Continue alternating procedure for the two containers until run is complete

16. When feed material is depleted, stop feed auger (or feed supply pump) and record time on G S Run Sheet.

17. Continue G S operation until hutch water is clear.

18 Close hutch valves. Stop dilution water

19 Stop Cell 1 and Cell 2 water flow by turning off pump Close cell water valves.

20 Determine volumes, weights, and pulp density of concentrate and G S tails and enter results on Run Sheet.

21. Remove bed material and steel balls Following removal of the bed material and steel balls, the balls are separated from the bed material using a magnet. The

steel balls are placed on a cloth bag or equivalent and allowed to air dry prior to next run. Determine volume, weight, and moisture content and enter results on Run Sheet.

22. Drain water from G S following each run and flush valves with clean water.

23. Prepare samples of bed material, concentrate, tails, and feed streams for radioactive assay Record results of assay on Run Sheet

5 3 Maintenance Procedures

The routine maintenance schedule for the G S is listed below

1. Grease the six (6) pillow blocks on the rocker arm weekly during operation

2. Grease the three (3) pillow blocks on the eccentric shaft weekly during operation

3 Inspect the two (2) diaphragms monthly for cracks and deteriation

4 Record maintenance activities in the maintenance section of the project logbook

6 0 Quality Controls

None

7.0 Environment, Safety and Health

7 1 Caution should be used when working around rocker arm. The up and down motion can cause potential pinch points

7.2 Lab coats or Anti-C coveralls shall be worn when processing contaminated soils.

7.3 See Special Precaution on Run Sheet for additional requirements specified by Safety

8.0 Records

The following documents will be maintained as Quality Records.

- G.S Run Sheet
- Project Logbook

9 0 References

None

10 0 Attachments

Attachment 10 1 Principles of Operation of the Gravimetric Separator

Attachment 10 2 "G S Run Sheet" form

PRINCIPLES OF OPERATION OF THE GRAVIMETRIC SEPARATOR

The Gravimetric Separator is designed to cause a separation of materials with different specific gravities This is accomplished by flowing a stream of liquid-suspended material over a screen and subjecting the screen beds to a vertical hydraulic pulsation This pulsation momentarily expands the beds and allows the heavier materials to work toward the bottom of the bed and lighter materials to the top of the bed Heavier material, or concentrate, that is finer than the screen opening will gradually pass down through the beds and the screen into the hutch, or lower compartment, from which it is usually discharged continuously If the concentrate is coarser than the screen, it will work down to the top of the shot bed, and can be withdrawn intermittently or at the end of each run. The lighter material, or tailing, will flow over the top of the beds and be rejected over the end of the Gravimetric Separator.

The G S has several variables which effect the recovery of contaminated heavy material and thus the amount of contamination remaining in the tail or decontaminated soil Each of these variables is discussed below·

Feed Dilution

For proper operation it is essential that the pulp be delivered to the G.S in such a form as to flow easily over the bed and permit the heavy particles to settle The pulp should not be so thick that the hutch water added to the G S will have the burden of disintegrating lumps The minimum dilution of the feed will vary between the limits of 30 to 40 percent solids by weight, depending on the viscosity of the pulp. If the pulp density of the material in the G.S is too low there will be no crowding of the light material and the result will be a larger volume of light material passing into the hutch concentrate

Bedding

The G S requires a certain amount of bedding material on the G S screen. This bedding consists of steel shot of a size slightly larger than the aperture of the screen. The depth of steel shot on the screen will vary between 1" and 2" depending on the soil characteristics The optimum depth of steel shot is determined through experimentation. In general, with finer feeds the shot bed should be deeper As the depth of the shot is increased, the hutch concentrate produced will be decreased in amount and is higher in concentration During extended operations a natural bed of heavy minerals may develop above the artificial bed and therefore impact the operation of the G S by creating a bed with an increased apparent thickness

Hutch Water

The hutch water adjustment is made by means of the valve in the hutch water line The amount of hutch water used will determine the amount of concentrate made, and also the bed condition on the G S The greater the amount of water used, the less suction will be felt on the bed, the smaller will be the amount of concentrate in the hutch, and the higher will be the concentration of the concentrate. The amount of hutch water required is usually between 3 and 8 gallons per minute per square foot of G S screen area.

Stroke Length

The eccentric hub on the G S provides variability of the stroke settings from 1/4" to 1 1/2". The length of stroke is measured at the center of the hutches by rotating the drive and measuring the length of rocker arm travel. In general, the coarser and heavier feeds require longer strokes (between 3/8" and 5/8") and the finer feeds require shorter strokes (between 1/4" and 3/8")

Speed of Stroke

The stroke speed can be varied between 50 and 350 strokes per minute Typical stroke frequencies are around 125 strokes per minute with higher frequencies required for finer feed sizes The hutch water adjustment, length of stroke, and speed of stroke are all, to a certain extent, interdependent. When the length of stroke is diminished, the speed can be increased and the hutch water reduced Generally, slower speeds are used with longer strokes since more settling time is required between strokes.

Making G S Adjustments

As noted above, the several G S adjustments are more or less interdependent, and in obtaining the proper activation of the G.S it is customary to follow a general schedule of adjustment. The speed of the G.S is the more independent of the variables, and so is selected in the range of the speeds

recommended for the particular duty A length of stroke is selected that is appropriate for the size of the feed particles, and the G S then runs while making the hutch water adjustment.

No standard criteria can be established for judging the bed condition of the G S, this is a matter of personal judgement exercised by the operator, who must learn to recognize what constitutes a properly activated bed and the right amount of suction. In general, it may be said in the way of helpful guidance that when the bed is properly activated, it feels loose on the pulsation stroke and is not raised in lumps or masses at any spot. When the bed feels lumpy in spots, it is the first indication that the bed condition is not right, because of either insufficient activation or partial blinding of the screens

To judge the proper amount of suction, place several fingers below the top water and in the top layer of the sand bed. In this upper layer of sand particles an alternate lifting of the individual particles (not of a mass or crust) should be felt on the pulsation stroke, and a definite tightening up of the particles should be felt on the suction stroke When the fingers are immersed below the top layer of the bed, the suction stroke should actually draw the fingers down into the bed

AWC

G.S RUN SHEET	Date ______ Laboratory Supervisor ______ Run # ______
System Configuration	

System Configuration by ______	Cell 1 Flow ______ l/m by ______
G S Stroke Length ______ cm by ______	Cell 2 Flow ______ l/m by ______
G S Stroke Frequency ______ cm by ______	Dilution Water ______ l/m by ______
Bedding Size ______ cm² by ______	Feed Rate ______ kg/hr by ______
Bedding Thickness ______ cm by ______	Time Feed Started ______ by ______
Feed Weight ______ lbs. by ______	Time Feed Stopped ______ by ______

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Instructions

G.S Run Sheet Reviewed by ______ Date ______

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STANDARD OPERATING PROCEDURES
OPERATION OF THE CENTRIFUGAL GRAVIMETRIC SEPARATOR

SOP No NTS 102
Revision 1
Page 1 of 10

Approvals

Terry Wenstrand	7/1/91	Gregory Eadie	7/1/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory Eadie	7/1/91	Gregory Eadie	7/1/91
QA Manager	Date	E,S&H Coordinator	Date

1 0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the vertical Centrifugal Gravimetric Separator (CGS)

1 2 This procedure was developed to standardize operations of the CGS and to optimize operating parameters of the unit.

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests to optimize CGS settings

2.2 The CGS operates most effectively on feed material sized to minus 1/4" (6 mm) and containing heavy particles between 5 and 6000 microns

3.0 Definitions

None

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned the task of operating the CGS are familiar with this SOP, that they have been trained in this SOP, and that a controlled copy of this SOP is available to them.

4.2 All personnel performing CGS operations are responsible for following this SOP

5 0 Procedure

5 1 Equipment and Supplies

1 Centrifugal Gravimetric Separator
2. Centrifugal pump 35 gpm
3 Receiver tank
4 Mixer
5 Feed auger or feed tank
6 Miscellaneous piping and fittings
7 Concentrate container
8 Stop watch
9 Scale (0-100 lbs) or equivalent
10 Decantation cylinder
11 Miscellaneous tools

NOTE Some experiments may require the pieces of equipment to size the tails or scrub the feed Expenment configuration will be determined by the supervisor

5.2 Centrifugal Gravimetric Separator Operation

1 A description of the operational theory and operational variables is found in Attachment 10 1.

2. Refer to the CGS Run Sheet (Attachment 10.2) and position CGS in the experimental configuration. The CGS Run Sheet contains supervisory instructions on system configuration and all CGS settings to be used in the test run.

3. Position remaining system components as specified in the CGS Run Sheet and connect system piping and fittings The operator will verify system configuration and settings by initialing CGS Run Sheet

4 Set shaker screen frequency and amplitude as specified on CGS Run Sheet.

5. Measure specified quantity of feed material and place in feed hopper or dilute to specified pulp density (% by weight) in feed tank If feed tank is used, start mixer and feed pump and adjust flow to Run Sheet specifications by measuring volume transferred to a measuring container returning the material to the feed tank When flow has been established, turn off feed pump and sieve discharge line to CGS inlet

6 Start pump and set bowl back pressure as specified in CGS Run Sheet

7 Start feed and record time on CGS Run Sheet.

8 When feed material is depleted, add 10 gallons of clean rinse water to the feed tank or continue dilution water flow

9. Reduce back pressure by 6 psi, however, do not set to less than 5 psi

10 Shut off feed pump or dilution water flow

11. Reduce back pressure to 5 psi

12. Shut off power to the bowl motor and watch the unit as rotation decreases

13 Once the bowl has slowed to about one half its operating speed, begin to close the pressure control valve Complete closure of valve should correspond simultaneously with, or just prior to stop of bowl rotation

14 Remove bowl lid

15 Engage pulley lock

16 Using spanner wrench, remove locking ring from top of inner bowl (to remove, rotate clockwise)

17 Remove inner bowl and position over concentrate container

18 Flush concentrate thoroughly from bowl into concentrate container.

19 Verify holes at the bottom of the riffles in the bowl are clear

20 Place inner bowl back into water chamber

21 Lock bowl in place by rotating lock ring counter-clockwise using spanner wrench.

22. Disengage pulley lock

23. Transfer contents of concentrate container into decant cylinder. Rinse concentrate container thoroughly into decant cylinder

NOTE. The small particles recovered by the CGS will settle slowly in the decant cylinder For example, a 5 micron plutonium oxide particle settles at a rate of 0 5 cm per minute Let concentrate settle until soil interfaces appear before starting decantation

24 Decant water to area just above solids starting with the top decant spigot.

NOTE During settling and decantation, the decantation cylinder must not be moved or agitated

25 Repeat decantation procedure for tailings as indicated in steps 22 and 23

26. Determine volumes, weights, and moisture content of concentrate and CGS tails and enter results on CGS Run Sheet.

27 Prepare samples of each stream for radioactivity assay Record results of assay on CGS Run Sheet.

28 Return completed CGS Run Sheet to the laboratory supervisor The laboratory supervisor will review the results and sign/date the CGS Run Sheet

5 3 Maintenance

The routine maintenance schedule for the CGS is listed below

1. Grease shaft bearings and rotating union grease fitting weekly during operation.

2. Grease electric motor nipples once every three months of operation.

3 Check belt tension once per week Hand pressure on the belt halfway between the sheaves should deflect the belt about one half inch

4 If the CGS is stored for periods of one month or more, it is advisable to remove the rotating union, allow it to dry out, and store it in a cool, dry place

5. Store bowl upside down in a dry location when not in use

6 Record maintenance activities in the maintenance section of the project logbook

6 0 Quality Controls

None

7 0 Environment, Safety and Health

7 1 Verify all guards are in place before operating equipment.

7.2 Lab coats or Anti-C coveralls shall be worn when processing contaminated soils

7 3 See "Special Precautions" on Run Sheet for additional requirements specified by Safety.

8.0 Records

The following documents are maintained as Quality Records.

- CGS Run Sheets
- Project logbook

9.0 References

None

10 0 Attachments

Attachment 10 1 Principles of Operation of the Centrifugal Gravity Separator

Attachment 10.2 "CGS Run Sheet"

PRINCIPLES OF OPERATION OF THE CENTRIFUGAL GRAVITY SEPARATOR

The CGS is a gravity separation device which separates heavy particles from lighter host soils utilizing centrifugal force to enhance the separation process. The feed material is fed to the bottom of a revolving bowl which rotates at sufficient speed to produce a force of up to 60 Gs. A back pressure on the cavity behind the bowl is slowly bled through 1/16" holes in the bowl to maintain the bed on the inner surface of the bowl in a semi-fluid state As the feed material slowly works its way up the side of the bowl the heavy materials sink to the bottom of the bed and are caught in the bowl riffles The lighter tails continue to work their way up the inside of the bowl surface and exit the CGS The concentrate which collects on the inner bowl riffles can be removed by removing the bowl and cleaning the bowl riffles

Several operating parameters effect the operation of the CGS, the grade or concentration of concentrate produced and the residual contamination present in the tails Each of these variables is discussed below

Feed Dilution

The quantity of water added or present in the feed must be sufficient to allow movement of the feed material across the riffles of the inner bowl Typically, a slurry of 30% solids (by weight) is a good starting point for first test runs with adjustment to higher solids content if the feed material contains fine particles

Feed and Feed Rate

Feed material must be minus 1/4" (6 mm) If feed material is fine, the addition of some coarser material will be beneficial in establishing the bowl bed and increasing recovery of finer particle sizes Feed rates to the CGS can vary from zero to the maximum feed rate of 1000 lbs./hour

Bowl Back Pressure

The most critical operating parameter to producing a high grade of concentrate and minimizing contamination in the tail is the back pressure maintained on the bowl. The bowl back pressure is variable from 0 to 30 psi. The general approach to optimizing the back pressure is to start with the higher settings and reduce the pressure until the maximum recovery or minimum contamination in the tail is observed Fine feed material (below 100 mesh) may require a pressure as low as 4 or 6 psi to maximize recovery. Coarse materials will require pressures of 12 to 20 psi The back pressure settings are particularly critical for recovery of fine particles since settling rates of a 5-10 micron dense particle is on the order of only a few cm per minute at a force of 1G

Shaking Screen Vibration

Adjustment of the frequency of vibrations of the shaking screen can be made by first loosening the set screw on the variable sheave on the motor, and then by turning the outer half of the sheave Turning the sheave in a clockwise direction increases the frequency of vibrations The amplitude of the vibrations can be adjusted by loosening the set screws on the counter weights underneath the shaking pan and turning the counter weights Turning the off set counter weights to oppose each other lessens the amplitude of the vibration and aligning them increases the amplitude All adjustments should be made in small increments Always retighten the set screws after each adjustment.

AWC

C.G.S. RUN SHEET

Date ______________

Laboratory Supervisor______________

Run #______________

System Configuration:

System Configuration by ______________

Shaker Screen Frequency ________ cm by ________ Dilution Flow ________ l/m by ________

Shaker Screen Amplitude ________ cm by ________ Pulp Density ________ % by ________

Feed Weight ________ kg by ________ Time Feed Started ________ by ________

Feed Rate ________ kg/hr by ________ Time Feed Stopped ________ by ________

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Instructions:

C G.S Run Sheet Reviewed by ______________ Date ______________

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STANDARD OPERATING PROCEDURE
OPERATION OF THE MULTI-GRAVITY SEPARATOR

SOP No NTS 104
Revision 1
Page 1 of 12

Approvals

Project Manager	Date 7/1/91	Radiation Safety Officer	Date 7/1/91
QA Manager	Date 7/1/91	E,S&H Coordinator	Date 7/1/91

1.0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the Multi-Gravity Separator (MGS)

1.2 This SOP provides a standard method for testing of different soil types and determines optimal MGS settings to obtain the highest level of soil decontamination

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests to optimize MGS settings

2.2 The MGS operates most effectively on feed materials less than 250 microns which contain liberated contaminant particles between 1 and 250 microns

3 0 Definitions

None

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned the task of MGS operation are familiar with this SOP, that they have been trained in this SOP, and that a controlled copy of this SOP is available to them.

4.2 All personnel operating the MGS on soil samples are responsible for following this SOP.

5.0 Procedure

5 1 Equipment and Supplies

1. Multi-Gravity Separator
2. Two 0-10 gpm centrifugal pumps
3. Two concentrate containers
4 Two tailings containers
5. Water supply tank
6. Feed supply tank
7. Decantation cylinder
8. Mixer
9 Miscellaneous piping and fittings
10. Stop watch
11 Ruler
12. Level
13. Scale (0-100 lbs) or equivalent
14 Miscellaneous tools
15. Concentrate receiver tank
16 Middlings receiver tank

5 2 MGS Operations

1. A description of the operational theory and operating variables is found in Attachment 10 1

2. Refer to the MGS Run Sheet (Attachment 10 2) and position the MGS in the experiment configuration. The MGS Run Sheet contains supervisory instructions on system configuration and all MGS settings to be used in the test run.

3. Position remaining system components as specified on the Run Sheet and connect system piping and fittings The operator will verify system configuration and settings by initialing MGS Run Sheet.

4 Set angle of tilt as specified on Run Sheet. The tilt angle is adjusted by screwing the two front feet bolts up or down. The angle of tilt can be determined by placing a straight edge on the horizontal frame of the MGS and determining tilt angle with a level, or by using tilt angle indicator on the MGS

5 Set rotational speed of drum to specifications on Run Sheet. To change rotational speed first remove tension on the drive "V" belt by slackening clamp bolt on motor mounting plate Remove "V" belt from motor pulley Slacken taper-lock fitting securing drive pulley and remove pulley from motor shaft. Slide required pulley onto motor shaft

160 rpm = 75 mm pulley
200 rpm = 90 mm pulley
240 rpm = 112 mm pulley

Replace "V" belt Turn large shake drive pulley until shake is at center stroke Adjust position of motor pulley on shaft until "V" belt is correctly lined up Tighten taper lock fitting Re-tension "V" belt by pressing down on motor and tightening motor mounting plate clamp bolt.

6 Set shake frequency as specified on Run Sheet. To change shake speed, first remove tension on the drive "V" belt by slackening clamp bolt on motor mounting plate. Reposition belt on stepped pulley, as required (moving to a larger diameter pulley will reduce shake speed and vice-versa) Reposition belt on large upper driver pulley so that it is lined up Retention "V" belt by pressing down on motor and tighten motor mounting plate clamp bolt.

7. Set shake amplitude as specified on Run Sheet. To change amplitude, first slacken crank pin in the eccentric Partially withdraw pin to disconnect yoke from eccentric. Care must be taken not to lose the washer/spacer in between. Having disconnected the two components, the three pin positions are visible on the eccentric block. Reassemble with pin position which gives required amplitude Ensure that washer/spacer is in position between yoke and eccentric block.

8 Measure specified quantity of feed material and mix in feed tank to pulp density indicated on Run Sheet

9 Start mixer to keep solids suspended

10 Start feed pump and adjust feed rate to flow specified on Run Sheet The feed rate is determined by collecting feed in a calibrated container and returning it to the feed tank.

11 Stop feed pump when specified flow has been established.

12. Position concentrate and tailings containers under their respective MGS positions

13. Start MGS

14 Set wash water flow rate as specified on Run Sheet. The wash water flow is set by the value directly below the rotameter

15. Start feed pump and record time on Run Sheet.

16 Carefully watch the two collection containers under the MGS and switch containers, as required, emptying the full retrieved containers into their respective receiver tanks

17. When feed supply is exhausted, record time on Run Sheet and continue operations for 1 minute by adding water to feed tank. This purges the MGS feed line Wash concentrate from MGS by adding several slushes of wash water, observing concentrate collection container carry over for solids

18 Shut off feed pump and wash water

19 Shut off MGS

20 Transfer remaining collection containers to their respective receiver tanks Rinse containers thoroughly to ensure transfer of contents

21 Transfer concentrate receiver tank into the decantation cylinder

NOTE The MGS is capable of recovering particles as small as 1 micron. Since the settling time for a 1 micron particle of plutonium oxide is 2 cm per hour it is necessary to allow sufficient time for particles to settle before decantation of liquid phase During settling period the decantation cylinder must not be disturbed, moved, or agitated

22. Calculate settling time for the 1 micron particle to reach the solid phase of the decantation cylinder Observe soil interface and start decantation after settling

is complete The decantation process is started with the top spigot and progresses to just above the solid phase/water interface

23 Repeat decantation procedures for tailings and middlings stream as indicated in Steps 21 and 22.

24 Determine volumes, weights, and moisture content of the three MGS streams and record on the MGS Run Sheet.

25. Prepare samples of each stream for radioactive assay Record results of assay on Run Sheet.

26 Return the completed MGS Run Sheet to the supervisor The supervisor will review results and sign/date the MGS Run Sheet.

5.3 Maintenance Procedures

1. Tension on "V" belts are checked every week

2. Pillow blocks are greased every 40 hours of operation

3. Record maintenance activities in maintenance section of project logbook.

6.0 Quality Control

None

7.0 Environment, Safety and Health

7.1 Verify all guards are in place before operating equipment.

7.2 Lab coats or anti-C overalls shall be worn when processing contaminated soils

7.3 See "Special Precautions" on Run Sheet for additional requirements specified by safety

8.0 Records

The following documents are maintained as Quality Records

- MGS Run Sheet
- Project Logbook

9 0 References

None

10.0 Attachments

Attachment 10 1 Principles of Operation of the Multi-Gravity Separator

Attachment 10.2 MGS Run Sheet

PRINCIPLES OF OPERATION OF THE MULTI-GRAVITY SEPARATOR

The MGS is a gravity separation device which separates heavy particles from lighter host soils utilizing centrifugal force and shaking motion to enhance the separation process. The MGS may be visualized as rolling the horizontal surface of a conventional shaking table into a drum, then rotating it so that many times the normal gravitational pull can be exerted on the heavy particles as they flow in the water layer across the surface. This concept enables the recovery of considerably finer particles

Feed slurry is introduced continuously midway onto the internal surface of the drum via an accelerator launder, the purpose of which is to reduce turbulence caused by the introduction of the feed. Wash water is introduced via a similar accelerator launder close to the outer end of the drum. Observation indicates that the slurry follows a spiralling pattern on the revolving drum surface. Heavier particles, or particles of higher SG, penetrate the slurry and are pinned to the surface of the drum as a result of the centrifugal forces to form a semi-solid base layer An intermediate layer forms above this consisting of a relatively dilute suspension of lower SG particles and slime particles The top layer consists of relatively clear water The shake provides an additional shearing force on the particles in the flowing film, resulting in improved separation, while the specially designed scrapers moving across the drum surface continually re-grade the settled particles, thus minimizing entrainment of gangue.

The high density particles which are pinned to the surface of the drum are continuously swept up the slope by the scrapers to discharge at the open end as the concentrate The lower density minerals (or gangue) along with the majority of the wash water flow down-stream to discharge as tailings through slots at the inner end of the drum. Both products are collected in circumferencial launders which discharge below the machine

The most important variables governing the operation of the MGS are the rotational speed of the drum, the shake intensity, the wash water flow rate, the angle of tilt, the pulp density, and the flow rate of the feed slurry Each of these operating parameters are discussed below

Rotational Speed

The rotational speed of the drum affects the operation of the MGS in two ways An increase in speed results first in an increase in the flowrate of the slurry in an axial direction towards the tailings end of the drum Secondly, it increases the inertial mass of the particles, reinforcing their tendency to pin to the drum wall and form a solid layer

An increase is the rotational speed of the drum (all other variables constant) therefore, increases the total weight and weight of heavy mineral recovered to concentrate and reduces concentrate grade

Drum speed is adjustable to 160, 200, and 240 rpm. The lower rpm ("g" forces) are suitable for the separation of high density parameters from low density gangue Higher rpm ("g" forces) are required for separating minerals with a smaller density differential

Shake Intensity

Shake frequency is adjustable to 4 0, 4 8, and 5 7 cycles per second Amplitude is adjustable to 12.7, 19 0, and 25 4 mm Shake is applied in an axial direction with a sinusoidal wave form Experience has shown that a high shake frequency is best used with a small amplitude, whereas at lower frequencies, larger amplitudes are preferable

The effect of shake is to impart an additional shearing action on the particles which aids the separation process. With increased shake intensity concentrate concentration increases, however, concentrate carry over into the tails will probably be higher

Washwater Flowrate

Washwater is added close to the concentrate discharge end of the drum It washes over and cleans the concentrate by carrying away particles of gangue (lower density mineral) released by the ploughing action of the scrapers Washwater flowrate is an important factor governing concentrate grade It should be noted that washwater requirement will also depend on feed pulp density A higher flowrate will be required where feed pulp density is high

Washwater flowrate is adjustable between zero and 10 liters per minute by means of the valve below the rotameter. The quantity of washwater required is normally similar to the feed flowrate

Increased washwater gives a cleaner concentrate (dense fraction), but also results in increased loss of dense material to tailings (low density fraction) Solids of lower specific gravity usually require less washwater than materials with higher specific gravity or coarse solids

Angle of Tilt

The angle between the drum axis and the horizontal (angle of tilt) may be adjusted between 0 and 5 degrees The angle used will depend on the nature of the material treated, fine low density mineral will require a shallow angle, coarse or high density mineral will require a larger angle Increasing tilt angle will increase throughput a little, but too large an increase will tend to reduce heavy particle recovery

Feed Rate

Depending on the nature and particle size of the feed solids, throughput may be between 50 and 200 kg per hour of dry solids. For finer solids (minus 75 microns) a throughput of 100 kg per hour is usually found to give an acceptably clean concentrate with good recovery

Feed Pulp Density

Feed pulp density may be between 15% and 50% solids w/w The higher pulp density feeds will require additional washwater

Small particle sizes will require higher rotational speeds and vice-versa.

AWC

M G S RUN SHEET	Date ______ Laboratory Supervisor ______ Run # ______
System Configuration.	
System Configuration by ______	Feed Weight ____kg by ______
Angle of Tilt ______ c/m ° by ______	Pulp Density ______ % by ______
Rotation Speed ______ R/m by ______	Feed Rate ______ kg/hr by ______
Shake Frequency ______ cm by ______	Time Feed Started ______ by ______
Shake Amplitude ______ cm by ______	Time Feed Stopped ______ by ______

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Instructions:

M G.S. Run Sheet Reviewed by ______________ Date ______

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STANDARD OPERATING PROCEDURES
OPERATION OF TROMMEL

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SOP No. 201
Revision 1
Page 1 of 7

Approvals

Terry Wenstrand 7/1/91
Project Manager Date

Gregory Eadie 7/1/91
Radiation Safety Officer Date

Gregory Eadie 7/1/91
QA Manager Date

Gregory Eadie 7/1/91
E,S&H Coordinator Date

1.0 Purpose and Scope

1.1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the trommel

1.2 This SOP provides a standard method for testing of different soil types and determines optimal settings to obtain the highest level of soil decontamination

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests to optimize trommel settings

2.2 The trommel operates most effectively on feed materials less than 2 inches containing contaminant particles less than 1/8 inches

3.0 General

3.1 Equipment and Supplies

1. Trommel
2. 35 gpm centrifugal pump
3. Water supply tank
4. Miscellaneous piping and fittings
5. Receiver tank
6. Stop watch
7. Level

8. Straight edge
9 Ruler
10 Feed auger
11. Oversize receiver tank
12. Tilt angle shims
13. Discharge receiver tank
14 Scale (0-100 lbs) or equivalent

NOTE Some expenments require other pieces of equipment to treat the tails Experimental configurations will be determined by the supervisor

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned the tasks related to trommel operation are familiar with this SOP, that they are trained in this SOP, and that a controlled copy of this SOP is available to them

4 2 The laboratory supervisor is responsible for determining experimental configuration and establishes all run parameters

4 3 The laboratory supervisor or his designee reviews and initials all Run Sheets and logbook entries at least on a weekly basis.

4.4 All personnel operating the trommel on soil samples are responsible for following this SOP.

5.0 Procedure

5.1 Trommel Operation

1 A description of the operational theory and operating variables are found in Attachment 10.1.

2. Refer to the Trommel Run Sheet (Attachment 10 2) and position the trommel in the experiment configuration The Trommel Run Sheet contains laboratory supervisory instructions on system configuration and all trommel settings to be used in the test run.

3 Position remaining system components as specified on the Run Sheet and connect system piping and fittings The operator will verify system configuration and settings by initialing Trommel Run Sheet

4 Set angle of tilt as specified on Run Sheet The tilt angle is adjusted by elevating the two feet on the discharge side of the trommel The angle of tilt can be measured by placing a straight edge on the horizontal bracing bar of the trommel and determining the tilt angle with a level and ruler.

5. Place receiver tank at discharge of trommel and oversize receiver tank at oversize discharge

6 Start water supply pump and adjust water flow to value specified on Run Sheet. The flow rate is determined by measuring the trommel discharge volume in a measuring container or using flowmeter reading on water inlet line

7. When specified flow rate has been set, shut off water supply pump

8. Position feed hopper at trommel opening

9 Weigh feed material as specified on Run Sheet and load in hopper

10. Reconfigure additional test equipment as specified on Run Sheet, if required

11. Start water supply pump and trommel

12. Start feed auger Record time on Run Sheet.

13 Continue operations until feed is exhausted Record time feed is exhausted on Run Sheet.

14 Continue water supply and trommel operation until trommel discharge water clears

15 Stop trommel and water supply

16 Determine volumes, weights, and moisture content of the two streams and record on the Trommel Run Sheet

17 Prepare samples of each stream for radioactive assay Record results of assay on Run Sheet

18 Return completed Run Sheet to laboratory supervisor

5 2 Maintenance

1. The four trommel drum rollers require grease every 40 hours of operation.

2. Check oil level in gear box every three months Fill with manufacturer recommended oil, as required.

3 Lubricate chain idler with light oil every 40 hours of operation.

4 Record maintenance activities in the maintenance section of the project logbook

6.0 Quality Control

None

7.0 Environment, Safety and Health

7.1 Verify all guards are in place before operating equipment.

7 2 Keep clear of rotating trommel drum during operation

7.3 Lab coats or anti-C clothing shall be worn when processing contaminated soils

7 4 See "Special Precautions" on Run Sheet for additional requirements specified by Safety

8.0 Records

The following documents are maintained as Quality Records

- Trommel Run Sheet
- Project Logbook

9 0 References

None

10 0 Attachments

Attachment 10 1 Principles of Operation of Trommel

Attachment 10.2 "Trommel Run Sheet" form

PRINCIPLES OF OPERATION OF TROMMEL

The trommel is a screening/scrubbing device which is used to scrub soil and divide the soil into two size fractions (+ 1/8 inch and - 1/8 inch) The trommel contains a rotating drum which is divided into two sections consisting of an enclosed scrubbing drum and a cylindrical screen. A spray bar is located inside the entire length of the trommel drum to wash the soil as it traverses the length of the drum The soil is introduced in the end of the scrubbing section of the trommel drum where it is subjected to a continuous water spray The rotation of the drum mixes the soil and breaks up soil clods As the soil travels down the trommel drum incline it passes into the screening section where the minus 1/8 inch soil particles fall through the screen and are collected in the discharge chute The plus 1/8 inch soil particles continue through the screen section and are directed into the oversize chute for collection

The most important variables governing the operation of the trommel are the water flow through the spray bar, feed rate, and the tilt angle of the trommel Each of these operating parameters are discussed below

Water Flow

An increase in the water flow increases the pressure at which the water is delivered against the soil particles in the trommel drum and increases the suspension and separation of the finer soil particles from the coarser particles In general, a flow which sufficiently scrubs the finer parts from the coarse particles and results in a desired pulp density of the minus 1/8 inch fraction is the ideal flow

Angle of Tilt

The angle of tilt on the trommel determines the residence time of the soil in the trommel drum. Raising the discharge end of the trommel increases residence time and increases scrubbing action.

Feed Rate

The feed rate determines the cleanliness of the oversize discharge An excessive feed rate may overcrowd and blind the screen by trapping fines with the oversize

AWC

TROMMEL RUN SHEET Serial # ______	Date ______ Lab Supervisor ______ Run # ______

System Configuration

System Configuration by ______

Feed Rate ______ kg/hr by ______

Water Flow ______ l/m by ______

Time Feed Started ______ by ______

Tilt Angle ______ ° by ______

Time Feed Stopped ______ by ______

Feed Weight ______ kg by ______

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Precautions

Safety ______ Date ______

Trommel Run Sheet Reviewed by ______ Date ______

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STANDARD OPERATING PROCEDURES
OPERATION OF THE ATTRITION SCRUBBER

SOP No 203
Revision 1

Approvals

Terry Weinshand	7/3/91	J. M. Newey	7/3/91
Project Manager (acting)	Date	Radiation Safety Officer	Date
C. Thompson	7/3/91	J. M. Newey	7/3/91
QA Manager	Date	E,S&H Coordinator	Date

1 0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the attrition scrubber

1.2 This SOP provides a standard method for testing of different soil types and determines optimal settings to obtain the highest level of soil decontamination by liberation of contaminant particles from larger soil grains

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc. personnel when performing tests to optimize attrition scrubber settings

3.0 General

3 1 Equipment and Supplies

1 Attrition scrubber
2. 35 gpm centrifugal pump
3. Feed supply tank
4 Miscellaneous piping and fittings
5. Receiver tank
6. Stop watch
7. Drain container
8. Scale (0-100 lbs) or equivalent
9 Mixer

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned the tasks related to attrition scrubber operations are familiar with this SOP, that they are trained in this SOP, and that a controlled copy of this SOP is available to them.

4 2 The laboratory supervisor is responsible for determining experiment configuration and establishes all run parameters

4 3 The laboratory supervisor or his designee reviews all run sheets and logbook entries on at least a weekly basis

4 4 All personnel operating the attrition scrubber on soil samples are responsible for following this SOP

5.0 Procedure

5 1 Attrition Scrubber Operation

1 A description of the operational theory and operating variables are found in Attachment 10 1

2. Refer to the Attrition Scrubber Run Sheet (Attachment 10.2) and position the attrition scrubber in the experimental configuration The Attrition Scrubber Run Sheet contains laboratory supervisory instructions on system configuration and all attrition scrubber settings to be used in the test run.

3. Position remaining system components as specified on the Run Sheet and connect system piping and fittings Verify system configuration and settings by initialing Attrition Scrubber Run Sheet

4 Set impeller speed to value specified on Run Sheet. The speed is adjusted using the vari-pitch motor sheaves Increasing sheave size increases propeller speed

5. Weigh feed material as specified on Run Sheet, add to feed supply tank, and adjust to pulp density to indicated value on Run Sheet.

6 Start mixer

7. Start feed pump and adjust flow to Run Sheet specifications by measuring volume transferred to a measured container and return to feed tank When Run Sheet flow has been established, turn off pump and secure discharge line to attrition scrubber inlet

8 Start attrition scrubber

9 Start feed pump and record time on Run Sheet

10 Continue attrition scrubber operations until feed supply is exhausted Add water to feed tank to flush feed material through attrition scrubber Continue flushing until water starts to clear at discharge

11 Stop feed pump Record stop time on Run Sheet.

12. Stop attrition scrubber

13 Drain remaining volume in attrition scrubber and transfer to receiver tank.

14 Determine volumes, weights, and moisture content of the discharge stream and record results on the Attrition Scrubber Run Sheet.

15 Prepare samples of the discharge stream for radioactive assay Record results of assay on Run Sheet.

NOTE Laboratory supervisory instructions may require sieve analysis of discharge stream or retention for further treatment before analysis in steps 14 & 15 (see "Special Instructions")

16 Return completed Run Sheet to laboratory supervisor

5 2 Maintenance

1 After initial 85 hours of operation, drain and flush the reducer When draining, inspect for metal deposits, sludge, water, and other foreign material (Refill with Mobilgear 636 or equivalent.)

2. Repeat draining, flushing, and inspection every 1000 hours of operation

3 Periodically check oil level when reducer is stopped Oil level should be maintained at center of oil level gauge Do not overfill Overfilling interrupts pumping action of worm and gear and causes overheating

4. Periodically check tightness of hold-down bolts.

5 Grease elements on upper housing every 40 hours of operation

6 Record maintenance activities in the maintenance section of the project logbook.

6 0 Quality Control

None

7 0 Environment, Safety and Health

7.1 Verify all guards are in place before operating equipment.

7 2 Lab coats or anti-C clothing shall be worn when processing contaminated soils

7 3 See "Special Precautions" on Run Sheet for additional requirements specified by Safety

8 0 Records

The following documents are maintained as Quality Records

- Attrition Scrubber Run Sheet
- Project Logbook

9 0 References

None

10 0 Attachments

Attachment 10 1 Principles of Operation of Attrition Scrubber

Attachment 10 2 "Attrition Scrubber Run Sheet" form

PRINCIPLES OF OPERATION OF ATTRITION SCRUBBER

The attrition scrubber is designed to remove surface films or coatings from individual soil grains, breaking up clays and cementations This is accomplished by introducing the soil in a slurry form and submitting it to sheer forces generated by opposing pitch impellers The resulting currents of the slurry cause soil grains to collide against each other, breaking up softer materials and removing coating from harder grains

The attrition scrubber has several variables which effect the scrubbing action of the attrition scrubber Each of these variables are described below

Pulp Density

Adjustment of the pulp density is made by addition of water to the attrition scrubber feed There is a point at which the flow characteristics of the slurry in the machine changes markedly over a short range of pulp density This range is known as the "control range" At densities above this control range, the pulp appears to have viscous qualities and takes the form of smooth waves, starting from the corners of the tank, which overturn as they enter the impeller zone or vortex. There is very little turbulence or irregularity evident on the surface

Below this "control range" the flow is turbulent, there may be considerable splashing, the slurry may spin rapidly in the space between the impeller tips and the tank walls Circulation of pulp through the impellers is erratic and not positive Typically, the control range for clean silica sand with a size range of 500 to 150 microns is about 70% solids by weight, while sand with a large percentage of clays will be around 65% solids by weight.

Impeller Speed

Impeller speed does not change the flow characteristics of the slurry once it is in the control range Increasing the speed of the impeller will, however, cause increase scrubbing action per unit time the slurry is in the attrition scrubber

Feed Rate

The rate at which the slurry is fed to the attrition scrubber determines the length of time the material will be submitted to the scrubbing action. The optimum feed rate is determined by experimentation

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ATTRITION SCRUBBER RUN SHEET	Date ____ Lab Supervisor ____ Run # ____

System Configuration

System Configuration by ____________

Feed Rate ____________ kg/hr by ________

Impeller Speed ____________ RPM by ________

Time Feed Started ________ by ________

Pulp Density ____________ % by ________

Time Feed Stopped ________ by ________

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Instructions

Special Precautions

Safety ____________ Date ________

Attrition Scrubber Run Sheet Reviewed by ____________ Date ________

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STANDARD OPERATING PROCEDURES
OPERATION OF THE SPIRAL CLASSIFIER

SOP No	301
Revision	1
Page	1 of 9

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Approvals

Terry Wenstrand	7/1/91	Gregory Eadie	7/1/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory Eadie	7/1/91	Gregory Eadie	7/1/91
QA Manager	Date	E,S&H Coordinator	Date

1.0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the spiral classifier

1.2 This SOP was developed to standardize testing of different soil types and optimize settings to achieve dewatering and decontamination of the larger size soil fractions

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests to optimize spiral classifier settings.

2.2 The spiral classifier operates most effectively on soils with particle sizes up to 3/8 inch.

3.0 General

3 1 Equipment and Supplies

1 Spiral classifier
2. 35 gpm centrifugal pump
3. Feed supply tank
4. Miscellaneous piping and fittings
5 Oversize receiver tank
6 Undersize receiver tank
7. Stop watch
8 Flush container (5 gallon capacity)

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned the tasks related to spiral classifier operations are familiar with this SOP, that they are trained in this SOP, and that a controlled copy of this SOP is available to them

4.2 The laboratory supervisor is responsible for determining experimental configurations and establishing all run parameters

4 3 The laboratory supervisor or his designee reviews all run sheet and logbook entries at least on a weekly basis

4 4 All personnel operating the spiral classifier on soil samples are responsible for following this SOP

5.0 Procedures

5 1 Spiral Classifier Operation

1 A description of the operating theory and operating variables are found in Attachment 10 1

2. Refer to the Spiral Classifier Run Sheet (Attachment 10 2) and position the spiral classifier in the experiment configuration. The Spiral Classifier Run Sheet contains laboratory supervisory instructions on system configuration and all spiral classifier settings to be used in the test run.

3 Position remaining system components as specified on the Run Sheet and connect system piping and fittings. The operator will verify system configuration and settings by initialing Spiral Classification Run Sheet.

4. Set spiral classifier speed to value specified on Run Sheet. The speed is adjusted using the rheostat control located under the top leg of the spiral classifier. Increasing the rheostat setting increases the speed of the classifier Refer to Attachment 10 3 "Spiral Classifier Speed" to determine proper setting

5 Set weir height to value specified on Run Sheet The weir height is set by removing or adding wood weir blocks to the discharge of the spiral classifier pool

6 Weigh specified quantity of feed material, place in feed tank, and mix to pulp density indicated on Run Sheet.

7. Start mixer to keep solids suspended

8 Start feed pump and adjust feed rate to flow specified on Run Sheet. The feed rate is determined by collecting feed in a measured container and returning it to the feed tank

9 Stop feed pump when specified flow has been established

10. Position feed line to spiral classifier inlet.

11 Start spiral classifier

12. Start feed pump and note time on Run Sheet.

13 Continue operations until feed supply is exhausted Add two gallons of water to feed tank to flush feed line to spiral classifier

14 Stop feed pump and record time on Run Sheet

15. Stop spiral classifier Secure power supply with safety tag

CAUTION Before washing or cleaning out spiral classifier by hand, unplug power supply to spiral classifier and secure plug with safety tag at spiral classifier top leg

16 Drain spiral classifier pool into a flush container by removing weir blocks followed by drain plug

17 Clean remaining solids from bottom of spiral classifier and transfer to oversize receiver tank.

18 Determine volumes, weights, and moisture content of the streams and record on Spiral Classifier Run Sheet

19 Prepare samples of each stream for radioactive assay Record results of assay on Run Sheet.

20 Return the completed Spiral Classifier Run Sheet to the laboratory supervisor

5.2 Maintenance Procedures

1. Grease bearing fittings at base and top of classifier screw every 40 hours of operation.

2. Check gear box oil level every three months and add Mobil 636 gear box oil or equivalent, as required

3 Record maintenance activities in maintenance section of project logbook

6.0 Quality Control

None

7.0 Environment, Safety and Health

7 1 Verify all guards are in place before operating equipment.

7.2 Lab coats or Anti-C coveralls shall be worn when processing contaminated soils

7 3 Before washing or cleaning out spiral classifier by hand, unplug power supply to spiral classifier and secure plug with safety tag at spiral classifier top leg

8 0 Records

The following documents are maintained as Quality Records

- Spiral Classifier Run Sheet
- Project Logbook

9 0 References

None

10 Attachments

Attachment 10.1 Principles of Operation of Spiral Classifier

Attachment 10 2 "Spiral Classifier Run Sheet" form

Attachment 10 3 "Spiral Classifier Speed" table

PRINCIPLES OF OPERATION OF THE SPIRAL CLASSIFIER

The spiral classifier is a device which separates soil particles according to size The spiral classifier consists of an inclined tank in which a spiral, mounted parallel to the tank bottom, rotates without contacting the sides or bottom of the tank. The spiral structure provides the necessary pool agitation and conveys the settled solids to the discharge The feed slurry is introduced at the pool level through the side wall The pool level is maintained by adjusting the height of the overflow weir

The pool area permits particles larger than the separation size to settle depending on the density, shape of the particle, turbulence, density, and viscosity of the slurry within the pool. The smaller particles travel with the undersize over the weir, while the oversize particles which sink to the bottom of the pool are elevated to the discharge by the auger

The spiral classifier has several variables which determine the separation size achieved by the classifier These variables are discussed below

Auger Speed

The speed of the auger in the classifier determines the amount of agitation in the pool This action liberates the entrapped water and undersize particles which rise in the pool and report to the undersize stream. Increasing the speed of the raking mechanism increases agitation, and thus increases the size of the particles reporting in the undersize flow over the pool weir.

Feed Rate

The feed rate also determines (to a lesser extent) the size of particles which report to the undersize and oversize streams. Higher flow rates cause more turbulence in the pool which in turn causes larger particles to report to the undersize flow.

Pulp Density

The pulp density of the feed determines the fraction of undersize remaining with the oversize flow In general, high pulp densities will have more undersize reporting to the oversize flow and vice versa.

SPIRAL CLASSIFIER RUN SHEET	Date ______ Lab Supervisor ______ Run # ______

System Configuration.

System Configuration by ______

Feed Weight ______ kg by ______

Pulp Density ______ % by ______

Time Feed Started ______ by ______

Feed Rate ______ kg/hr by ______

Time Feed Stopped ______ by ______

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Precautions

Safety ______ Date ______

Spiral Classifier Run Sheet Reviewed by ______ Date ______

SPIRAL CLASSIFIER SPEED

RHEOSTAT SETTING	AUGER RPM
20	5
30	12
40	19
50	25
60	31
70	37
80	44
90	48
100	49

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STANDARD OPERATING PROCEDURES
OPERATION OF HYDROCYCLONE TEST UNIT

SOP No 302
Revision 1
Page 1 of 10

Approvals

Terry Winebrand	7/1/91	Gregory G Eadie	7/1/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory G Eadie	7/1/91	Gregory G Eadie	7/1/91
QA Manager	Date	E,S&H Coordinator	Date

1.0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the use of the hydrocyclone test unit

1.2 The following procedure was developed to standardize testing of different soil types and optimize soil feed sizing for the TRUclean systems

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests on the hydrocyclone test unit

2.2 The hydrocyclone test unit will perform d_{50} cut points from 2 to 5 microns, 3 to 6 microns, 5 to 10 microns, and 15 to 40 microns

3.0 General

3.1 Equipment and Supplies

1. Hydrocyclone test unit
2. Underflow containers (2)
3. Overflow containers (2)
4. Underflow tank
5. Overflow tank
6. Stop watch
7. Feed supply tank

8 Mixer

9 35 gpm centrifugal pump or hydrocyclone test unit pump

10 Miscellaneous piping and fittings

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned the tasks related to hydrocyclone test unit operations are familiar with this SOP, that they are trained in this SOP, and that a controlled copy of this SOP is available to them

4 2 The laboratory supervisor is responsible for determining experimental configuration and establishing all run parameters

4 3 The laboratory supervisor or his designee reviews all run sheets and logbook entries at least on a weekly basis

4 4 All personnel operating the hydrocyclone test unit on soil samples are responsible for following this SOP.

5.0 Procedures

5 1 Hydrocyclone Test Unit Operation

1 A description of the operational theory and operating variables are found in Attachment 10 1

2. Refer to the Hydrocyclone Test Unit (HTU) Run Sheet and position the HTU in the experiment configuration. The HTU Run Sheet contains supervisory instructions on system configuration and all HTU settings to be used in the test run.

3 Position remaining system components as specified on the Run Sheet. The operator will verify system configuration and settings by initialing the HTU Run Sheet

4 Attach required size cyclone to the HTU as specified on Run Sheet.

5 Weigh specified quantity of feed material and mix in feed tank to pulp density indicated on Run Sheet.

NOTE Feed material must be screened to less than 300 microns when using the 10mm hydrocyclone or less than 1000 microns if using the one inch and two inch hydrocyclone

6 If feed material is already in slurry form adjust pulp density to Run Sheet specifications by adding or removing water from the feed mix.

NOTE The minimum volume of slurry required for a test is 5 gallons (20 liters) However, higher volumes can be accommodated by transferring material, as required, from the feed tank to the HTU to maintain the 5 gallon minimum volume

7. Open drain valve and drain pump, sump and flush with clean water. This step should be carried out with pump running As soon as the sump is empty stop the pump and close drain valve. Check that the 6mm sump strainer and vibration damping tube are clear of solids

8. Open by-pass valve and close feed valve on HTU.

9. Start mixer in feed supply tank.

10. Add feed slurry to sump and start HTU pump immediately to prevent solid particles from settling out. The amount of feed slurry which is added to the tank must be above 5 gallons, however, the HTU sump may be filled to within 2 inches of the top of the sump

11 Continue to recycle test volume in HTU through the by-pass for a few minutes to remove any trash from the feed pulp

12. Open hydrocyclone feed valve and partially shut by-pass valve until hydrocyclone pressure gauge registers operating pressure indicated on Run Sheet. Note time on Run Sheet.

13 Simultaneously start collecting overflow and underflow into collection containers

NOTE The overflow from the hydrocyclone can be diverted directly to the overflow receiver tank The underflow is collected in the underflow container

14 When the first underflow container is full, simultaneously collect underflow and overflow from hydrocyclone in tared glass beakers and retain for further analysis in Step 19 Note collection of beakers on Run Sheet.

15 Continue collection of overflow in overflow receiver tank and alternate underflow receiver containers, as required, emptying full containers into underflow receiver tanks.

16 Add slurry from feed tank to HTU sump, as required, until feed supply is exhausted Shut off mixer just before transferring last batch of feed to HTU sump

17. As feed supply in HTU sump is exhausted, add one gallon of water to sump to flush HTU lines

18 Stop HTU pump

19 Weigh beakers of slurry collected in Step 14 and record weight on Run Sheet. Allow solids in beaker to settle and record volume of solids and volume of water on Run Sheet.

20 Determine volumes, weight, and moisture content of the underflow and overflow streams and record on HTU Run Sheet

21 Prepare samples of each stream for radioactive assay Record results of assay on Run Sheet.

22. Return the completed Run Sheet to the laboratory supervisor. The laboratory supervisor will review results and sign/date the HTU Run Sheet.

5.2 Maintenance

1 Before each run, check trash screen in sump to verify no coarse particles or fibrous materials are present on screen.

2. Before each test, check the vibration damping tube to verify it is not blocked with solids If it is blocked, remove the 16mm nuts on each end, remove tube, and flush with water

3. Check tension on drive belts every 40 hours of operation

4. Check gland packing on pump every 40 hours of operation and adjust, as required

5 Record all maintenance activities in maintenance section of project logbook

6 0 Quality Control

None

7 0 Environment, Safety and Health

7 1 Verify all guards are in place before operating equipment.

7.2 Lab coats or anti-C clothing shall be worn when processing contaminated soils

7.3 See "Special Precautions" on Run Sheet for additional requirements specified by Safety.

8.0 Records

The following documents are maintained as Quality Records.

- Hydrocyclone Test Unit Run Sheet
- Project Logbook

9 0 References

1 Operating Manual C 700 Hydrocyclone Test Reg

2 Operating Manual C 124 Two Inch Hydrocyclone

3 Operating Manual C 155 One Inch Hydrocyclone

4 Operating Manual C1009 1 x 10 mm Hydrocyclone Assembly

10 0 Attachments

Attachment 10 1 Principles of Operation of Hydrocyclone Test Unit

Attachment 10 2 "Hydrocyclone Test Unit Run Sheet" form

PRINCIPLES OF OPERATION OF HYDROCYCLONE TEST UNIT

The hydrocyclone test unit is a device used to size feed material for TRUclean equipment. The HTU consists of a sump for the test slurry, a recycling system to retain solids in suspension, a hydrocyclone pressure gauge, and a test stand to evaluate different cyclones

The following discussion describes the theory of a hydrocyclone to obtain a "cut point" which is defined as a point where 50% of a particular size above the cut point will report to the underflow and 50% of a particle size will report to the overflow Feed slurry enters the hydrocyclone tangentially under pressure. As a result of the high centrifugal forces, particles coarser than the "cut point" migrate into a primary vortex adjacent to the wall and move down toward the discharge spigot with a small volume of water Particles finer than the "cut point" migrate into a secondary upward moving vortex in the center of the hydrocyclone and exit into the vortex finder into the overflow spout.

The cut point size is governed by many factors, most important of which are hydrocyclone internal diameter, hydrocyclone length, core angle, vortex finder diameter, underflow apex diameter, feed pulp density, and inlet pressure Since the physical dimensions of the hydrocyclone used in the test unit are fixed, the three variables governing the hydrocyclone cut point will be feed pulp density, inlet pressure, apex diameter, and vortex diameters. Each of these variables are discussed below

Feed Pulp Density

The single most important factor affecting hydrocyclone operation is the feed pulp density the higher the water content in the slurry results in a finer and sharper separation. The lower the water content of the feed results in a coarser (larger) size separation.

Inlet Pressure

The inlet pressure measures the pressure drop across the hydrocyclone. An increase in operating pressure will lead to higher throughput, a finer cut point, a sharper cut, a decrease in volume split, an increase in the recovery of solids to the underflow, a denser underflow, and a less dense overflow The maximum operating pressure on the one and two inch hydrocyclone should not exceed 50 psi. The recommended pressure drop for the 10 mm hydrocyclone is between 50 and 100 psi

Vortex Diameters

The most obvious effect of changing outlet diameters is to vary the volume split A reduction in overflow outlet diameter leads to a finer cut point, a slightly less sharp cut, a lower underflow density, and an increase in volume split and solids recovery to underflow

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HYDROCYCLONE TEST UNIT RUN SHEET

Date ____________

Lab Supervisor ____________

Run # ____________

System Configuration

System Configuration by ____________

Hydrocyclone Size ____________ by ________

Underflow Beaker Weight ____________ by ________

Overflow Beaker Weight ____________ by ________

Feed Weight ____________ kg by ________

Water Volume Underflow ____________ l by ________

Pulp Density ____________ % by ________

Water Volume Overflow ____________ l by ________

Time Feed Started ____________ by ________

Solids Volume Underflow ____________ kg by ________

Time Feed Stopped ____________ by ________

Solids Volume Overflow ____________ kg by ________

Hydrocyclone Pressure ____________ psi by ________

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Precautions

Safety ____________ Date ____________

Hydrocyclone Test Unit Run Sheet Reviewed by ____________ Date ____________

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STANDARD OPERATING PROCEDURES
OPERATION OF FEED AUGER

SOP No 202
Revision 1
Page 1 of 7

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Approvals

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Project Manager	Date	Radiation Safety Officer	Date
Gregory G Eadie	7/1/91	Gregory G Eadie	7/1/91
QA Manager	Date	E,S&H Coordinator	Date

1.0 Purpose and Scope

1 1 The purpose of this Standard Operating Procedure (SOP) is to instruct personnel in the operation of the feed auger

1.2 This SOP provides a standard method for metenng soil into the TRUclean components at specified rates

2.0 Applicability

2.1 This SOP is applicable to all AWC, Inc personnel when performing tests using the feed auger

3.0 General

3.1 Equipment and Supplies

1 Feed auger
2. Stop watch
3 Scale (0-100 lbs) or equivalent

4 0 Responsibilities

4 1 The laboratory supervisor is responsible for assuring that all personnel assigned tasks related to feed auger operation are familiar with this SOP, that they are trained in this SOP, and that a controlled copy of this procedure is available to them

4.2 The laboratory supervisor is responsible for determining experiment configuration and establishing all run parameters

4 3 The laboratory supervisor or his designee reviews all run sheets and logbook entries at least on a weekly basis

4 4 All personnel operating the feed auger are responsible for following this SOP

4 5 The Project Health Physicist will evaluate airborne contamination hazards and advise special precautions required

5 0 Procedure

5 1 Feed Auger Operation

1. A description of the operational characteristics of the feed auger are found in Attachment 10 1.

2. Refer to Feed Auger Run Sheet and position feed auger in the experiment configuration. The Feed Auger Run Sheet contains laboratory supervisory instructions on system configuration and all feed auger settings to be used in the test run

3. Position remaining components as specified in the Run Sheet. The operator will verify system configuration by initialing the Feed Auger Run Sheet.

4. Weigh specified quantity of feed material and slowly transfer material into feed hopper The feed hopper contains a screen to remove plus 3/4" rocks from feed material.

CAUTION The Project Health Physicist will evaluate the potential airborne contamination resulting from the transfer operation and advise special precautions, if required, on the Run Sheet.

5 Retain material which does not pass through the 3/4" screen on the hopper. Determine volume, weight, and moisture content (if applicable) and record as + 3/4" on Feed Auger Run Sheet

6 Prepare sample of + 3/4" for radioactive assay Record results of assay on Run Sheet.

7 Set rheostat for desired feed rate Refer to Attachment 10.3 (Auger Feed Rate) to obtain required setting for feed rate specified on Run Sheet.

8 Start feed auger and record time on Run Sheet.

NOTE Watch delivery of feed material from feed auger If feed supply is interrupted use a wood dowel to break cavity formed from material bridging in feed hopper

9 When feed has been depleted, shut off feed auger and record time on Run Sheet.

10. Return completed Run Sheet to laboratory supervisor.

6 0 Quality Control

None

7.0 Environment, Safety and Health

7.1 The feed discharge auger must be positioned in its operating condition before operating equipment.

7.2 Lab coats or anti-C coveralls shall be worn when processing contaminated soils.

7.3 See "Special Precautions" on Run Sheet for additional requirements specified by Safety

8.0 Records

The following documents are maintained as Quality Records

- Feed Auger Run Sheet
- Project Logbook

9 0 References

None

10 0 Attachments

Attachment 10 1	Principles of Operating Feed Auger
Attachment 10 2	"Feed Auger Run Sheet" form
Attachment 10 3	"Auger Feed Rate" table

PRINCIPLES OF OPERATING FEED AUGER

The feed auger is designed to deliver soil samples to the TRUclean equipment at a specified rate Soil is transferring into the feed hopper and screened to less than 3/4 inch. The 3/4 inch screen prevents clogging the feed screw at the bottom of the hopper A rheostat control on the side of the feed hopper regulates the rate of feed flow delivered by the auger The rheostat setting for various feed rates is shown in Attachment 3 (Auger Feed Rate)

AWC

FEED AUGER RUN SHEET	Date ____ Lab Supervisor ____ Run # ____

System Configuration.

System Configuration by ____

Feed Rate ____ kg/hr by ____

Angle of Tilt ____ ° by ____

Time Feed Started ____ by ____

Time Feed Stopped ____ by ____

Feed Weight ____ kg by ____

Stream	Weight (kg)	Volume (cc)	Moisture (%)	Activity (pCi/gm)	By

Special Precautions

Safety ____ Date ____

Feed Auger Run Sheet Reviewed by ____ Date ____

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STANDARD OPERATING PROCEDURES
OPERATION OF FEED AUGER

AUGER FEED RATE

RHEOSTAT SETTING	Kg/hr*	yds ^{3} /hr
100	752	0 371
90	694	0 343
80	564	0 279
70	311	0 154
60	273	0 135
50	226	0 111
40	158	0 078
30	75	0 037

*Based on density of 2.65 gm/cm^3

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ANALYTICAL PROCEDURES
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ANALYTICAL PROCEDURES
BULK DENSITY DETERMINATION

AP No AWC 2
Revision 0

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Approvals.

Terry Wenstrand	5/2/91	Gregory Eadie	5/2/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory Eadie	5/2/91	Gregory Eadie	5/2/91
QA Manager	Date	E,S&H Coordinator	Date

1.0 PURPOSE AND SCOPE

The purpose of this analytical procedure (AP) is to instruct laboratory personnel in the methods used for determining the bulk density of soil samples

2.0 APPLICABILITY

This AP applies to laboratory personnel involved in soil analysis activities in which the bulk density must be determined.

3.0 DEFINITIONS

3.1 Bulk Density

Weight of dry soil per unit volume including the pore space.

3.2 Clod

A self-adhering piece of earth collected away from any digging shear face

CAUTION Impermeable rubber gloves must be worn during all procedures involving soils suspected to contain radionuclides.

4.0 RESPONSIBILITIES

The laboratory supervisor is responsible for assuring that all personnel assigned tasks related to this AP are familiar with this AP, that they have been trained in this AP, and that a controlled copy of this AP is available to them.

All personnel performing bulk density determination are responsible for following this AP.

5.0 PROCEDURE

Discussion

Density is defined as weight per unit volume and is expressed in units of g/cm^3. The bulk density of a soil is defined as the weight of dry soil per unit volume including the pore space For mineral soils, bulk density generally ranges from 0.6 to 2.0 g/cm^3. With increasing organic matter content, soils generally exhibit a decrease in bulk density because organic matter has higher porosity and lower density than mineral particles of the same diameter.

The clod method is the primary method for determining bulk density. Where possible, three replicate clod samples are extracted from each horizon. The average bulk density of the replicates is assumed to be the bulk density of that particular horizon. Analysis of the clods is based on the method described in the USDA/SCS (1984), Kem and Lee (1989), and Kem et al. (in preparation).

Two alternate methods are also presented for soil horizons that fail to yield satisfactory clods. One method is volume replacement (VR), a method similar to one described by Flint and Childs (1984), which utilizes a known volume of small foam beads packed into a cylinder to replace a selected volume of soil excavated from a given horizon Subtracting the initial from the final volume yields the estimated volume of sample collected The other method is a volume filling (VF) method that is used if the clod or VR methods do not produce representative samples. The volume of this type of sample is based on the absolute volume of a 250-mL beaker, which is a constant 300 cm^3 The known volume samples are processed in a manner similar to the method described in Blake (1965) Whenever possible, use the clod method.

Interferences

Evaporating dishes used in the clod method must be thoroughly cleaned after each use, as their weights are pre-determined and used in the calculation of results. If soils are suspected to contain radionuclides impermeable gloves must be used when transferring the dishes from one location to another.

5 1 Sample Collection, Preservation, and Storage

Clod samples are fist-sized, structurally intact, bulk density samples taken from designated horizons In the field, each clod is wrapped in a hairnet and dipped briefly in a 1:5 Saran:acetone solution to help maintain the clod structure and reduce moisture loss from the clod during transport and storage. Each clod is labeled, covered by a small plastic bag, and placed in a divided box. Clods must be collected away from shear faces

Known volume bulk density samples are taken from horizons where clods are unobtainable There are two types of known volume samples, volume replacement and volume filling samples These bulk density samples are packaged in small, pre-labeled plastic bags.

Samples are stored at 4 °C ± 2° C until analysis If the analysis is for only radionuclides this temperate control can be ignored

5 2 Equipment and Supplies

5.2.1 Apparatus

The following items are used in both the clod and volume methods

1. Drying oven or convection oven, if available .

2. Desiccator and desiccant.

3. Brass sieve, squared-holed, 2 mm.

4. Forceps.

The following additional apparatus is needed for the clod method:

1. Fume hood

2. Balance, capable of weighing to 0.1 g.

3 Beakers, 1000-mL and 2000-mL.

4 Ring stand or similar apparatus.

5. Test tube clip, adjustable, or similar apparatus.

6 Evaporating dishes, pre-numbered, tolerance to 450 °C

7 Furnace gloves (optional)

8 Furnace tongs

9 Muffle furnace

10 One-gallon metal cans with airtight lids (paint cans).

11. Magnetic stirrer and stir bars, or long stir sticks.

12. Shower curtain rod or similar apparatus.

13. Stop watch.

14 Thermometer

15. Balance calibration weights, 3-5 weights covering expected range.

16 Class "P" balance weight, 500 g

The only item needed for the volume methods in addition to the four listed previously is

- Balance, accurate to 0 01 g

5 2.2 Reagents

NOTE. All reagents listed are for the clod method. The volume methods do not require any reagents

1. Acetone, industrial grade.

2. Saran acetone clod dipping mixture, approximately 1:5 by weight.

NOTE The clod dipping solution must be mixed only under a properly operating vented fume hood The operator must wear a laboratory coat while mixing the dipping solution

The Saran powder is prepackaged in 540-g allotments. One packet mixed with approximately 3400 mL of acetone provides a nearly 1·5 by weight mixture resembling light syrup. If possible, use a magnetic stirrer and a stir bar to mix the ingredients in a beaker until well blended, then transfer mixture to paint container for storage. One-gallon paint containers are used for mixing and storing the solution. Slowly add the contents of each packet to the acetone while stirring. Continue stirring to ensure thorough dissolution of the powder. The solution normally is well mixed when it has the color and consistency of amber syrup and there is no gummy Saran residue on the edges or bottom of the container If the solution is a milky color, additional mixing is required The powder has a tendency to precipitate and clump around a container's lower rim when mixed with acetone. To prevent this, use a long stir stick and thoroughly scrape the inner rims

After mixing the solution, the container should be capped as tightly as possible to prevent leakage of the solution or evaporation of the acetone

3 Water -- Tap grade or better water may be used Allow the water to reach room temperature before using

5 2.3 Consumable Materials

Consumable items required for the clod method are.

1 Paper bags, pre-labeled

2. Plastic bags, large.

3 Clod bulk density raw data form (Attachment 10.1).

Consumable items required for the known volume methods are:

1. Paper bags, pre-labeled.

2. Known volume bulk density raw data forms (Attachment 10 2).

3 Known volume log book (known volume method).

4. Volume data from sample receipt log book (known volume method).

5 3 Calibration and Standardization

Standardization of the balance is detailed in AP No 1, General laboratory Procedures

Check thermometers monthly against an NBS Traceable Standard thermometer to ensure that they are measuring temperature accurately If a thermometer varies by more than 2° C from the NBS Traceable Standard, it will be removed from service.

5 4 Clod Method

NOTE All raw data obtained from the clod analysis are recorded on the clod bulk density raw data form (see Attachment 10 1). For each clod to be analyzed, record the set ID, sample code, and the replicate number on the form. Examine the label attached to the clod and record the number of field dips performed by the sampling crew under "FIELD_DP" on the form. Weigh the clod, without removing the label, to the nearest 0 1 g and record this weight under "FIELD_WT/MOIST"

1 Suspend the clod in a convection oven and dry for at least 12 hours or overnight at 105 °C for mineral samples, or 60 °C for organic samples. After drying, transfer the clod into a desiccator and allow it to cool for 30 minutes. Weigh the sample to the nearest 0 1 g and record this weight under "FIELD_WT/DRY".

2. Hang the clod on a suspended rod within an operating vented fume hood. Dip the clod into a container of 1:5 by weight Saran·acetone mixture (see Section 5.2.2, Step 2) for three seconds and then allow the coating to dry for approximately 15 minutes Do not allow the mixture to impregnate that portion of the hairnet hanging above the top of a clod.

NOTE· Alternately, the clod may be sprayed with water just prior to dipping in the Saran·acetone solution. The water reduces the penetration of Saran into the clod and produces a frost appearance, indicating the solution has coated the outside of the clod Whichever alternative is chosen, it is important that the same technique be used on all samples

3 Apply additional dips as necessary until the clod does not produce excessive bubbles and a coating of Saran is obtained that appears to be impervious to water. Usually three to six dips is sufficient for most clods. Record the total number of dips made in the laboratory under "LAB_DP", then reweigh the clod to the nearest 0 1 g and record this weight under "LAB_WT". Also perform and record the dry-weight quality control check (Section 6.0).

4. Add approximately 1600 mL of deionized water to a 2000-mL beaker. Place the beaker of water on a balance and tare Record the temperature of the water under "TEMP" so that the density of the water can be calculated. Also perform and record the submerged weight quality control check (Section 6 0)

5 Suspend the clod over the beaker by attaching the top of the hairnet to the test tube clip, then lower the clod gently into the water until the top of the clod is entirely submerged Record the weight displayed on the balance to the nearest 0 1 g under "CLOD_H2O". If the clod floats, forcibly submerge it by pushing down with forceps and record the weight. Note on the raw data form, with a "Y" under "FLOAT", that the clod floated. Retare the balance before proceeding with other clods

NOTE. When submerging, ensure that the clod is not touching the edge of the beaker and that the clod label hangs freely. Occasionally, air bubbles may rise from the clod and the weight reading on the balance does not stabilize but steadily decreases. This occasionally occurs in clods sampled from relatively porous surface horizons and simply indicates that all of the primary macropores along the exterior of the clod were not thoroughly water-sealed By reading the weight immediately after submersion, error from this source of instability is minimized. Note the bubbling on the raw data form under "COMMENTS". Also note any other problem, such as a broken clod, under "COMMENTS".

6 After submersion, place the clod in a pre-numbered evaporating dish and record the dish number on the raw data form under "CRUC_NO". Remove as much of the clod label and hairnet as possible and place in a large plastic bag with others from the same run.

7. Place the evaporating dish plus clod in a muffle furnace equilibrated at 400 °C. The muffle furnace must be within an operating vented fume hood Allow the Saran coating to be burned off the clod surface for two hours. Allow the furnace to cool, then carefully remove the evaporating dish from the muffle furnace After the clod has cooled thoroughly, place it in a pre-labeled paper bag If the soil is suspected to contain radionuclides place the paper bag containing the clod into a plastic bag

8. Disaggregate the clod through a 2-mm sieve. Weigh any rock fragments retained on the sieve to the nearest 0.01 g and record this weight under "R_FRAG". Place the rock fragments into the paper bag and archive all such bags

CAUTION If the soil is suspected to contain radionuclides perform this operation in an approved fume hood.

Alternatively, the clods may be soaked in water and dispersing agent to aid in disaggregation followed by drying of coarse fragments at 105°C.

5 5 Known Volume Method

NOTE. Known volume bulk density samples are shipped from the field in small, plastic bags. Upon passing the sample receipt verification, these samples can be placed out to air dry in the drying area (see Section 5.5.1). The drying facilitates the transfer of the entire sample from its plastic bag into a pre-labeled paper bag. If sample is suspected to contain radionuclides, this drying area must be in an approved fume hood. Do not remove any material from the bag, even if the material is thought to be morphologically different from the type of horizon sampled.

NOTE. Record the set ID and sample code of the VR or VF sample on the known volume bulk density raw data form (see Attachment 10.2)

5.5.1 Laboratory Measurements

When clods cannot be obtained, the volume-replacement method is used. A level step is prepared in the soil pit at least large enough to dig two circular holes approximately 10 cm in diameter and 10 cm deep, or to the boundary of the next lowest horizon. Larger diameter holes must be used for thin horizons. When a level step cannot be obtained a metal frame is used to provide a reference point for calibrating the surface roughness (see Section 5.5.1.1). All material (including roots) excavated from the small holes is placed into separate sample bags, paying careful attention to retain all of the sample. Label each sample bag.

The volume of each hole is determined by lining the hole with cheesecloth by carefully pushing the material into all the irregularities of the hole Fill a plastic graduated cylinder with beads Record notes in a field logbook indicating which sample is being measured (i e , 1/2 for the first of two) Read the initial volume of the beads in the cylinder by placing the circular block into the cylinder and tapping the side twenty times (or more until large voids not visible) with a trowel handle Record the initial volume in a field logbook as V_i. Fill the fabric lined hole with beads, tamping and then levelling them. Use a straight-edge to help judge when the hole is full. Record the final volume of beads in the cylinder as V_f. Remove the beads and repeat for the second hole.

Seal the plastic bags as instructed for routine samples and place all the volume-replacement samples for one horizon in a canvas bag that is labelled with "Volume-Replacement," date sampled, crew ID, site ID, and set ID.

5 5 2 Volume-Replacement Sampling with Frame

In cases where a level step cannot be obtained due to rock fragments or abundant roots the volume-replacement method must be used with a metal frame When the metal frame is used with this method, only one replicate is required, instead of the usual two, because it is more time consuming The volume measurements are recorded in the field logbook.

Two volume measurements are to be made when using this method The first is to calibrate the volume from the top of the frame to the soil surface The second measurement is made after a hole has been excavated within the area enclosed by the frame The prep lab will subtract the second measurement from the first to obtain the volume of soil excavated

Prepare a level step, as best possible, then position the metal frame and secure it with nails. Line the inside of the frame with cheesecloth and tamp it into all corners Place beads into the graduated cylinder and tamp it as described above Fill the frame with beads, tamping them gently while filling. Record the amount of beads used in the field logbook. It may take more than one cylinder of beads to fill the frame, in which case, record in the "V_i" space the total volume in the first cylinder and write the volume in the second cylinder before pouring beads into the frame For "V_f" write the volume in the last cylinder after filling the frame to the rim For example, if 1,900 cm^2 of beads were placed in the frame and then the cylinder was filled back up to 1,800 cm^2, the entry for "V_i" calibration would be "1,900 + 1,800" If after filling the frame to the rim, striking it off with a straight-edge and returning the excess beads to the cylinder, the volume in the cylinder was 1,500, then the entry for "V_f" is 1,500

Remove the beads from the frame used for calibration and place in a plastic bag. Excavate a sample, as described above, from a hole within the frame and label it. Line the hole and frame with cheesecloth. Pour all the beads used for calibration into the cheesecloth and write in the "V_f" section for final volume "calibration beads + " Fill a graduated cylinder with beads and record the volume in "V_i" for initial volume Pour beads from the cylinder until the frame is filled. Strike off the top surface of the frame with a straight-edge and return the excess beads to the cylinder Record the final volume in the cylinder in the space for "V_f"

1. Weigh the paper bag plus sample to the nearest 0.01 g and record this weight under "AIR_WT"

2. Place the bag in a drying oven equilibrated at 105 °C ± 5° C for mineral soils and 60 °C ± 5° C for organic soils Allow the sample to oven dry overnight.

3. The following morning, remove the sample from the oven and allow to cool for 30 minutes Weigh the sample to the nearest 0 01 g and record this weight under "OD_WT"

4 Sieve the contents of the bag through a 2-mm sieve to remove any rock fragments Weigh the rock fragments to the nearest 0.01 g and record this weight under "R_FRAG". Place the rock fragments in the paper bag and archive all such bags.

5 Transcribe the computed volume (V_i minus V_f) for a VR sample from the sample receipt log book to the "VOL" column on the raw data form. For a VF sample, 300 cm^3 can be entered under "VOL"

5.5.3 Sample Drying

1. Label a bulk sample processing raw data form (see attachment 3) for each sample to be air dried.

2. Place two fresh sheets of kraft paper, approximately 1 m x 1 m in area, on the mesh partition of the drying table With gloved hands, slowly spread the sample on top of the sheets of paper, taking care not to lose any soil off the paper or contaminate any adjacent samples. If a sample is

suspected to contain radionuclides, it must be dried in an approved fume hood

NOTE: In some cases, samples may be received from the field in more than one sample container (bag) Combine the contents of all containers comprising a single sample

3 Disaggregate any large clumps that impede the spreading of the sample over the entire area of the paper. Place an additional sheet of kraft paper loosely over the sample

4 Identify the sample by attaching the sample's processing raw data form to a hook attached to the drying table or other mechanism. The original canvas and plastic sampling bags should be kept on the floor beneath the sample as a second check on sample identity

5 Daily, stir the soil sample with gloved hands to facilitate drying

6 For the first few days that a wet sample is spread, the bottom sheet of paper may need to be changed daily in order to alleviate excessive moisture accumulation. Any observations of fungal or algal growth should be noted on the bulk sample processing raw data form.

NOTE: Soils high in clay may harden nearly irreversibly if allowed to dry without a preliminary disaggregation of medium and coarse aggregates. An effort should be made during the air-drying procedure to disaggregate these pedons by physical manipulation with gloved hands while still somewhat moist or friable, before reaching an air-dry state

7 Allow the sample to air dry until it is believed to be at or below the specified moisture content. This process generally takes about two days, although drying time may vary from one day to a week or more

5.5 4 Volume-Filling Bulk Density Sampling

When the previous two bulk density methods do not work, the volume-filling method is used This method is reserved for material such as loose sand, which cannot maintain an excavation, or irregular surface horizons. Samplers fill plastic beakers cylinders of known volume as best they can to recreate the same packing as naturally found in the soil Fill the container completely and strike off with a straight-edge The material is carefully transferred to a plastic bag and labeled. Two samples will be taken each time this method is used

Seal the plastic bags as instructed for routine samples and place all the volume-filling samples for one horizon in a canvas bag that is labelled with "Volume-Filling," date sampled, crew ID, site ID, and set ID.

5 6 Calculations

5.6 1 Clod Method

It is assumed that the weight of each two-second Saran coating applied in the field is equal to the weight of each three-second coating applied in the laboratory, as some of the dipping solution normally is absorbed into the clod when it is applied in the field.

It is assumed that the specific gravity of air-dry Saran is 1.30 g/cm^3 and that the coating loses 15 percent of its weight upon oven-drying. It is assumed that the particle density of the rock fragments is 2.47 g/cm^3.

It is assumed that the average gross weight of the hairnet and clod label is 1 88 g and the net weight of the submerged portion of the hairnet is 0.20 g.

The following calculations may be performed by computer after the raw bulk density data are entered If so, it is advantageous to manually check a few samples using these calculations to understand the procedure and to test the accuracy of the computer program. A list of temperature-corrected water density values is provided in Table 5-1.

Table 5-1 Density of Pure Water[a]

Temp °C	Water Density
13 0	0.9992
14 0	0 9991
15 0	0 9990
16 0	0 9988
17 0	0 9987
18 0	0.9986
19.0	0.9984
20 0	0 9982
21 0	0 9980
22.0	0 9978
23 0	0 9976
24 0	0.9973
25.0	0 9971
26.0	0 9968
27.0	0.9965
28 0	0.9963
29 0	0.9960
30 0	0.9957
31 0	0 9954
32.0	0 9951
33 0	0.9947
34 0	0.9944
35 0	0.9941

[a] Adapted from List (1984)

Use the following calculations to derive the weights and volume of the air-dry and oven-dry Saran coatings:

$$\text{SARAN\_WT (g)} = \frac{[(\text{FIELD\_DP} + \text{LAB\_DP}) \times (\text{LAB\_WT} - \text{FIELD\_WT/DRY})]}{\text{LAB\_DP}}$$

$$\text{OD SARAN\_WT (g)} = \text{SARAN\_WT} \times 0.85$$

$$\text{SARAN VOL (cm}^3) = \frac{\text{SARAN\_WT}}{1.30}$$

Use the following calculations to derive the volumes of rock fragments, water displacement, and soil/pore fraction.

$$\text{R\_FRAG VOL (cm}^3) = \frac{\text{R\_FRAG}}{2.47}$$

$$\text{WATER VOL (cm}^3) = \frac{\text{CLOD\_H2O}}{\text{DENSITY OF WATER}}$$

$$\text{SOIL/PORES VOL (cm}^3) = \text{WATER VOL} - (\text{R\_FRAG VOL} + \text{SARAN VOL})$$

Finally, use the following calculation to derive the oven-dry bulk density (BD_CLD) for the individual clod:

$$\text{BD\_CLD (g/cm}^3) = \frac{\text{LAB\_WT} - (\text{R\_FRAG} + \text{OD SARAN\_WT} + 1.88)}{\text{SOIL/PORES VOL} - 0.20}$$

5.6.2 Known Volume Method

The particle density for rock fragments in a VR bulk density sample is derived individually by a submersion technique similar to that used in the clod analysis. It is assumed that the particle density for rock fragments in a VF bulk density sample is 2.65, unless specific particle density measurements are made of different classes of rock fragment types.

The following calculations for known volume bulk density (BD_KV) may be performed by computer. It is advantageous to manually check a few samples using these calculations to understand the procedure and to test the computer program.

FINES_WT (g) = OD_WT *_* R_FRAG

$$BD\_KV\ (g/cm^3) = \frac{FINES\_WT}{VOL *\_* (R\_FRAG + \text{particle density})}$$

6.0 QUALITY CONTROLS

NOTE. This applies only to the clod method.

Record the dry weight and suspended submerged weight of a 500-g balance weight immediately before and after a run of samples These weights are used to verify proper balance operation and should be charted on a daily basis whenever bulk density determinations are made

7 0 ENVIRONMENT, SAFETY AND HEALTH

7 1 Clod Method

Laboratory personnel should use caution when working around the muffle furnace because temperatures of up to 450 °C are common The furnace should be activated only in an operable fume hood or other approved ventilation area. Heat resistant or furnace gloves may be needed when placing samples in the furnace. The furnace must be adequately vented and protected from incidental human contact and no combustible/flammable materials should be placed in or near the furnace.

Extra precaution must be taken in the use of the Saran powder and acetone solution (see Section 5 3 2, Step 2). When mixed, the resulting solution has a tendency to volatilize hydrogen chloride gas which can cause deleterious health effects. The solution should be used only in an operating vented fume hood. Half mask with appropriate cartridge respiratory protection, gloves, and laboratory coat should be worn as specified in the Laboratory Run Sheet.

In the field, exposure to Saran solution through inhalation and skin contact must be minimized. Gloves and respiratory protection are recommended and will be specified in the Laboratory Run Sheet. Use solution only in a well-ventilated area which is downwind of the sampling site

7.2 Volume Methods

The safety concerns cited above do not apply to the VR or VF methods Protective clothing (laboratory coat and gloves), safety glasses, and dust masks should be worn

8.0 RECORDS

The following documents will be maintained as Quality Records.

- Clod bulk density raw data
- Known volume bulk density data
- Bulk sample raw data
- Field logbook

9.0 REFERENCES

American Society for Testing and Materials 1984 *Annual Book of ASTM Standards, Vol. 11.01, Standard Specification for Reagent Water,* D-1193-77 (reapproved 1983). ASTM, Philadelphia, Pennsylvania.

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List, R. J. 1984 *Smithsonian Meteorological Tables*, 6th Edition Smithsonian Institute Press, Washington, D C

USDA/SCS. 1984 *Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples Soil Survey Investigations Report No 1* U S. Government Printing Office, Washington, D C.

10 0 ATTACHMENTS

Attachment 10 1 "Clod bulk density raw data" form
Attachment 10.2 "Known volume bulk density data" form
Attachment 10.3 "Bulk sample raw data" form

ANALYTICAL PROCEDURES
BULK DENSITY DETERMINATION

[illegible] BULK DENSITY RAW DATA

page ___/___

ALL WEIGHTS RECORDED TO 0.01 GRAMS

[illegible]	[illegible]	[illegible]	[illegible] moist/dry	[illegible]	[illegible]	[illegible]	TEMP C		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	COMMENTS

AWC

KNOWN VOLUME BULK DENSITY DATA

	AIR WT	OD WT		VOL. (cc)	DATE	ID	COMMENTS	SAMPLER (INITIALS)	DATE

Supervisor ____________ Date ____________

AWC

BULK SAMPLE RAW DATA

SAMPLE ID: ______________________ DATE SAMPLED ___/___/___

SITE ID ______________________ DATE RECEIVED: ___/___/___

SET ID ______________________ PROCESS START ___/___/___

BATCH ID: ______________________ PROCESS COMPLETE ___/___/___

SOIL TYPE M / O FIELD pH __________

Initials. __________ Initials: __________

AIR SAMPLE DRYING

Date	% Moisture	Initials
___/___	______	______
___/___	______	______
___/___	______	______

TOTAL BULK WT

Date ___/___/___ __________ g Initials: __________

ROCK FRAGMENT WT

2 TO 4.75 mm: __________ g 4.75 to 20 mm: __________ g

Date: ___/___/___ Initials: __________

ENTERED IN COMPUTER. Date ___/___/___ Initials: __________

COMMENTS.

______________________ Supervisor ________ Date

AWC
A Lockheed Company

ANALYTICAL PROCEDURES
PARTICLE SIZE ANALYSIS

AP No AWC 3
Revision 0

CONTROLLED COPY No. 007 THIS IS A RED STAMP

Approvals

Project Manager	Date 5/2/91	Radiation Safety Officer	Date 5/2/91
QA Manager	Date 5/2/91	E,S&H Coordinator	Date 5/2/91

1.0 PURPOSE AND SCOPE

The purpose of this analytical procedure (AP) is to instruct laboratory personnel in the methods used in particle size analysis

Particle size analysis is determined on the less than 1.25-cm fraction for mineral and activity horizons The sieve/pipet/gravimetric method described in Methods of Soil Analysis (ASA/SSSA, 1986) is used with adaptions for activity analysis.

The soil sample is first dry sieved and then each of the seven fractions weighed and assayed for radioactivity The soil fractions are returned to their respective screens and wet sieved followed by drying, weighing, and assaying for radioactivity The soil fraction collected in the pan is suspended in water; aliquots taken from the suspension under specific conditions are dried, weighed, and assayed for radioactivity

2.0 APPLICABILITY

This AP applies to laboratory personnel involved in particle size analysis of soil samples.

3.0 DEFINITIONS

SRCC - Standard Radiological Counting Can

4.0 RESPONSIBILITIES

The laboratory supervisor is responsible for assuring that all personnel assigned tasks related to this AP are familiar with this AP, that they have been trained in this AP, and that a controlled copy of this AP is available to them.

All personnel performing particle size analysis of soil samples are responsible for following this AP.

5.0 PROCEDURE

Interferences

While the soil in suspension is settling, the graduated cylinders containing the suspension cannot be disturbed, nor can the temperature vary. Foam insulation, a constant temperature water bath, or temperature-controlled room may be used to maintain constant temperature When handling weighing bottles, use forceps, finger cots, cotton gloves, or vinyl gloves to avoid adding weight from moisture and from body salts and oils.

5 1 Particle Size Sample Collection

The subsamples for particle size analysis are taken from the bulk soil sample after it has been air dried and homogenized

5 2 Equipment and Supplies

5 2.1 Apparatus

1. Sedimentation cylinders (1-L graduated cylinders, optional)

2. Stirrer, hand--Fasten a circular piece of perforated plastic to one end of a brass rod

3. Shaw pipet rack or equivalent (preferred).

4 Pipets, 25-mL, automatic (Lowry with overflow bulb or equivalent).

5. Sieve shaker, 1.25-cm vertical and lateral movement, and 500 oscillations per minute, or equivalent. Unit must accommodate a nest of sieves.

6. Weighing pans, 20-cm diameter by 5 cm deep, or equivalent, (tare to ±0 1 mg), capable of withstanding intermittent heating to 110 °C and cooling to room temperature

7. Balance, top-loading, capable of weighing to 0.01 g

8 Balance, analytical, capable of weighing to 0 0001 g.

9 Set of sieves, square-mesh, woven phosphor-bronze or stainless steel wire cloth, U.S. Series and Tyler Screen Scale equivalent designations as follows.

Nominal Opening (mm)	U.S. No
2.0	10
0 85	20
0.30	50
0.15	100
0.075	200
0 045	325

10. Receiving pan, used with sieves

11 Hot plate (block digester, optional)

12. Thermometer, range 10 to 50 °C.

13. Evaporating dishes, or equivalent, 125- or 250-mL.

14 Desiccator and desiccant

15 Planchets.

16 Standard Radioactivity Counting Cans (SRCC)

17 Drying oven or Convection oven.

18 Clamp and ring stand or equivalent.

19 Stoppers (optional)

20 Stop watch or other timer.

5 2.2 Reagents and Consumable Materials

1 Sodium carbonate (Na_2CO_3).

2. Sodium hexametaphosphate [$(NaPO_3)_6$], dispersing agent--Dissolve 35 7 grams of $(NaPO_3)_6$ and 7.94 grams of Na_2CO_3 in deionized (DI) water and dilute to 1 L.

3. Water--Commercial DI water is suitable for these procedures.

4 Kimwipes or equivalent.

5. Forms--Form 2 particle size parameters raw data, Form 3 particle size parameters calculated data, Form QC-2, and Form QC-3 (Attachments 10.1 through 4, respectively).

5.3 Calibration and Standardization

Check thermometers monthly against an NBS traceable standard thermometer to ensure that they are measuring temperature accurately.

If a thermometer varies by more than 2 °C from the NBS standard it will be removed from service Temperatures of the suspensions used in these procedures should vary no more than ±1 °C.

Standardization the balance is described in AP No. 1, General Laboratory Procedures.

5 4 Dry Sieving Method

CAUTION Wear impermeable rubber gloves when handling any sample suspected to contain radionuclides

1 Set up sieve shaker in hood with #10, #20, #50, #100, #200, #325 sieves and receiving pan.

2. Weigh approximately 1000 grams of sample and record weight on dry sieve data sheet (Attachment 10 1)

3. Place sample in drying oven at ± 10°C for 1 hour beyond apparent dryness.

4 Cool sample to room temperature.

5. Remove sample from oven and weigh, recording weight on dry sieve data sheet.

6. Place sample in top sieve (#10), place cover over #10 sieve and secure in shaker.

7. Start sieve shaker and shake for 10 minutes.

8. Remove #10 screen and transfer soil fraction into a tared SRCC Weigh SRCC, subtracting tare weight and record on dry sieve data sheet.

9 Repeat step 8 for each sieve and receiving pan.

NOTE If the sieve fraction will not fit into one SRCC, place remaining soil fraction into second SRCC

10. Count each SRCC containing a sample for radioactivity and record results on dry sieve data sheet using the appropriate calibrated radiological detection system.

11 Complete mass and activity balance on dry sieve data sheet.

5.5 Wet Sieving Method

1. Replace soil fractions removed from dry sieving procedure back into their respective pans starting with the #325 sieve

   NOTE Do not replace material from receiving pan

2. After all material has been replaced into their respective pans, wash #10 sieve with a squirt bottle while agitating soil with a rubber policeman. Wash until the water coming through the sieve is nearly clear. Large samples can be more effectively processed by slurrying in a pan and then pouring into the sieve. Repeat until the effluent is nearly clear.

3. Following washing of #10 sieve, transfer sieve contents to a tared drying pan and dry in oven at 110°C ± 5 °C for 1 hour beyond apparent dryness.

4. Repeat step 3 for the remaining sieve fractions working from the #20 sieve to the #325 sieve.

5. Each dried sieve fraction is transferred to a tared SRCC and the sample weight recorded on the wet sieve data form.

   NOTE: If the sieve fraction will not fit into one SRCC place remaining soil fraction into second SRCC

6 The material collected in the pan is dried in a drying oven until a thin film of water remains over sample Do not allow any dry areas to form in slurry.

Combine dried material from receiving pan with material retained from receiving pan in dry sieving and mix to obtain homogeneous sample Transfer material to tared tuna fish can for weight determination and radioactivity assay Record weight and radioactive assay results on wet sieve data sheet.

7. Count each SRCC for radioactivity and record results on wet sieve data sheet.

8. Complete mass and activity balance on wet sieve data sheet.

5.7 Pipetting Method

CAUTION Wear impermeable rubber gloves when handling samples suspected to contain radionuclides.

All pipetting must be performed in a location free from drafts and temperature fluctuations A temperature-controlled room, constant-temperature water bath, or foam insulation may be used

1. Add 10 ml of 0.5 g/L Na - hexametaphosphate (HMP) solution to a 1 liter sedimentation cylinder. Dilute to 1000 ml with DI water.

2. Weigh 100 grams of soil from the receiving pan (combined wet & dry sieve receiving pan sample) and add to the sedimentation cylinder. Shake cylinder or stir to release trapped gasses from the soil. The 100 grams of soil should not include the moisture content of the soils. The moisture content can be determined by drying a small subsample of pan fraction.

3. Allow 12 to 24 hours for the temperature of suspension to equilibrate to room temperature If water is stored at room temperature, one to two hours is adequate

4. Stir the material in the sedimentation cylinder for 6 minutes with the motor-driven stirrer. Stir 8 minutes if suspension has been standing for more than 16 hours.

NOTE: If stoppers of adequate size are available, it is preferable to stopper the cylinder, invert, and swirl. Care must be taken to ensure that the stopper is held tightly in the cylinder. Repeat this procedure at least six times. Inspect the bottom and sides of the cylinder to ensure that fine particles are not adhering to the glass walls of the cylinder.

5. Remove the stirrer and either (1) cover the cylinder with a length of polyurethane foam pipe-insulation, (2) immerse the cylinder in a constant-temperature water bath, or (3) place the cylinder in a temperature-controlled room

6 Stir the suspension for 30 seconds with a hand stirrer; use an up-and-down motion. Record the time when the stirring is complete Do not move, stir, or otherwise disturb the cylinder from this point until all pipetting has been completed

7. Take the temperature of the solution in the cylinder by gently lowering a thermometer 5 cm into the suspension. Support the thermometer with a clamp to reduce disturbance to the suspension.

8. Use the temperature and Table 5-1 to determine the settling time required for the 20 micron fraction, e g , at 22 °C allow 4 minutes, 35 seconds.

Table 5-1. Sedimentation Times for Fine Silt and Clay Particles Settling Through Water to a Depth of Ten Centimeters

Temperature	Settling Time with Indicated Particle Diameter[a]		
	2 microns	5 microns	20 microns
°C	hr·min	min·sec	min sec
20	8 00	68·18	4:48
21	7 49	66 42	4·41
22	7:38	65·06	4·35
23	7:27	63 36	4·28
24	7·17	62.06	4 22
25	7.07	60 42	4:16
26	6·57	59·18	4:10
27	6.48	58·00	4:04
28	6 39	56.48	4 00
29	6.31	55·36	3 55
30	6:22	54·24	3·49

[a]Values calculated from Stokes' equations, assuming a particle density of 2.65 g/cm^3. This figure for particle density is arbitrary and has been chosen to satisfy simultaneously the two definitions of the clay fraction, i e , particles that have an effective diameter of 0 002 mm or less and particles that have a settling velocity of 10 cm in 8 hours at 20 °C.

9 Approximately 60 seconds before the sedimentation time has elapsed, slowly lower the Lowry automatic pipet 10 cm into the suspension. (A 25-mL volumetric pipet premarked for a 10-cm depth and clamped firmly in place on a stand may be used)

10. At the appropriate time, slowly (allow about 12 seconds) fill the pipet. Carefully remove it from the suspension

11. Wipe clean the outside of the pipet and empty the contents into a glass container, such as a 90-mL widemouth bottle. Rinse the pipet into the bottle once with DI water (add the rinse water to the contents of the bottle). Transfer contents of glass container into tared planchet in 10 ml increments Evaporate the water slowly with heat lamp or on hot plate (no splattering or boiling). Rinse empty glass container with DI water and transfer rinsed solutions to planchet.

12. Cool planchet in desiccator and weigh to nearest 0 1 mg and record net weight on wet sieve data sheet.

13 Repeat steps 7 through 12 for the 5 µm and 2 µm clay fraction The <2-µm fraction may be pipetted at a time between 5 and 8 hours depending on the temperature and the table used The use of Table 5-1 and a depth of 10 cm is strongly recommended and is the easiest method

6 0 QUALITY CONTROLS

Reagent Blanks--A 25-mL aliquot of the diluted dispersion solution (10 0 mL of the hexametaphosphate dispersion solution diluted to 1 L), dried and weighed, is used as the clay reagent blank. One blank should be analyzed with each batch of ten samples or weekly if fewer than ten samples are run in that week

Replicates--One sample from each batch of ten samples should be analyzed in duplicate.

7 0 ENVIRONMENT, SAFETY AND HEALTH

Forceps, tongs, or heat-resistant gloves should be used to handle weighing bottles after removal from the oven. Wear protective clothing and/or safety glasses when handling reagents or materials known to contain radionuclides

8 0 RECORDS

The following documents will be maintained as Quality Records

- Field logbook
- Dry Sieve Data Sheet form
- Wet Sieve Data Sheet form
- Pipette Method Data Sheet form

9 0 REFERENCES

American Society for Testing and Materials. 1984 *Annual Book of ASTM Standard Specification for Reagent Water*, D-1193-77 (reapproved 1983) ASTM, Philadelphia, Pennsylvania.

U S Department of Agriculture/Soil Conservation Service. 1984. *Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples* Soil Survey Investigations Report No. 1, U.S. Government Printing Office, Washington, D.C.

10 0 ATTACHMENTS

Attachment 10 1 "Dry Sieve Data Sheet" form
Attachment 10 2 "Wet Sieve Data Sheet" form
Attachment 10 3 "Pipette Method Data Sheet" form

AWC

DRY SIEVE DATA SHEET

DATE__________ SAMPLE ID__________

TECHNICIAN__________ AS RECEIVED WEIGHT__________

DRIED WEIGHT__________

ISOTOPE__________

SIEVE SIZE	NET SIEVE SAMPLE WEIGHT (gm)	SIEVE ACTIVITY (pCi/gm)	SIEVE ACTIVITY (pCi)	PERCENT TOTAL WEIGHT (%)	PERCENT TOTAL ACTIVITY (%)
#10 (2000 μ)					
#20 (850 μ)					
#50 (300 μ)					
#100 (150 μ)					
#200 (75 μ)					
#325 (45 μ)					
PAN (<45μ)					
TOTAL					

__________ Date

__________ Supervisor

AWC

WET SIEVE DATA SHEET

DATE ____________ SAMPLE ID ____________

TECHNICIAN ____________ DRIED WEIGHT ____________

ISOTOPE ____________

SIEVE SIZE	NET SIEVE SAMPLE WEIGHT (gm)	SIEVE ACTIVITY (pCi/gm)	SIEVE ACTIVITY (pCi)	PERCENT TOTAL WEIGHT (%)	PERCENT TOTAL ACTIVITY (%)
#10 (2000 µ)					
#20 (850 µ)					
#50 (300 µ)					
#100 (150 µ)					
#200 (75 µ)					
#325 (45 µ)					
PAN (<45µ)					
TOTAL					

____________ Supervisor

____________ Date

AWC

PIPETTE METHOD

SAMPLE ID ______________

DRIED WEIGHT ______________

ISOTOPE ______________

DATE ______________ TECHNICIAN ______________

	NET SAMPLE WEIGHT (gm)	CORRECTED SAMPLE WEIGHT (gm)	PAN WEIGHT	SAMPLE ACTIVITY (pCi/gm)	SAMPLE ACTIVITY (pCi)	CORRECTED SAMPLE ACTIVITY (pCi)	PAN ACTIVITY	PERCENT TOTAL WEIGHT (%)	PERCE TOTA ACTIVI (%)
45 µ									
20 µ									
5 µ									
2 µ									
TOTAL									

______________ Supervisor

______________ Date

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ANALYTICAL PROCEDURES
pH DETERMINATION

Approvals:

Terry Wenstrand	5/2/91	Gregory Eadie	5/3/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory Eadie	5/3/91	Gregory Eadie	5/3/91
QA Manager	Date	E/S&H Coordinator	Date

1 0 PURPOSE AND SCOPE

The purpose of this analytical procedure (AP) is to instruct laboratory personnel in the method used to determine the pH of soil samples

The pH is defined as the negative loganthm of the activity of hydrogen ions (H^+). The H^+ activity is a measure of the 'effective' concentration of hydrogen ions in solution; it is always equal to or less than the true concentration of hydrogen ions in solution Values range from pH 1 to pH 14, with pH 1 most acidic, pH 7 neutral (at 25 °C), and pH 14 most alkaline Each pH unit represents a tenfold change in H^+ activity (i e , a pH 4 solution is 10 times more acidic than a pH 5 solution)

When the pH of a sample solution is measured, the hydrogen ions come into equilibrium with the ion exchange surface (glass) of a calibrated pH electrode, which creates an electrical potential. This voltage difference is measured by the pH meter in millivolts (mv), which is then converted and displayed as pH units

2.0 APPLICABILITY

The following procedure was developed to standardize the measurement of pH in soils.

The applicable pH range for soil solutions is 3.0 to 11 0

This AP applies to laboratory personnel tasked to determine the pH of soil samples

3.0 DEFINITIONS

None

4 0 RESPONSIBILITIES

The laboratory supervisor is responsible for assuring that all personnel assigned the task of pH determination are familiar with this AP, that they have been trained on the AP, and that a controlled copy of the AP is available to them.

All personnel performing pH determination of soil samples are responsible for following this AP.

5 0 PROCEDURE

Discussion

Two suspensions of each soil sample are prepared, one in deionized (DI) water and one in 0.01 M calcium chloride ($CaCl_2$) The pH of each suspension is measured with a pH meter and a combination electrode This method is modified from USDA/SCS (1984) The DI water pH is generally higher than the pH of the 0 01 M $CaCl_2$

Interferences

Factors that normally affect the measurement of pH are (1) electrolyte content of the extractant; (2) soil-to-solution ratio; (3) temperature and CO_2 content of the extractant; (4) errors that occur with instrument calibration, standard preparation, and liquid junction potential; (5) organic and inorganic constituents, (6) length of time the soil and solution stand before they are measured; and (7) technique used in reading the sample suspension.

Soils high in salts, especially sodium, may interfere with the pH reading and the electrode response time Clay particles may clog the liquid junction of the pH reference electrode, slowing the electrode response time; thoroughly rinse the electrode with DI water between sample readings to avoid this problem. Wiping the electrode dry with cloth, laboratory tissue, or similar materials or removing the electrode from solution when the meter is not on standby may cause electrode polarization

The initial pH of a nonalkaline soil will usually be as much as 0.5 pH unit greater than the pH taken after the sample has set for 30 minutes or longer The pH can vary as much as 1.0 pH unit between the supernatant and soil sediment. Always place the electrode junction at the same distance (approximately 3 mm) above the surface of the soil sediment to maintain uniformity in pH readings.

NOTE The figures in the square brackets, [ ], represent the column of the appropriate form where the data are recorded

5 1 Sample Collection, Preservation, and Storage

The subsamples for pH measurement are taken from the bulk soil sample after it has been air dried and homogenized Samples should be stored at 4 °C ± 2 °C until ready for analysis Preparation of the soil suspensions for pH measurement is described in Section 5 4

5 2 Equipment and Supplies

5 2.1 Equipment Specifications

1 Digital pH/mV meter, capable of measuring pH to ±0.01 pH unit, potential to ±1 mV, and temperature to ±0 5 °C. The meter must also have automatic temperature compensation capability (Orion Model 611 or equivalent)

2. A combination pH electrode, made of high quality, low-sodium glass. At least two electrodes, one as a backup, should be available. Gel-type reference electrodes must *not* be used; an Orion Ross combination pH electrode or equivalent with a retractable sleeve is recommended.

3 Balance, accurate to ±0 001 g.

4 Balance calibration weights, 3-5 weights covering expected range.

5.2.2 Reagents

1. pH Calibration Buffers (pH 4 0, 7.0, and 10 0)--Commercially available pH calibration buffers (National Bureau of Standards [NBS]-traceable) at pH values of 4 0, 7 0, and 10 0 (two sets from different sources for calibration and quality control checks).

2. Buffer of pH 7 0 for quality control check standard (QCCS)--The QCCS can be purchased or it can be prepared from 0 05 M potassium hydrogen phthalate ($KHC_8H_4O_4$ or KHP) This buffer must be from a different container or lot than the NBS-traceable standards used for electrode calibration. Dry KHP for 2 hours at 110 °C, cool to room temperature in a desiccator. Weigh 10 21 g of KHP, dissolve it in DI water, and dilute the solution to 1.00 L. To preserve the KHP solution, add 1.0 mL of chloroform or one crystal (about 10 mm in diameter) of thymol per liter of the buffer solution. This solution has the following pH values at the temperatures given: 3.99 at 15 °C; 4 002 at 20 °C; 4 008 at 25 °C, and 4 015 at 30 °C.

3. Water--Commercial DI water

4. Calcium hydroxide--Dissolve 0.185 g $Ca(OH)_2$ in DI water and dilute to 1 L.

5. Hydrochloric acid (HCl)--Dilute 1 mL concentrated HCl to 1 L with DI water.

6. Stock calcium chloride solution ($CaCl_2$), 1.0 M--Dissolve 55.49 g of anhydrous $CaCl_2$ or 73 51 g of $CaCl_2 \cdot 2H_2O$ in DI water and dilute to 500 mL.

7. Calcium chloride, 0 01 M $CaCl_2$--Dilute 20 mL of stock 1.0 M $CaCl_2$ to 2.0 L with DI water If the pH of this solution is not between 5 and 6 5, adjust the pH by addition of dilute $Ca(OH)_2$ or HCl, as needed

8 Potassium chloride (3 M)--Dissolve 224 g KCl in DI water and dilute to 1 L

9. Potassium chloride (0 1 M)

10. Sodium hydroxide (NaOH) pellets.

5.2.3 Consumable Materials

1 Beakers, plastic, or paper containers, 50-mL

2. Glass stirring rods or disposable stirrers, one per sample

3 Weighing pans, disposable

4. Forms--Form 4 pH in water, Form 5 pH in 0.01 M calcium chloride, Form QC-4, and Form QC-5 (Attachments 10 1 through 4, respectively).

5.3 Calibration and Standardization

NOTE For storage and readings, the electrode need only be immersed to cover the liquid junction of the reference electrode (typically about 3 mm). Rinse the electrode with DI water between each sample and each buffer to prevent solution carryover. Do not rub or blot electrode dry because this may produce a static electric charge and thereby polarize the electrode Electrodes are stored in lm KCL

5.3.1 Instrument Preparation

1. Plug in the instrument and verify that the control knob is on "STD BY."

   NOTE. If instrument is used frequently, leave on and in "STD BY" mode between uses

2. Connect the combination electrode to the meter. Consult the pH electrode manual for the proper procedure.

3 Verify that the level of reference filling solution (3 M KCl) in the electrode is just below the fill hole and that the fill hole is uncovered during measurement (slide the plastic sleeve down).

5.3.2 Calibration with Buffers for pH less than 7.0

1. Check the meter temperature calibration daily with a beaker of room temperature DI water and an NBS-traceable thermometer. If the display differs from the NBS-traceable thermometer by more than 1.0 °C, complete adjustments as described in manufacturer's manual

2. Pour fresh pH 7.00 and pH 4.00, buffer solutions into labeled 50-mL beakers (one "RINSE", one "CALIBRATION", and one "CHECK" beaker filled with each buffer). Rinse all beakers three times with buffer solutions and fill with the appropriate buffer solutions.

3. Rinse the electrode with DI water. Place the electrode into the pH 7.00 "RINSE" beaker and swirl for 40 seconds. Place the electrode into the "CALIBRATION" beaker, turn the knob to "pH", swirl for 30 to 60 seconds (or until the pH reading is stable), and read the value on the display. Consult the pH-temperature chart, Table 5-1. Use the "CALIBRATE" knob to adjust the pH reading on the meter to the theoretical pH of the buffer solution at the appropriate temperature.

4. Repeat Step 3 for pH 4 00 buffer using the "% SLOPE" knob to adjust the pH reading

5. Repeat steps 3 and 4 until both the pH 7.00 and the pH 4 00 buffers agree with the theoretical pH of the buffer solution at the appropriate temperature.

6. Check the standardization using the buffer solutions in the "CHECK" beakers. If the values differ by more than ±0.03 units from the theoretical value, repeat the standardization process. When the meter standardization is acceptable, record the pH and temperature readings for each buffer solution in the pH logbook

5 3 3 Calibration for Buffers for pH Measurements Greater than 7.0

Proceed as in Section 5 3 2 but substitute pH 7.0 buffer for pH 4 0 buffer and substitute pH 10 0 buffer for pH 7 0 buffer.

5 3 4 Maintenance

- Check the level of the 3 M KCl filling solution in the electrode If it is more than 1 cm below the filling hole, replenish the solution from a bottle of electrode filling solution.

5.3 5 pH Meter Electronic Checkout

This procedure should be performed in accordance with the manufacturer's manual whenever a new pH meter is set up or when calibration problems occur

Table 5-1. pH Values of Buffers at Various Temperatures

Temperature						
25 °C	0 °C	5 °C	10 °C	20 °C	30 °C	40 °C
1.68	1.67	1.67	1.67	1.67	1.68	1.69
3.78	3.86	3.84	3.82	3.79	3.77	3.75
4.01	4.00	4.00	4.00	4.00	4.02	4.03
6.86	6.98	6.95	6.92	6.87	6.85	6.84
7.00	7.11	7.08	7.06	7.01	6.98	6.97
7.41	7.53	7.50	7.47	7.43	7.40	7.38
9.18	9.46	9.40	9.33	9.23	9.14	9.07
10.01	10.32	10.25	10.18	10.06	9.97	9.89

5.3.6 Electrode Etching Procedure

NOTE 1: Use caution when using the NaOH pellets. Wear gloves, eye protection, and a lab coat.

NOTE 2. If the electrode response is sluggish or if the instrument cannot be standardized, the following procedure is recommended for cleaning the ceramic junction of the electrode and improving the electrode response time.

NOTE 3 Etch electrodes in groups of three when possible Prepare a fresh NaOH solution for each group of electrodes.

1. Drain the filling solution from the electrode.

2. Rinse the filling chamber with DI water and drain it.

3 Refill the chamber with DI water.

4 Prepare a 50 percent (w/v) NaOH solution by slowly adding 30 g of NaOH to 30 mL of DI water.

5 Gently stir the solution with up to three electrodes to dissolve the NaOH. The solution will be very hot and may boil and splatter; caution must be used.

6 Stir the solution an additional 2 minutes with the electrodes.

7 Rinse the electrodes in DI water.

8. Rinse the electrodes in pH 7.00 buffer for 2 minutes.

9 Drain the DI water from the filling chambers.

10. Refill each electrode with 3 M KCL, agitate the electrodes, and drain the chambers.

11. Refill the chambers once more with 3 M KCL and spin each electrode from the leader to remove air bubbles.

5 4 Preparing Soil Suspensions

1. Weigh 20 0 ± 1 gram of air-dry mineral soil into a beaker and add 20 0 mL of DI water; for organic soils, use 5 0 g of soil and 25.0 mL of DI water. Log exact sample weight [4-B] and volume [4-C].

2. Allow soil to absorb the liquid without stirring

3 Stir the mixture for 10 seconds and allow mixture to sit for 15 minutes.

4 Repeat Step 3 three times

5 Repeat steps 1 through 4, replacing the DI water with 0 01 M $CaCl_2$. Log sample weight [5-B] and volume of 0 01 M $CaCl_2$ [5-C].

5.4.1 pH Measurements

1. After the final stirring, allow the suspension to settle for at least 1 minute. Place the pH electrode in the supernatant of the soil suspension.

   For mineral soils, the reference junction should be below the solution surface and above the soil-solution interface.

   Some organic soils swell upon wetting, so there is no free water available As long as the reference junction is below the surface of the organic material, an acceptable, repeatable reading generally is attained. When the reading is stable, record pH to the nearest 0.01 pH unit.

2. Report the pH of the soil DI water suspension, [4-D] and the soil.0.01 M $CaCl_2$ suspension [5-D], for each sample.

3. After measurements are completed, store the electrode in 0 1 M KCl storage solution. Do not let the sensing element and reference junction dry out. The level of the storage solution should be one inch below the filling solution level to prevent influx of the storage solution. Check periodically that the electrode reservoir is full of filling solution.

5.5 Calculations

No calculations are required to obtain pH values. Replicate measurements of the same sample or of duplicate samples should not be averaged.

6.0 QUALITY CONTROLS

Log all quality control (QC) data on appropriate form (Attachments 10 3 and 10 4).

Reagent Blanks--Analyze one blank of each suspension solution. The blank used for each pH method is the reagent used: DI water or 0.01 M $CaCl_2$ The measured pH of each blank should fall between 4.5 and 7 5 pH units

Replicates--One sample from each batch of ten samples should be analyzed in triplicate for pH in each of the DI water and 0 01 M $CaCl_2$ solutions. The standard deviation for each set of three replicates should be 0 10 pH units or less If fewer than ten samples are run in one day, then one sample processed that day should be analyzed in triplicate

Quality Control Check Sample (QCCS)--A pH 7.00 standard from a different preparation source or lot number than that used for the calibration is used as the QCCS. Analyze a QCCS before beginning analysis of routine samples, at specified intervals thereafter, e.g., after every ten samples and after completion of routine sample analysis for the day. Measured values of each QCCS should be 7 00 ± 0.05. If the QCCS does not meet this criterion, recalibrate the electrode and repeat the QCCS measurement using a fresh QCCS. If acceptable results still cannot be obtained· check electrode for clean reference junction, check wiring straps into meter, check for static electricity, and check to see if enough filling solution is contained within the electrode. If a problem still persists, replace electrode or meter, or both.

QC Audit Sample (QCAS)–The QCAS (provided by the quality assurance [QA] manager) should fall within the ± 0.05 unit accuracy window

7.0 ENVIRONMENT, SAFETY AND HEALTH

Wear protective clothing (laboratory coat and gloves) and safety glasses when preparing reagents, especially when concentrated acids and bases are used The use of concentrated acids should be restricted to a fume hood. Always add acid to water.

8 0 RECORDS

The following documents will be maintained as Quality Records.

- Field logbook
- "Parameter - pH_H_2O, pH in water" form
- "Parameter - pH_01M, pH in 0.01M Calcium Chloride" form
- "Parameter - pH_H_2O, pH in water" QC form
- "Parameter - pH_01M, pH in 0 01M Calcium Chloride" QC form

9 0 REFERENCES

American Society for Testing and Materials. 1984. *Annual Book of ASTM Standards Vol. 11 01, Standard Specification for Reagent Water,* D-1193-77 (reapproved 1983). ASTM, Philadelphia, Pennsylvania.

Orion Research Incorporated. 1983 *Institutional Manual - Model 611 pH/millivolt meter.* Orion, Cambridge Massachusetts.

U S Department of Agriculture/Soil Conservation Service. 1984. *Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples* Soil Survey Investigations Report No. 1, U S. Department of Agriculture, U S Government Printing Office, Washington, D.C.

10 0 ATTACHMENTS

Attachment 10 1 "Parameter - pH_H2O, pH in water" form

Attachment 10 2 "Parameter - pH_01M, pH in 0 01M Calcium Chloride" form

Attachment 10 3 "Parameter - pH_H2O, pH in water" QC form

Attachment 10 4 "Parameter - pH_01M, pH in 0 01M Calcium Chloride" QC form

AWC

Parameter - PH _ H_20
pH in Water

Batch # ____________
Lab Code ____________

Submission # ________
Orig Analysis ________
Re-Analysis ________
Re-Submission ________
Operator Initials ________

Date Analysis Started ___/___/___
Date Analysis Completed ___/___/___
Date Form Completed ___/___/___
Lab Manager Initials ____

A Samp #	B Sample Weight (g) XX.X	C Solution Volume (mL) XX.X	D Result (pH) X.XX
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
RBLK1	XXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXX	

AWC

Parameter - PH _01M
pH in 0 01M Calcium Chloride

Batch # ____________
Lab Code ____________

Submission # ________
Run # ____________
Re-Analysis ________
Operator Initials ________

Date Analysis Started ___/___/___
Date Analysis Completed ___/___/___
Date Form Completed ___/___/___
Lab Manager Initials ____

A Samp #	B Sample Weight (g) XX X	C Solution Volume (mL) XX X	D Result (pH) X.XX
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
RBLK1	XXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXX	

AWC

Parameter - PH _ H_2O
pH in Water

Batch # ______________
Lab Code ______________

Submission # ________
Run # ______________
Re-Analysis __________
Operator Initials ________

Date Analysis Started ___/___/___
Date Analysis Completed ___/___/___
Date Form Completed ___/___/___
Lab Manager Initials ____

REPLICATES				
A Samp # Used XX	B Sample Wt. (g) XX.X	C Solution Vol. (mL) XX.X	D Result (pH) X.XX	E SD XXX.XX

QCCS	(pH) X.XX
True	
High	
Low	
QCCS 1	
QCCS 2	
QCCS 3	
QCCS 4	
QCCS 5	
QCCS 6	
QCCS 7	
QCCS 8	

AWC

Parameter - PH _ 01M
pH in 0 01M Calcium Chloride

Batch # ____________
Lab Code ____________

Submission # ________
Run # ____________
Re-Analysis ________
Operator Initials ________

Date Analysis Started ___/___/___
Date Analysis Completed ___/___/___
Date Form Completed ___/___/___
Lab Manager Initials ___

REPLICATES				
A Samp # Used XX	B Sample Wt (g) XX.X	C Solution Vol (mL) XX.X	D Result (pH) X.XX	E SD XXX.XX

QCCS	(pH) X.XX
True	
High	
Low	
QCCS 1	
QCCS 2	
QCCS 3	
QCCS 4	
QCCS 5	
QCCS 6	
QCCS 7	
QCCS 8	

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ANALYTICAL PROCEDURES
AIR - DRY MOISTURE DETERMINATION

Approvals

Terry Wenstrand	5/2/91	Gregory Eadie	5/2/91
Project Manager	Date	Radiation Safety Officer	Date
Gregory Eadie	5/2/91	Gregory Eadie	5/2/91
QA Manager	Date	ES&H Coordinator	Date

1 0 PURPOSE AND SCOPE

The purpose of this analytical procedure (AP) is to instruct laboratory personnel in the methods used for determining the moisture content of soil samples

2.0 APPLICABILITY

This AP applies to laboratory personnel involved in soil analysis activities in which the moisture content of soil samples must be determined

Air-dry moisture determination is accomplished at the analytical laboratory. The procedure for assessing air-dry moisture is not to be performed, however, until the soil is believed to be air dry (see section 5 4) Initially, the process is used to ensure that each sample is at an acceptable moisture level for further processing, after which, the air-dry moisture is determined on all samples to convert all results to an oven-dry basis, and if specified in a procedure, to calculate the weight of sample equivalent to a given weight of oven-dry soil (Brady, 1974).

A subsample of the air-dried bulk soil sample is weighed, oven-dried for approximately 24 hours, and reweighed. The initial and final weights are used to calculate a percent weight loss.

3.0 DEFINITIONS

4 0 RESPONSIBILITIES

The laboratory supervisor is responsible for assuring that all personnel assigned a task related to this AP are familiar with this AP, that they have been trained in the AP, and that they have a controlled copy of this AP

All laboratory personnel are responsible for following this AP

5 0 PROCEDURE

Interferences

Sample weights can be affected by salts, oils, and moisture present on skin. Losses of fine silt and clay, caused by excessive movement of the samples, will cause erroneously calculated moisture values

CAUTION. If a sample is suspected to contain radionuclides, workers must wear impermeable rubber gloves when handling the sample

5 1 Sample Collection, Preservation, and Storage and Aliquot Preparation

A subsample is taken from the bulk soil sample after it is believed to be fully air-dried. Analysis takes place immediately thereafter; no preservation or storage is required

5 2 Equipment and Supplies

5 2.1 Apparatus

1. Balance, capable of weighing to 0 01 g
2. Drying or Convection oven
3. Desiccator oven
4. Forceps or impermeable rubber gloves.
5. Thermometer, 0° C to 200° C range
6. Weighing containers capable of withstanding intermittent heating to 110°C and cooling to room temperature
7. Balance calibration weights, 3-5 weights covering expected range.

5 2.2 Consumable Materials

1. Aluminum weighing dishes, pre-numbered

2. Aluminum weighing pans, disposable

3 Gloves, powdered

4. Air-dry moisture raw data forms (Attachment 10.2) and air-dry moisture log book

5 Form 1, air-dry moisture percent, and form QC-1 (Attachment 10 3 and 10.4, respectively)

5 3 Calibration and Standardization

The standardization of the balance is described in AP 1, General Laboratory Procedures. The thermometers should be checked monthly against an NBS traceable standard thermometer to ensure that they are measuring temperature accurately The oven should be monitored to ensure that temperature fluctuation does not exceed ± 10° C

5 4 Sample Drying

1. Label a bulk sample processing raw data form (see Attachment 10.1) for each sample to be air dried

2. Place two fresh sheets of kraft paper, approximately 1m x 1m in area, on the mesh partition of the drying table With gloved hands, slowly spread the sample on top of the sheets of paper, taking care not to lose any soil off the paper or contaminate any adjacent samples

CAUTION Any sample suspected to contain radionuclides must be processed in an approved, ventilated area such as a fume hood

NOTE In some cases, samples may be received from the field in more than one sample container (bag) Combine the contents of all containers comprising a single sample

3. Desegregate any large aggregates that impede the spreading of the sample over the entire area of the paper Place an additional sheet of kraft paper loosely over the sample

4. Identify the sample by attaching the sample's processing raw data form to a hook attached to the drying table or other mechanism The original canvas and plastic sampling bags should be kept on the floor beneath the sample as a second check on sample identity.

NOTE· Immediately after a sample is spread to dry, field-moist pH is determined (see AP 4).

5 Daily, stir the soil sample to facilitate drying

6 For the first few days that a wet sample is spread, the bottom sheet of paper may need to be changed daily in order to alleviate excessive moisture accumulation. Any observation of fungal or algal growth should be noted on the bulk sample processing raw data form.

NOTE Soils high in clay may harden nearly irreversibly if allowed to dry without a preliminary disaggregation of medium and coarse pedons. An effort should be made during the air-drying procedure to desegregate these pedons by physical manipulation with gloved hands while still somewhat moist or friable, before reaching an air-dry state

7. Allow the sample to air dry until it is believed to be at or below the specified moisture content. This process generally takes about two days, although drying time may vary from one day to a week or more.

8 Subsample an aliquot for the air-dry moisture determination

5 5 Laboratory

NOTE· Data for this procedure are recorded on the air-dry moisture raw data form (see Attachment 10 2) Once a soil sample is determined to be air dry, the information is also entered on the bulk sample processing raw data form (Attachment 10 1).

1. Thoroughly mix the air-dry sample. Transfer a subsample of approximately 15 g into a pre-numbered aluminum weighing dish of known weight. Enter the dish number on the air-dry moisture raw data form under "TIN_NO." Carefully handle the weighing dish by its edges or with forceps If the sample is suspected to contain radionuclides wear impermeable rubber gloves when handling the dish directly

NOTE: Because the aluminum weighing dishes or equivalent are manufactured to be a nearly constant weight, the average weight of ten labeled aluminum weighing dishes may be used

2. Weigh the dish plus sample to the nearest 0 01 g and record this initial weight under "INIT_WT." Place the dish in a convection oven which has equilibrated at 105° C for mineral samples or 60° C for organic samples. Allow the sample to oven dry overnight at this temperature

3 The following morning, remove the sample from the oven and allow to cool for 30 minutes in desiccator Weigh the dish plus sample to the nearest 0 01 g and record this oven dry weight under "OD_WT."

NOTE Data for this procedure are recorded on form 1 oven dried moisture percent (Attachment 10 3) Figures within the square brackets, [ ], represent the form number and column in which the data are recorded

4 Remove weighing pan from oven, allow soil to cool in a desiccator Weigh each sample to ± 0 01 g and record oven-dry weight [1-C]

5 6 Calculations

The following calculations may be performed by computer It is advantageous to manually check a few samples using these calculations to understand the procedure and to test the accuracy of the computer program.

$$\textit{PERCENT AIR-DRY MOISTURE (MOIST P)} = \frac{\textit{INIT WT} - \textit{OD WT}}{\textit{OD WT} - \textit{TIN WT}} \times 100$$

If the calculated moisture content is above 2.5 percent for mineral soils or above 6 0 percent for organic soils, allow the bulk sample to continue air-drying and repeat the procedure at a later time However, if the sample is below the cutoff percent moisture content for the soil type, then the air-dry sample may be rebagged and placed in cold storage or it may immediately undergo the next stage of processing

NOTE Designations within the square brackets, [], represent the form number and column in which the data are recorded on Form 1 (Attachment 10.3).

Percent moisture = ([Air-dry wt. - Oven-dry wt.] ÷ Oven-dry wt.) x 100

OR

MOIST [1-D] = ([1-B] - [1-C]) ÷ [1-C] x 100

6 0 QUALITY CONTROLS

NOTE Analytical laboratory quality control (QC) results are recorded on Form QC-1 (Attachment 10 4)

Replicates--One sample from each batch of ten samples or less per day should be analyzed in duplicate The percent relative percent difference (%RPD) should be 15 percent or less

QC Audit Sample (QCAS)--The QCAS should fall within the accuracy window provided by the quality assurance (QA) manager

7.0 ENVIRONMENT, HEALTH AND SAFETY

Forceps or heat-resistant gloves should be used to handle weighing dishes after removal from the oven. If samples are suspected to contain radionuclides impermeable rubber gloves must be worn when directly handling the weighing dishes

8.0 RECORDS

The following documents will be maintained as Quality Assurance records.

- Bulk sample raw data
- Soil sample air dry determination
- Parameter moist air dry moisture percent
- QC Form parameter moist air dry moisture percent

- Field logbook
- "Bulk Sample Raw Data" form
- "Soil Sample Air Dry Determination" form
- "Parameter-Moist, Air Dry Moisture Percent" form
- "Parameter-Moist, Air Dry Moisture Percent" form

9 0 REFERENCES

Brady, N C (ed) 1974 The Nature and Property of Soils Eighth Edition MacMillan Publishing Co , Inc , New York, New York

10.0 ATTACHMENTS

Attachment 10 1 "Bulk Sample Raw Data" form
Attachment 10 2 "Soil Sample Air Dry Determination" form
Attachment 10 3 "Parameter-Moist, Air Dry Moisture Percent" form
Attachment 10 4 "Parameter-Moist, Air Dry Moisture Percent" QC form

AWC

BULK SAMPLE RAW DATA

SAMPLE ID: ______________________ DATE SAMPLED: ___/___/___

SITE ID ______________________ DATE RECEIVED ___/___/___

SET ID ______________________ PROCESS START ___/___/___

BATCH ID ______________________ PROCESS COMPLETE ___/___/___

SOIL TYPE M / O FIELD pH __________

Initials __________ Initials __________

AIR SAMPLE DRYING

Date	% Moisture	Initials
___/___	______	______
___/___	______	______
___/___	______	______

TOTAL BULK WT

Date: ___/___/___ ______ ______ g Initials ______

ROCK FRAGMENT WT

2 TO 4 75 mm. ______ ______ g 4 75 to 20 mm: ______ ______ g

Date: ___/___/___ Initials ________

ENTERED IN COMPUTER. Date ___/___/___ Initials. ________

COMMENTS

______________________ ______________

Supervisor Date

ANALYTICAL PROCEDURES
AIR - DRY MOISTURE DETERMINATION

SOIL SAMPLE AIR DRY DETERMINATION

ALL WEIGHTS REPORTED TO 0.01 GRAMS

SAMPLE CODE	TIN NO	TIN WT	AIR DRY (TIN+SOIL)	OVEN DRY (TIN+SOIL)	DATE	ID	COMMENTS	OPERATOR INITIALS	DATE

ANALYTICAL PROCEDURES
AIR - DRY MOISTURE DETERMINATION

Parameter - Moist
Air Dry Moisture Percent

Batch # ______
Lab Code ______

Batch # ______
Submission # ______
Run # ______
Re-Analysis ______
Operator Initials ______

Lab Code ______
Date Analysis Started ___/___/___
Date Analysis Completed ___/___/___
Date Form Completed ___/___/___
Lab Supervisor Initials ______

A Samp #	B Air Dried Sample Wt. (g) XX.XX	C Oven Dried Sample Wt (g) XX.XX	D Calculated Result (%) XX.XX
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

AWC

Parameter - Moist
Air Dry Moisture Percent

Batch # ______________
Lab Code ______________

Batch # ______________
Submission # __________
Run # ______________
Re-Analysis __________
Operator Initials __________

Lab Code ______________
Date Analysis Started ___/___/___
Date Analysis Completed ___/___/___
Date Form Completed ___/___/___
Lab Supervisor Initials ____

REPLICATES				
A Samp #	B Air Dried Sample Wt. (g) XX.XX	C Oven Dried Sample Wt (g) XX.XX	D Calculated Result (%) XX.XX	E SD or %RSD XXX.XX

OPERATION AND MAINTENANCE MANUAL

PEM CROSSFIELD HIGH GRADIENT

MAGNETIC SEPARATOR

1" DIAMETER CANISTER

TABLE OF CONTENTS

SECTION

SECTION 1. GENERAL INSTALLATION

ELECTRICAL POWER

The crossfield magnetic separator is close-coupled to a 20KW, 40VDC, 450amp direct current regulated power supply. This power supply requires an electrical input of 480VAC, 3 phase, 3W, 60HZ, and a grounding conductor. The electrical power should be supplied from a nearby wall-mounted circuit breaker - minimum 50amp. The electrical input and gounding terminals are located on the back of the power supply. (Note: The electrical installation and grounding must be performed in accordance with the National Electric Code and all other pertinent codes.)

* For additional power supply information, see the EMHP power supply service manual. Model No. 40-450-41214-0683.

COOLING SYSTEM

The magnet open loop cooling system requires approximately 10-15 gpm of water at 65 degrees F. with an unfouled pressure loss of 10 psi. One inch NPT connections have been provided on the open loop manifolds for field installation.

SECTION 2. START-UP INSTRUCTIONS

NOTE: The crossfield magnetic separator has been shipped without water in the closed loop cooling system.

Step 1. -- Fill the closed loop cooling system with cool, clean water, preferably de-ionized. The system holds approximately 20 gallons of water. Open the de-ionizer gate valves and tank valve.

Step 2. -- Energize the power supply feeder. **(NOTE: The 3 phase indicator lights on the front of the power supply should be 'ON')**

Step 3. -- Start the water pump. Let the water circulate for at least 30 minutes. Add water as necessary to maintain the proper operating level. The site glass on the side of the air expansion tank should always be completely filled with water.

Step 4. -- With the pump 'OFF', open the gate valve on the side of the air expansion tank and drain off the excess water, then close the valve.

Step 5. -- Start the water pump. Check the water level and inspect for system leaks before continuing. **(NOTE: Monitor the site glass regularly to insure proper system water level.)**

Step 6. -- Set the current and voltage control knobs on the power supply to their lowest (counter clock-wise) position.

Step 7. -- With the water pump operating, close the 50 amp power supply circuit breaker on the front of the power supply. The power indicator light should be on and the cooling fans should be operating. No power should be delivered to the load. The panel meters should be indicating zero volts and amperes.

Step 8. -- Depress the "START" control button on the front of the control panel. The panel meter indicator lights may be illuminated, but the meters should be indicating zero. Slowly advance the voltage control to about 1/2 the maximum setting or 20V DC. Next, slowly advance the current control to about 1/2 the maximum setting or 200 amps. Oscillating conditions may be encountered during this period, but should stabilize quickly. Finally, adjust the voltage and current controls to obtain the desired output current. (Note: The red current indicator must be illuminated to operate in the current regulated mode.)

Step 9. -- After setting the desired operating current, the power supply can be switched ON and OFF by depressing either stop or start buttons. For remote stop and start operation, refer to power supply manual for additional information.

SECTION 3. SAFETY AND MAINTENANCE INSTRUCTIONS

ELECTROMAGNET

The electromagnet consists of water cooled electrical coils and a steel magnetic return circuit. The magnet is not suitable for frequent or prolonged exposure to liquids and will not withstand acids or caustic liquids.

The coils are water-cooled and the operating temperatures of these coils must be kept to values consistent with the original factory conditions. The water fittings to the coils and manifolds should be maintained to avoid leaks. The water hoses also must not leak, and should be replaced when the rubber becomes stiff or brittle.

When the magnet is energized, a portion of the magnetic field is not contained within the steel. A stray magnetic field exists completely around the magnet and this field will exert a pull on all magnetic objects in the vicinity. Therefore, it is necessary to remove all unsecured magnetic objects near the magnet before the magnet is energized. It is also advisable for personnel to have removed wrist watches and magnetically imprinted credit cards, and other magnetically susceptible items from the items from the vicinity of the magnet before the magnet is energized. Personnel should not be permitted in the stray field, especially those who may be equipped with any type of electrical or other medical equipment.

POWER SUPPLY

The power supply should never be exposed to water, acids, or caustics, and is not suitable for frequent or prolonged exposure to airborne acids, caustics, or high moisture.

SAFETY DEVICES

The power to the magnet will automatically de-energize if the equipment overheats or if there is an inadequate flow of cooling water. The normally closed contacts of the water flow and temperature sensors are connected in series between terminals TB2-4 & 5 of the power supply. If a safety contact opens, power to the magnet will be de-energized.

POWER SUPPLY AIR INTAKE FILTER

The plastic mesh air intake filters should be inspected at intervals determined by operating and environmental conditions. For access to the filter for cleaning, remove the filter holder frame and side covers.

CAUTION: Disconnect all power to the power supply before removing any panels. The filter material may be washed with detergent, not solvent. Material which has deteriorated or cannot be adequately cleaned should be replaced. With clean, dry air, carefully blow the dust from the power supply. Delicate electronic components can be easily damaged by high pressure air. Contact with internal components may result in electrical shock from energy stored in the electrical system.

WATER TO WATER HEAT EXCHANGER

The water to water heat exchanger must be maintained in a clean (unfouled) condition on both the open loop and closed loop sides. It is also necessary to maintain the copper conductor inside diameter in a clean and unfouled condition for effective heat transfer to the cooling water. Excessive temperature on the closed loop side is detrimental to the magnet coils, insulation, and the power supply. Maintain the heat exchangers, manifolds, and pumps in a good, clean condition.

WATER DE-IONIZER

The de-ionizer must be on-line and maintained in operating order at all times. If the de-ionizer water indicating light fails to light, replace the de-ionizer bottle. The water resistance should not be allowed to drop below 200,000 ohm's per cm.

GENERAL

Electrically ground (with proper size electrical conductor) the magnet, power supply, operator's panel, and slurry control piping in accordance with the provisions of the National Electrical Code, state, county, city, and/or any other applicable codes.

Maintain all of the equipment safety devices in an operational condition.

Maintain and observe all the warning name plates on the equipment.

Periodically test the equipment safety devices.

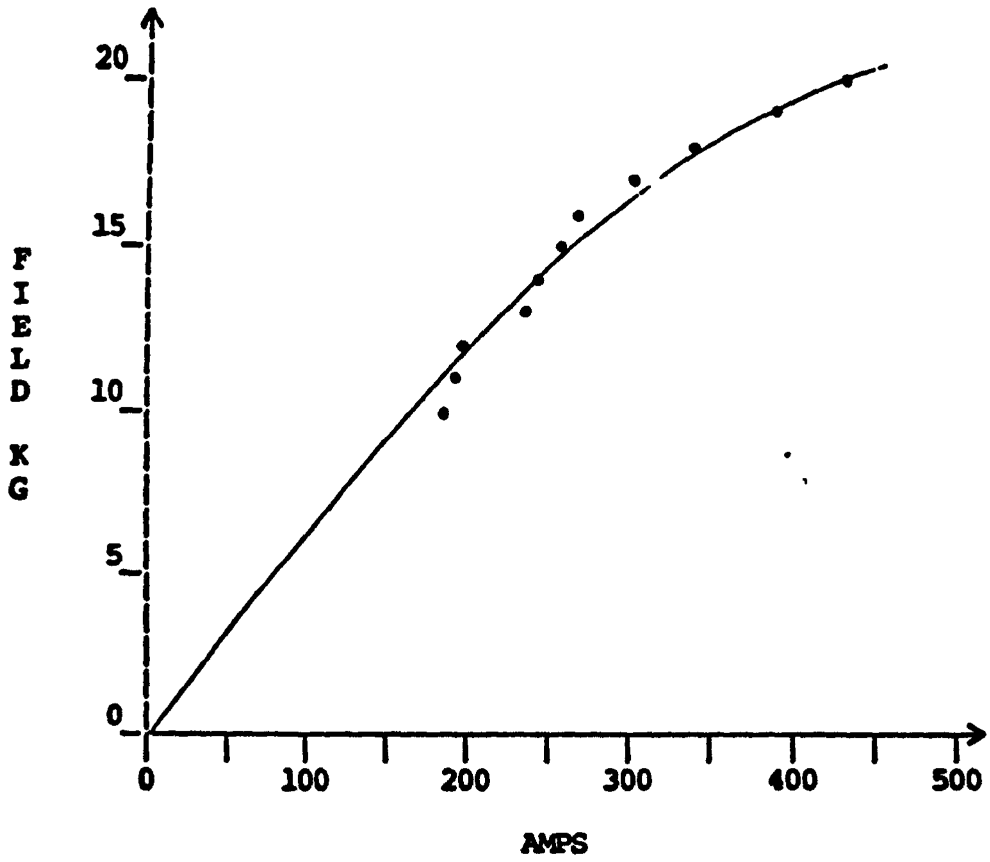
Periodically inspect for water leaks and for the proper system water level.

NOTE: ONLY PROPERLY TRAINED PERSONNEL SHOULD BE ALLOWED ACCESS TO THIS EQUIPMENT.

TYPICAL

CROSSFIELD MAGNETIC SEPARATOR TEST DATA

TEST DATA FIELD VS. AMP CURVE



FIELD (KG)	AMPS
20	436
19	373
18	332
17	301
16	274
15	255
14	236
13	218
12	200
11	182
10	165

FABRICATION			
REVISIONS		P.E.M.	DO NOT SCALE THIS PRINT SHEET____ OF____
	SCALE None		PACIFIC ELECTRIC MOTOR CO. 1009 - 66th Avenue - Oakland, California 94621 - Telephone 569-7621 Area Code 415
	DATE		
	DRAWN BY E. Drake	CROSSFIELD MAGNETIC SEPARATOR	DRAWING NO. N/A

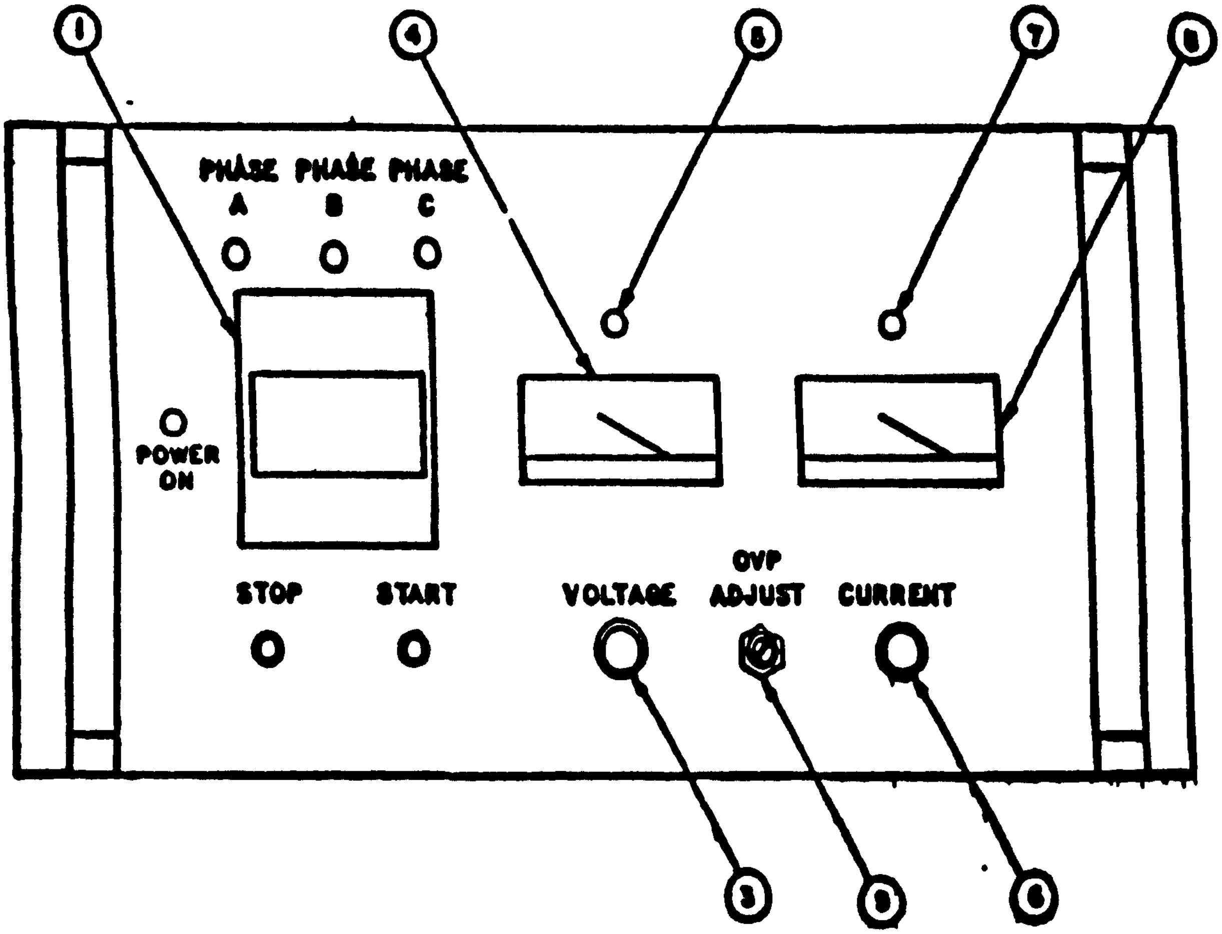
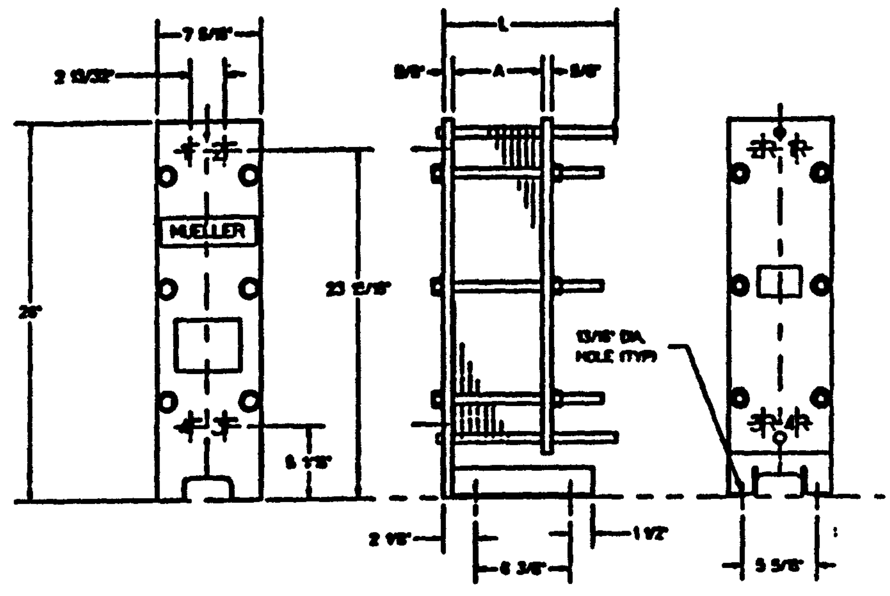


FIGURE A

The front panel surface contains all the controls and indicators necessary to operate the supply in its normal mode. (see Figure A).

(1) on/off switch
(3) voltage control
(4) DC voltmeter
(5) voltage indicator
(6) current control
(7) current indicator
(8) DC ammeter
(9) over voltage adjustment

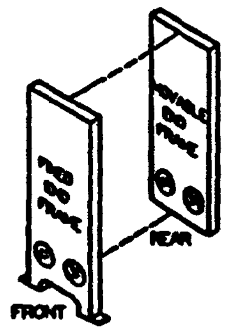
DWG NO. GH02633



FRONT VIEW SIDE VIEW REAR VIEW

A= 1.19" MAX. / 1.18" MIN. FOR 11 PLATES

L= 11.62"



PORT CONFIGURATION

CONNECTION ARRANGEMENT					
CONNECTIONS	TYPE	MATERIAL	SIZE	PORT	MEDIA
HOT IN	TOE PIPE	316 S/S	100	4F	WATER
HOT OUT	TOE PIPE	316 S/S	100	4R	WATER
COLD IN	TOE PIPE	316 S/S	100	3R	WATER
COLD OUT	TOE PIPE	316 S/S	100	3F	WATER

PART NUMBER	DESCRIPTION	QUANTITY PER
9813104	FRAME ASSY PHE AT 4 C-20	1
9808104	SHROUD ASSY PHE AT 4C 18GA 304 S/S	1
9807128	PLATE DATA PHE MUELLER SILVER MATTE W/BLUE COPY	1
9806683	PORT ASSY PHE 100 NP AT4 C/S W/1.0" THK FRAME	4
9808332	BOLT ASSY PHE .625"X 5" LG ZNC PL	6
9813476	PLATES .5MM PHE AT4F 316 S/S PUNCHED	3
9813475	PLATES .5MM PHE AT4F 316 S/S UNPUNCHED	3
9813552	PLATES .5MM PHE AT4G 316 S/S PUNCHED	5
9813100	GASKET HX PHE NBR AT 4P WV	12

DESIGN SPECIFICATIONS		
SPECIFICATION NUMBER	7496-0101	
ASME CODE STAMP	NO	
DESIGN PRESSURE PSIG	100	
DESIGN TEMPERATURE °F	150	
TEST PRESSURE PSIG	130	
PLATE TYPE/MATERIAL	4 FG / 316 S/S	
GASKET TYPE/MATERIAL	NBR	
PASSES HOT/COLD	2 / 2	
SPACES HOT/COLD	5 / 5	
BOLT LENGTH/CAPACITY	5.00" / 20	
GUIDE LENGTH/CAPACITY	18.00" / 73	
WEIGHT EMPTY LBS	88	
WEIGHT OPERATING LBS	91	
MEDIA HOT/COLD	WATER	WATER
VOLUME FLOW RATE GPM	5.0	5.0
TEMPERATURE IN °F	90.0	62.5
TEMPERATURE OUT °F	70.0	82.5
PRESSURE DROP PSI	9.5	9.6
COMMENTS		

STANDARD CONSTRUCTION MATERIALS	
END FRAMES	SA-516 OR SA-515-70
PLATE HANGER	304 S/S
COMPRESSION BOLTS (ZINC PLATED)	SA-193-B7
COMPRESSION NUTS (ZINC PLATED)	SA-194-2H
PAINT	POLYURETHANE
SHROUD (OPTIONAL)	18 GA. 304 S/S

REFER TO THE FOLLOWING DRAWINGS FOR ADDITIONAL DETAILS

DRAWING NUMBER	TITLE

SOLD TO WAGNER EQUIPMENT
ADDRESS OAKLAND CA
CUSTOMER ORDER NO 0120124
CUSTOMER REFERENCE NO. N/A
QUANTITY 1
ENTERED BY M. PARRISH DATE 01/24/89
APPROVED BY D. GARNER DATE 01/26/89

SYM	REVISIONS	BY	DATE

PAUL MUELLER COMPANY

MODEL AT4 C-20

SALES ORDER NO.

DRAWING NO. GH02633 B

PEM PACIFIC ELECTRIC MOTOR CO.
1009 - 66th AVENUE • OAKLAND, CALIFORNIA 94621

SECTION 6. PARTS LIST

SPARE PARTS

1. Water Flow Switch
   Shure Flo Model #2600-1911
   Manufacturer: Hays Company

2. Temperature Switch
   Klixon Model
   Manufacturer: Texas Instruments

3. Water Pump
   Price Pump 3/4 HP 50 psi

4. Heat Exchange
   Paul Mueller Plate and Frame

5. Power Supply
   EMHP (Modified by PEM)